

ABSTRACT

A study has been made of flow characteristics and mass transfer in vertical slug flow under unstable flow conditions. The systems studied were the absorption of hexane from different carrier gases, nitrogen, helium and Freon-14, into light and heavy paraffin oils.

Under all conditions flow patterns were found to be complex and affected by mass transfer. In the absence of mass transfer a characteristic chain like flow pattern was observed, which was generally broken when mass transfer from the gas phase to the liquid phase took place. Under these latter conditions bullet shaped slugs were formed which tended to coalesce as they rose up the absorber tube. The nose radius r_0 of these slugs was found to be a function of tube diameter D_p and the liquid flow thickness δ_0 . Due to coalescence, which depended on the separation distances between slugs, frequencies, surface areas and volumes were influenced by slug position and absorber length as well as system and operating variables. The ratio of the mean slug surface area and slug volume was correlated in terms of the system and operating variables. Slug rise velocities were correlated by an equation having the form $U_s = 1.2 U_L + C_0 (g D_p)^{\frac{1}{2}}$ where C_0 was a function of fluid flow rates, system properties and absorber geometry.

Absorption efficiencies E_{OT} ranged from 0.79 to 0.99 and were a function of operating and system variables as well as absorber geometries. End effect mass transfer was found to

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account for a considerable portion of mass transfer taking place, depending mainly on fluid rates, system properties and absorber diameter. Plots of E_{OT} versus absorber length or contact time exhibited a distinct discontinuity with the heavy paraffin oil. This discontinuity was found to be related to the minimum observed in the slug frequency measurement. The variation of slug size with absorber length H resulted in the increase and decrease of mass transfer coefficient $K_{OG}A_e$ with H for H less and greater than about 25 cm respectively. Overall mass transfer rates were primarily compared in terms of the point $K_{OG}a$ and $\overline{K_{OG}a}$ where a and $\bar{a}$ were the fractions of slug surface area effective to mass transfer. Both $K_{OG}a$ and $\overline{K_{OG}a}$ increased with increase in gas flow rate, absorber diameter and inlet gas phase concentration but generally decreased with increase in liquid flow rate. The increase in liquid flow rate was found to generally decrease slug separation distances and hence liquid mixing between slugs which resulted in a great reduction of mass transfer rates. Slug coalescence on the other hand slightly increased mass transfer rates.

A comparison was made with the experimental $\overline{K_{OG}a}$ and theoretical K_{OG} evaluated on the basis of two resistance and penetration theories. Approximate values of $\bar{a}$ were also calculated. The results indicated that the frontal area could be the most effective mass transfer area of the slug. The dependence of $\overline{K_{OG}a}$ on primary variables namely : gas and liquid phase diffusivities was also analysed. The mass transfer coefficients $\overline{K_{OG}a}$ were compared with K_{OG} , k_G and k_L values

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reported for mass transfer in single bubbles and in froths and foams. From the results obtained it was concluded that the contacting conditions in slug flow were more representative of contacting conditions in froths and foams than have been found with single bubbles studies.

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NOMENCLATURE

$\bar{a}$	: mean slug effective mass transfer area (cm^2/cm^2)
a	: slug effective mass transfer area (cm^2/cm^2)
a'	: interfacial area per unit volume in a froth and foam (cm^2/cm^3)
a^0	: constant defined in equation (V-49)
a_v	: constant defined in equation (V-43)
a_1-a_6	: constants defined in equation (4-5)
a_e	: slug frontal area/total surface area (cm^2/cm^2)
$\bar{A}_S$	: mean slug surface area (cm^2)
A_S	: slug surface area (cm^2)
A_p	: cross sectional area of the absorber (cm^2)
A_e	: effective mass transfer area (cm^2)
A_a	: slug frontal surface area (cm^2)
A_b	: slug bottom surface area (cm^2)
A_f	: slug upper surface area, (A_S-A_b) (cm^2)
A_r	: surface area of slug frontal spherical segment (cm^2)
A_c	: surface area of slug cylindrical body (cm^2)
A_j	: constant defined in equation (III-36)
AA_j	: constant defined in equation (III-41)
b_0-b_2	: constants defined in equation (V-52)
B_j	: constant defined in equation (III-36)
b_v	: constant defined in equation (V-43)
C_0, C_1	: constants defined in equation (VI-4)
D_g	: gas phase diffusivity (cm^2/sec)
D_L	: liquid phase diffusivity (cm^2/sec)

D_E	: $\cancel{W}D_g$ (cm^2/sec)
D_p	: absorber diameter (cm)
D_b	: bubble diameter (cm)
d_0-d_2	: constants defined in equation (V-41)
E_O	: Eötvös number ($g_c \rho_L R^2 / \sigma$)
E_{OT}	: overall mass transfer efficiency
E	: mass transfer efficiency
E_E	: end effect mass transfer efficiency
E_F	: formation mass transfer efficiency
E_C	: slug collapse mass transfer efficiency
E_Z	: rise period mass transfer efficiency
$\bar{F}$	: mean slug frequency (slugs/sec)
F	: slug frequency (slugs/sec)
F_1	: slug frequency at location Z_1 (slugs/sec)
F_2	: slug frequency at location Z_2 (slugs/sec)
F_O	: slug frequency at $Z \approx 5$ cm (slugs/sec)
G	: gas flow rate (cc/min)
G_s	: gas flow rate (cc/sec)
G_m	: molal gas flow rate (g-mole/sec)
g	: acceleration constant (cm/sec^2)
H	: absorber length (cm)
H_g	: gas hold up in plate columns
h_o	: formation bubble length (cm)
J_i	: Bessel function
k	: Boltzmann's constant
k_o	: constant defined in equation (V-49)
k_L'	: liquid phase mass transfer coefficient (cm/sec)

k_L	: liquid phase mass transfer coefficient (g-mole/sec cm ² atm)
k_G	: gas phase mass transfer coefficient (g-mole/cm ² sec atm)
K_{OG}	: overall mass transfer coefficient (g-mole/cm ² sec atm)
$\overline{K_{OG}^{Ae}}$	: mean overall mass transfer coefficient (g-mole/sec atm)
K_{OG}^{Ae}	: point overall mass transfer coefficient (g-mole/sec atm)
$\overline{K_{OG}^a}$	: mean overall mass transfer coefficient (g-mole/cm ² sec atm)
K_{OG}^a	: point overall mass transfer coefficient (g-mole/cm ² sec atm)
$(K_{OG})_r$	: average overall mass transfer coefficient for slug frontal spherical segment (g-mole/cm ² sec atm)
$(K_{OG})_c$	: average overall mass transfer coefficient for slug cylindrical body (g-mole/cm ² sec atm)
$\widetilde{K_{OG}^a}$	: $\overline{K_{OG}^a}$ corrected for the effects of changes in U_i and $\overline{L_s}$ (g-mole/cm ² sec atm)
$\overline{K_{OG}^a}^*$	: overall mass transfer coefficient defined in equation (V-57)
L_s	: slug length (cm)
$\overline{L_s}$	: mean slug length (cm)
L_p	: slug separation distance (cm)
l	: vertical distance from slug head (cm)
m	: slope of equilibrium line
$\overline{n}$	: number of slug measured
n	: number of slugs in the absorber
n_f	: number of location at which F was measured
NTU	: number of mass transfer unit in rise zone
P_H	: hexane vapor pressure at saturator temperature
P	: atmospheric pressure (atm)

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P_s	: saturator pressure mm of Hg
ΔP_T	: total pressure drop over the absorber (inch of cm of merian oil)
ΔP_w	: pressure drop due to wall friction (cm of merian oil)
ΔP_g	: pressure drop due to weight of contents in absorber (cm of merian oil)
Q_L	: liquid flow rate (cc/min)
q_1-q_3	: functions defined by equation (II-6)
OR	: gas constant (atm cm ³ /g-mole ^{°K})
R_c	: $R - \delta_o$ (cm)
R	: absorber radius (cm)
r_o	: spherical slug nose radius (cm)
r_i	: slug radius (cm)
r_d	: constant slug radius (cm)
R_i	: radius (cm)
R_v	: G/Q_L
S_I	: length of interface (cm)
S	: distance (cm)
t_c	: contact time between liquid elements and interface (sec)
t_L	: liquid residence time with no back flow (sec)
t	: contact time (sec)
U_o	: slug rise velocity in stagnant liquid (cm/sec)
U_s	: slug rise velocity in two phase flow (cm/sec)
U_L	: total superficial fluid velocity (cm/sec)
U_g	: superficial gas flow velocity (cm/sec)
U_g'	: superficial velocity based on bubbling area (ft/sec)

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U_I	: interfacial velocity with respect to tube wall (cm/sec)
U_i	: interfacial velocity with respect to slug (cm/sec)
$\bar{U}_S$	: mean slug rise velocity ($G_S/\alpha A_P$) (cm/sec)
U_F	: liquid film velocity with respect to tube wall (cm/sec)
$\langle U_F \rangle$	: average liquid film velocity with respect to tube wall (cm/sec)
U_{Ri}	: liquid film velocity with respect to slug (cm/sec)
V_S	: slug volume (cm ³)
$\bar{V}_S$	: mean slug volume (cm ³)
ΔV_L	: liquid volume trapped in the absorber (cm ³)
V_b	: volume of the absorber (cm ³)
W	: length of the developing region (cm)
$\bar{W}$	: enhancement factor for D_G
x	: liquid phase hexane composition (m.f.)
x_i	: interfacial liquid phase hexane composition (m.f.)
y_{on}	: inlet gas phase composition of hexane (m.f.)
y_{off}	: outlet gas phase composition of hexane (m.f.)
y_1, y_2	: gas phase compositions of hexane in rise zone (m.f.)
y^*	: mole fraction of hexane in equilibrium with liquid phase (m.f.)
y_{off}^*	: mole fraction of hexane in equilibrium with outlet liquid phase (m.f.)
z	: slug position (cm)
z_D	: dimensionless vertical distance (lg/U_S^2)

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Greek

α : gas phase void fraction
 β : $(r_i/R)^2$
 γ : holdup ratio of liquid
 δ : liquid film thickness (cm)
 δ_o : equilibrium liquid film thickness (cm)
 δ_d : diffusion depth (cm)
 ζ : r_o/R_c
 η : R_i/R
 θ_z : contact time in rise zone (sec)
 λ_j : roots of auxiliary equation (III-40)
 μ_L : liquid phase viscosity (cm²/sec)
 μ_g : gas phase viscosity (cm²/sec)
 ξ : δ/R
 ξ_o : δ_o/R
 ρ_L : liquid phase density (g/cc)
 ρ_g : gas phase density (g/cc)
 ρ_g' : gas phase density (lb/ft³)
 σ : surface tension (dynes/cm)
 ϕ : parameter defined in equation (III-21)
 ψ : functional dependence , equation (II-6)
 Ψ : roots of auxiliary equation (III-35)

I. INTRODUCTION

In vertical two phase flow, a number of flow patterns have been observed. These patterns ranged from discrete bubbles rising up a tube to slug flow then to annular and mist flow depending primarily on tube diameter and fluid flow rates. Slug flow which is characterized by the consecutive passage of bullet -shaped gas bubbles and liquid plugs has been the subject of numerous investigations (1-9). These studies have been primarily concerned with the prediction of pressure drops and correlation of slug rise velocities. On the other hand, the mass transfer aspects of the slug flow (10-13) have not been widely studied and have dealt solely with the liquid phase controlled mass transfer.

In vertical slug flow, the flow condition in which the slugs are surrounded by thin liquid films can be considered to be more characteristic of conditions existing in a froth or foam than those found in single bubble studies. The problem of experimentally simulating mass transfer conditions in a froth or foam is not easy and every experimental technique has had its own limitations. In the past, because of the importance in industrial applications, extensive studies of gas and liquid phase controlled mass transfer behaviour in foams and froths had been made using pilot plant sized equipment. These studies have been frequently complicated by the interaction of system variables, design variables and operating variables which have sometimes led to conflicting results (14-19) eg., in some pilot plant studies on a single

tray, mass transfer taking place at formation has been reported to account for about 40-60 per cent of the total mass transfer taking place (16,18) while in other studies (15,19), no end effect was observed.

In order to simplify and reduce the effects of design variables, mass transfer studies have been carried out in laboratory sized equipment, such as wetted wall columns and bubble columns (20-22). In a wetted wall column, though, the contacting conditions do not really resemble those existing in the plate column while in single bubble studies, formation end-effect mass transfer has been found to be high and mass transfer rates considerably greater than those in distillation columns (20,21). A few studies have been made in laboratory sized equipment which attempted to simulate the performance of a sieve plate (23-25), but high end-effect mass transfer was also observed in these studies. In an attempt to overcome some of these problems, Mah and Golding (12) carried out an investigation to see if vertical slug flow characteristics would be a useful method for studying mass transfer in a foam. Initial work was undertaken to compare the mass transfer rates in a bubble column, a slug flow absorber and under wetted wall contacting conditions. Efficiencies measured for the absorption of n-hexane from the nitrogen carrier gas into dodecane indicated that mass transfer rates in vertical slug flow were, in fact, considerably lower than those observed in either a bubble column or under wetted wall contacting conditions. The study was hampered, though, by high end effect

mass transfer taking place probably during bubble formation. Slug flow conditions were generally unstable, that is pairing and coalescence of slugs took place.

Preliminary work was at first carried out to determine whether the end-effect mass transfer which had handicapped the previous study (12) could be reduced. Two procedures were adopted, firstly the inlet section where the majority of the end-effect mass transfer took place was modified on the basis of apparatus used by Banerjee and Scott (26). Secondly more viscous liquid media were used to further restrict slug movement both during formation and while rising up the tube. The end-effect mass transfer efficiencies were appreciably reduced from 0.95 to 0.70 for the heavy paraffin oil.

The research has been divided into two distinct areas, an investigation of general slug flow characteristics and the mass transfer study. A study of flow characteristic became necessary when it was realized that the slug flow conditions were not fully developed. Consequently no correlation was available in the literature for calculations of contact time, mean frequencies and mean surface area required for evaluation of experimental mass transfer coefficients. The investigation was then undertaken to determine the effects of operating variables, tube geometries and system variables on flow characteristics, pressure drop, void fraction, slug frequencies and slug coalescence, slug shape and size, slug length and slug rise velocities.

The basic systems selected for this study were the absorption of hexane from inert carrier gases into hydrocarbon

oils. In order to vary liquid phase properties i.e. liquid viscosity and diffusivity, heavy and light paraffin oils and their mixtures were employed as the liquid solvents. Gas phase properties, density and diffusivity, were varied by using different carrier gases namely helium, nitrogen and Freon-14. This range in system properties could be expected to give varying mass transfer resistances in the gas and liquid phases. Approximate calculations using the parameters suggested by King (27,28) indicated that the percentage of gas phase resistance would vary from 72.0 to 35.0 over the range of physical properties employed.

II. PREVIOUS WORK

II-A. Characterization of Vertical Gas-Liquid Slug Flow

A-1. Introduction

In the past, studies have dealt with vertical slug flow characteristics in both stagnant liquid (1,2,4,32,33) and in two phase flow (3,5,6,9,36). The first investigation of rise velocities was made by Dumitrescu (1) on single large bubbles rising in a closed vertical tube in 1943 followed by those of Davis and Taylor (2) in 1950. Since then numerous studies (3,5,6,9,36) have been carried out on vertical two phase slug flow to investigate slug characteristics such as slug rise velocities, slug frequencies and slug size distribution. The majority of these investigations have however been confined to fully developed or stable flow when slug rise velocities and frequencies are constant.

A-2. Slug Shape and Rise Velocity

2-a. Stagnant Liquid Investigations

Dumitrescu (1), Davis and Taylor (2) studied the rise of a large gas bubble in closed vertical tube, the bubble being formed by draining water from the bottom of the tube. Both theory and experiment showed that the rise velocity of such a bubble could be correlated by an equation of the form :

$$U_o = C_o (g D_p)^{\frac{1}{2}} \quad (II-1)$$

where ; U_o = rise velocity
 g = acceleration due to gravity

D_p = tube diameter

C_o = constant

U_o was found to be independent of bubble length while for negligible surface tension and liquid viscosity effects C_o was 0.35. Dumitrescu (1) also evaluated theoretically the spherical nose radius r_o of the slug and r_o was found to be $0.75R$ where $R = D_p/2.0$. Similiar results were reported by Beek (11) and Brown (32) who measured the nose radius using photographic techniques.

For slugs rising through a stagnant liquid in an open vertical tube, Nicklin et al (5), Laird and Chisholm (4) observed that the slug rise velocities depended on slug length. This was shown to be the result of slug expansion which can be normally neglected unless slugs are longer than 12 inches. Slug shapes were found to be similiar to the Dumitrescu or Taylor bubble with a spherical nose and cylindrical tail. The rise velocity was also well predicted by equation (II-1) even though the slug was followed by an observable wake. It was then concluded that when the expansion effect was negligible U_o was the unique function of the frontal geometry of the slug (4,32).

In more viscous liquids, slug rise velocities have been found to be smaller than velocities predicted by equation (II-1) (32-34). Brown (32), White and Beardmore (33) derived two parameters to determine the relative importance of the effects of liquid viscosity μ_L and surface tension σ on U_o . It was shown that if $E_o(1-\xi_o)^2 > 5.0$ and $(\rho_L^2 g D_p^3 / \mu_L^2) > 3.0 \times 10^5$,

then these effects are negligible. ξ_0 and E_0 are δ_0/R and $\rho_L g R^2/\sigma$ respectively with δ_0 being the equilibrium liquid film thickness at the trailing end of the slug. In addition, Brown (32), in accounting for the liquid viscosity effect in the annular film around the slug, showed that if $2R\sqrt{14.5 \times \sqrt{(\rho_L^2 g / \mu_L^2)}} > 60.0$, the assumption of potential liquid flow around the slug nose region was still valid. On plotting $r_i/(R-\delta_0)$ and $l/(R-\delta_0)$ where r_i was the slug radius and l the vertical distance from the slug head, he found that in the absence of surface tension effects $r_0 = 0.75(R-\delta_0)$ and equation (II-1) was modified as

$$U_0 = 0.35\sqrt{g(D_p - 2\delta_0)} \quad (\text{II-2})$$

When both the effects of μ_L and σ were not negligible, equations (II-1) and (II-2) were not directly applicable in the predictions of slug rise velocities and C_0 in equation (II-1) was found to be less than 0.35. Goldsmith and Mason (35) while measuring the velocity profiles in the liquid slugs and viscous liquid films concluded qualitatively that U_0 decreased with increase in σ . The conclusion was further checked and confirmed experimentally by Zukoski (34). White and Beardmore (33) presented a graphical correlation of C_0 which ranged from 0.0 to 0.35 depending on the viscous, interfacial and inertial effects on the rise velocity. Using integral material and momentum balances, Street (36) also derived a general theoretical relation between the slug shape and rise velocity. The equation was complicated and could not be solved analytically without prior knowledge of slug shape.

When there was more than one slug rising up the tube, equation (II-1) has also been used under a limiting condition as reported by Griffith and Moissis (29). In these cases when the slug separation distances were greater or equal to a critical distance such that the slugs were not effected by wake. In inviscid liquids, this distance was found to be about $5.0D_p$ while less than $1.0D_p$ in viscous liquids. For smaller separation distances, Griffith and Moissis (29) found that the trailing slug was affected by the wake, distortion of the frontal surface took place and the slug accelerated. The two slugs consequently paired and in some cases slug coalescences took place. U_o was given as

$$U_o = (C_o + 2.8 e^{\frac{-L_p}{D_p}}) (g_o D_p)^{\frac{1}{2}} \quad (II-3)$$

where L_p is the separation distance between the slugs.

2-b. In Two Phase Flow

In fully developed two phase flow, investigators (3,5,9) have correlated the slug rise velocity data by the following equation

$$U_s = C_1 U_L + C_o (g_o D_p)^{\frac{1}{2}} \quad (II-4)$$

where U_L is the rise velocity of the liquid plugs or the total superficial velocity of the fluid flows. C_1 and C_o are parameters and generally appeared to be the functions of U_L and system properties.

In Griffith and Wallis's correlation (3), $C_1 = 1.0$ and $C_o = 0.35C_2$ where C_2 is the function of U_L . In Nicklin's

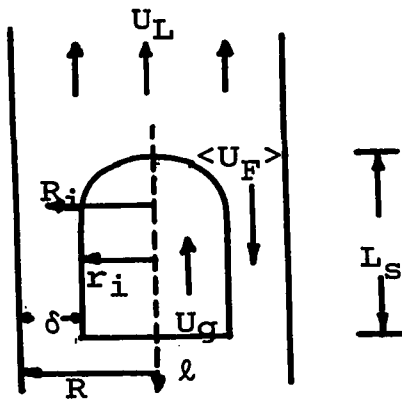
correlation (5), $C_o = 0.35$ with C_1 being the function of U_L and approached 1.2 at high liquid flow rates. Brown (9) further demonstrated analytically the dependence of C_1 and C_o on U_L in terms of the effects of μ_L and δ_o . The resulting expression for U_s was shown as

$$U_s = \frac{1}{(1 - \xi)^2} U_L + \frac{2}{3} \frac{\rho_L g R^2}{\mu_L} \frac{\xi^3}{1 - \xi} \quad (\text{II-5})$$

Where $\xi = \delta/R$ and δ is the film thickness.

Street (36) also derived theoretically a general relationship between the Reynolds number, Weber number, Froude number, slug shape and size in the fully developed slug flows. Further Akagawa and Sakaguchi (37) and Tatsnhiro Ueda (38) also presented empirical correlations similar to equation (II-4) for their fully developed slug rise velocity data.

A-3. Gas and Liquid Phase Velocity Profiles



$$U_s > U_L$$

Figure 1. Schematic diagram of a rising slug.

Street (36), in studying the slug shape and rise velocity, presented a theoretical equation for the liquid film velocity profiles around the slug through the integral mass and momentum balances :

$$U_D = \psi(\eta, z_D) = q_1 \beta \eta^2 + q_2 \beta \eta^4 + q_3 \beta \eta^6 \quad (\text{II-6})$$

where ;

$$U_D = U_{Ri}/U_s$$

$$\eta = R_i/R$$

$$z_D = \ell g_c / U_s^2$$

$$\beta = (r_i/R)^2$$

$$q_1 = \frac{\beta}{1-2\beta} \{-2 + (2-3\beta)q_3\}$$

$$q_2 = \frac{1+(3\beta^2-1)q_3}{1-2\beta}$$

$$q_3 = \frac{12\{U_s(1-2\beta) + (\beta-1/3-2/3\beta^3)\}}{-1+6\beta-6\beta^2-8\beta^3+15\beta^4-6\beta^5}$$

U_{Ri} was the velocity in the liquid film with respect to the gas slug. R_i and r_i were the tube and slug radius respectively while R_i was the radial distance from the central axis, see figure 1. ℓ was the vertical distance from the slug head.

Hence, knowing the slug shape and rise velocity, the liquid film velocity profiles at any R_i and ℓ and the interfacial velocity U_I at $R_i=r_i$ with respect to the tube wall could be calculated from equation (II-6). King (28) also evaluated the interfacial velocity in the gas-liquid flow and showed that the interfacial velocity was $(3/2)\langle U_F \rangle$ (II-7) with respect to the tube wall. In slug flows, as indicated in figure 1, $\langle U_F \rangle$ is the average velocity of the liquid film at any distance ℓ and could be simply related to U_s , U_L , slug shape and size from the material balance around the slug as :

$$\langle U_F \rangle = \frac{U_L R^2 - U_S r_i^2}{R^2 - r_i^2} \quad (\text{II-8})$$

Typical velocity profiles in the liquid film as calculated by Street from equation (II-6) are shown in figure 2. It can be seen that at the very short distance below the slug head, liquid velocities are positive with respect to the tube wall, but negative with respect to the slug. The average liquid velocity $\langle U_F \rangle$ being initially positive with respect to the tube wall decreased gradually with distance z until at a certain location $\langle U_F \rangle$ was zero. After that, a downward flow of liquid took place and velocity profiles changed gradually until the flow was fully developed. The velocity was maximum at the interface while zero at the tube wall. Further, interfacial velocities $U_i = U_L - U_S$ with respect to the slug increased with the vertical distance from slug head until the liquid film velocity profile or slug shape remain constant. Similar fully developed liquid velocity profiles were also reported by Mason and Goldsmith (35). The liquid film thickness $\delta_o = R - r_i$ at the lower part of the slug when r_i is constant has been also evaluated by Street (36) and Goldsmith (35) both theoretically and experimentally. Street (36) showed that

$$\frac{\delta_o}{R} = 1 - \left\{ 1 + \frac{2N_{Fr}}{N_{Re}} (2q_1 + 4q_2 + 6q_3) \right\}^2$$

where ; $N_{Fr} = \text{Froude number} = \frac{U_S^2}{g \cdot D_p}$

$$N_{Re} = \text{Reynolds number} = \frac{D_p U_S \rho_L}{\mu_L}$$

At the trailing end of the slug, dissipation of the developed velocity profiles induced wake mixing at the rear of the slug (29). Griffith and Moissis (29) attempted to investigate the velocity profiles in this region by measuring the static pressure and total pressure behind a plastic slug held stationary in a 2 inch tube when water flowed down the tube. However, no measurement of the liquid velocity close to the bottom of the slug was made. In studying the mass transfer of carbon dioxide into water and aqueous glycerol solutions from the rear of the spherical cap, Calderbank (39) proposed that due to the toroidal vortex in the wake mass transfer took place from the bubble bottom surface to thin liquid elements flowing along the bottom of the rising bubble. Velocities varied from zero at the center to a maximum at the edge of the bubble. In this study, similar analysis predicted that wake effect would not extend to the slug bottom surface as the radial velocity component at the edge of the slug would be zero or close to zero.

The velocity profile within the slug is much more difficult to visualize. Viscous drag on the gas-liquid interface has been reported to induce circulation within the gas bubble (35, 40, 41). Goldsmith and Mason (35) measured the velocity profiles in the liquid slug rising through a stagnant liquid by introducing aluminium tracer particles into the liquid slug and taking cine films through the microscope. The results reported by the author, figure 3, showed that because of viscous drag, the velocity profiles in an area near the interface was negative with respect to the tube wall whereas the main bulk

VELOCITY PROFILES INSIDE A SLUG

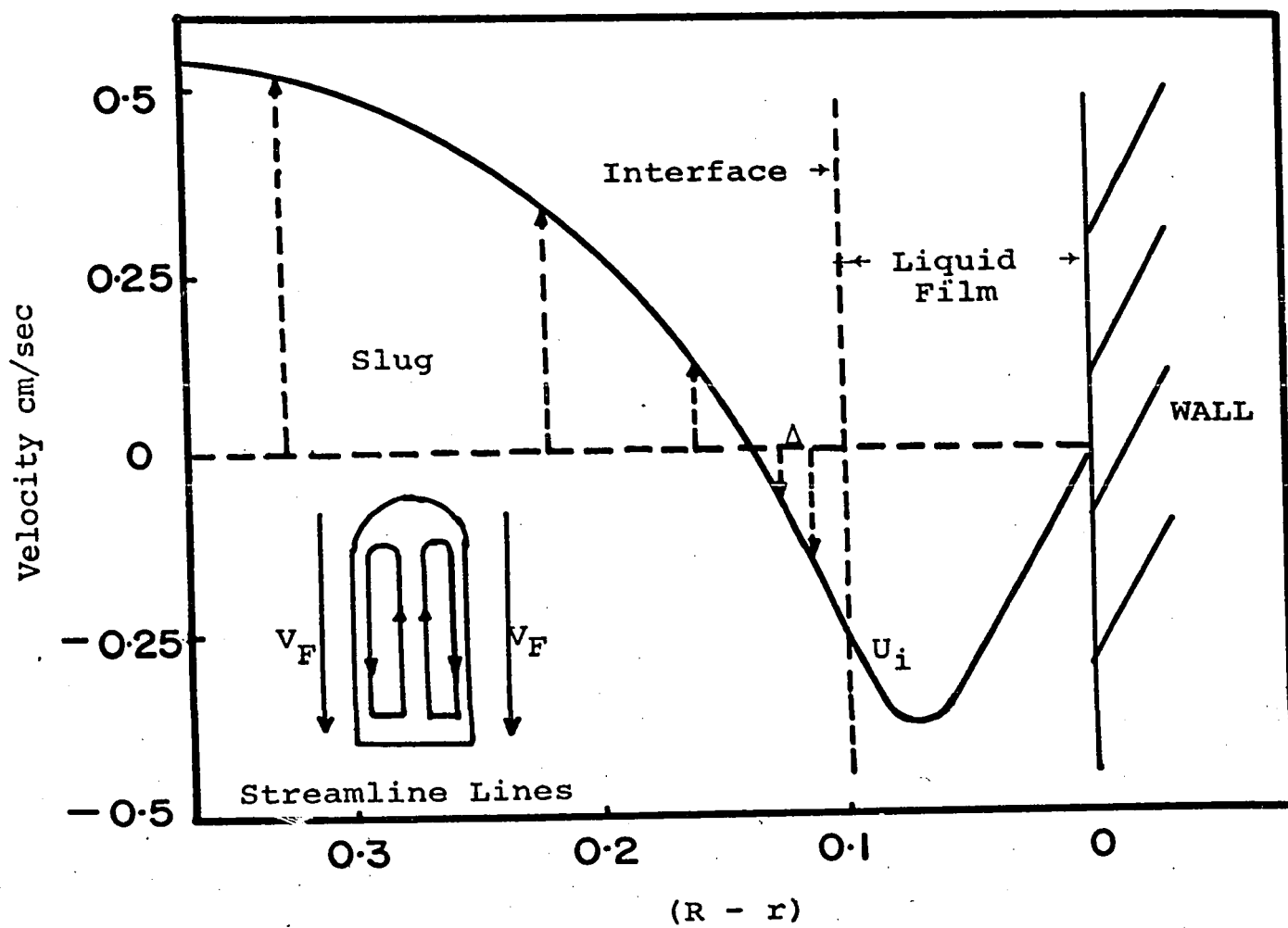


Figure 3

of the gas phase was flowing upwards. Hence internal circulation was induced inside the slug. For gas slugs, similar characteristic internal circulations could also be expected to be induced by the viscous drag of the liquid films around the slug. Velocity profiles however might not be completely formed within the gas slug since the gas phase viscosity is negligibly small when compared to the liquid phase viscosity.

A-4. Slug Length and Separation Distances

A wide variation of slug lengths and separation distances in fully developed slug flow has been reported by Griffith and Wallis (5). The authors studied flow characteristics of air-water systems in 1/2, 3/4 and 1 inch pipes. Beek (11) reported uniform slug lengths and separation distances when he studied the absorptions of carbon dioxide in narrow gas lifts of 0.48 and 0.238cm diameter. This type of flow pattern is not normally observed in larger diameter tubes. The mean average slug lengths over the entire pipe were reported by Griffith and Wallis (5) and Street (42) to increase almost linearly with the gas rates. Slug lengths on the other hand generally decreased with increase in liquid rates. Mean average slug separation distances were also found to be the increasing function of gas rate and were only slightly affected by the liquid flow rates, the data though were scattered.

Govier (43) and Moissis (31) further found that slug lengths and separation distances depended on the entrance geometries of the tubes, purity of the fluid as well as the dynamic quantities such as the fluid flow rates. They were

however not unique functions of the operating variables and it is considered that stable slug flows can occur, at given gas and liquid rates, over a wide range of slug lengths.

In unstable slug flows where the wakes of the leading slugs influenced the motion of the trailing slugs, Griffith and Moissis (29) have shown theoretically that the momentum flux at the rear of the slug was a function of L_s/D_p and r_d/D_p where L_s and r_d are the slug separation distance and slug radius at the trailing end of the slug. It was also found experimentally that in inviscid liquids, the wake effect might prevail as far as $5.0 D_p$ from the rear of the slug but in viscous liquids, the wake was found to be short and generally extended to a distance less than one tube diameter.

A-5. Pressure Drop and Void Fraction

The pressure drop over an individual slug has been experimentally measured and shown by Laird and Chisholm (4) and Nicklin (7) to be generally negligible. In two phase slug flow, the pressure drop has been observed to be greater than that for the single phase flow (3, 44).

In general, as described by Nicklin (7), the pressure drop ΔP_T was written as :

$$\begin{aligned}\Delta P_T &= (1-\alpha)\rho_L g H + \alpha\rho_g g H + \Delta P_w \\ &= \Delta P_g + \Delta P_w\end{aligned}\tag{II-10}$$

where ; α = gas phase void fraction defined as the fraction of total volume of the tube occupied by the gas phase

ΔP_g = pressure drop due to the weight of fluids
in the tube

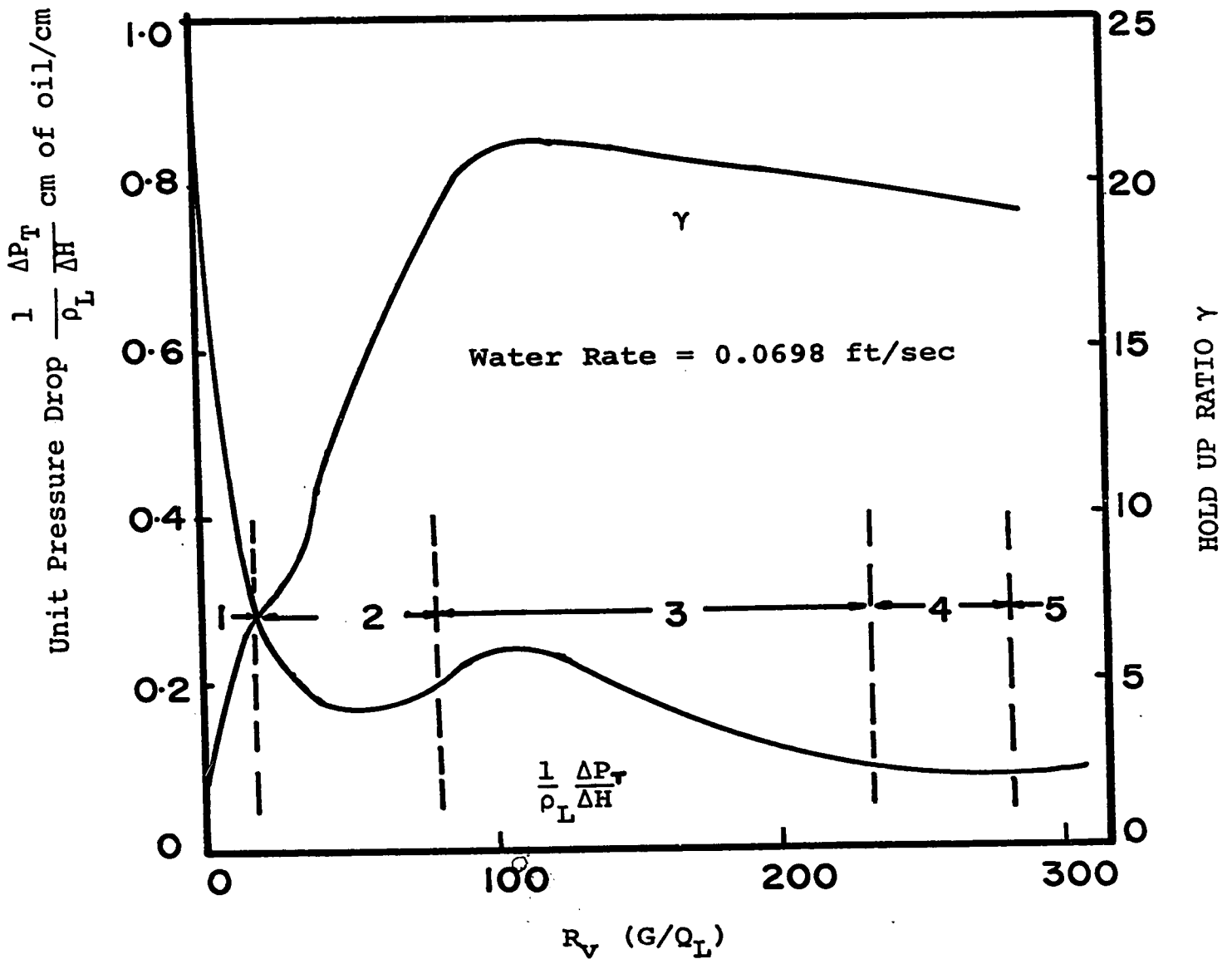
ΔP_w = pressure drop due to wall friction

Nicklin (5), Govier (45) and Higson (46) showed that due to downflow of liquid around the slug, pressure drops due to wall friction over the slug acted upwards and as a result ΔP_w was generally negative and so the measured ΔP_T was less than ΔP_g .

The in-situ gas volume fraction or void fraction α was frequently related to the hold up ratio γ defined as the ratio of the liquid-gas volume ratio in the flow section to the liquid-gas volume ratio in the feed or $\gamma = \frac{(1-\alpha)/\alpha}{Q_L/Q_G}$ (II-11). Numerous empirical correlations have been proposed by Govier (47, 48), Ros (49), Hughmark and Pressburg (50) and Ueda (38) to predict hold up ratio of the gas-liquid two phase particularly for the air-water system. However, none of these correlations, as noted by Govier (43), were in fact general.

Different from Kozlov (51) and Griffith and Wallis (3) who correlated the vertical two phase flow regimes in terms of the superficial volumetric gas fraction and average Froude number, Govier (47,48) classified the flow regimes by means of their unit pressure drop and hold up ratio behaviour when plotted against the gas-liquid volume ratio R_v , figure 4. Apparently, each flow regime was characterised differently by an increase or decrease in unit pressure drop and hold up ratio with R_v . In the slug flow regime, unit pressure drops first decreased with R_v until a minimum and then increased again with R_v . The behaviour was reversed as the flow patterns

VARIATIONS OF UNIT PRESSURE DROP AND HOLD UP RATIO WITH $R_V (=G/Q_L)$ FOR DIFFERENT VERTICAL TWO PHASE FLOW REGIONS



Flow Patterns : 1. Bubble Flow 4. Ripple Flow
 2. Slug Flow 5. Film
 3. Froth

Figure 4

changed into the froth, ripple and film regions. The corresponding hold up ratio was observed to continually increase with R_V in the slug flow regime.

II-B. Mass Transfer Studies

Studies of the absorption from bubbles in narrow tubes were undertaken as early as in 1919 when Adeney and Beeker (52) reported their experimental results on the absorption from a single air bubble by water in a closed vertical tubes but no basic theory was described. Higby (13) also investigated the absorption of carbon dioxide into water from a long bubble and applied the diffusion equations to explain his results, the theoretical mass transfer coefficients being given by $k'_L = 2(D_L/\pi t_c)^{1/2}$ (II-12). Equation (II-12) has been termed the penetration theory and applied when the penetration depth of the solute into the liquid medium is small. Danckwerts further modified this concept in terms of a surface renewal factor (53). Nate and Himmelblau (54) also studied mass transfer of carbon dioxide from large single bubbles formed in a fixed position and surrounded by a thin conical film of water flowing at average film Reynolds numbers in the range of 40 to 300. The calculated mass transfer coefficients agreed well with those predicted theoretically for small bubbles with surface areas of about 10.0 to 14.1 cm². With larger bubbles, the experimental results showed a distinct increase over the predicted values. The discrepancies were believed to be the result of an increase in liquid mixing perpendicular to the bubble interface by surface waves. Baird and Davidson (55) on the other hand investigated the absorption rates of carbon dioxide from

large rising bubbles (0.8-4.2cm diameter) in still water. It was found that for larger bubbles (over 2.5cm diameter) mass transfer was not constant with column height due to the concentration build-up in the liquid carried behind the bubble.

Actual investigations of mass transfer in two phase vertical slug flow are few (11,12) though in horizontal tube, mass transfer has received considerable attention, for example, the work of Scott (56,57). Beek (11) studied liquid phase controlled mass transfer by absorbing CO_2 into water using vertical tubes, flow conditions were fully developed. In this study, the product of the liquid phase mass transfer coefficient and effective area was evaluated both experimentally and theoretically. Experimental values were about 30 per cent lower than the predicted values which was considered to be caused by a decrease in the velocity gradient resulting in rippling of the gas-liquid interfaces at the trailing ends of the slugs. Mah and Golding (12) compared the gas phase controlled mass transfer efficiencies under different gas-liquid contacting conditions. The system studied was the absorption of hexane from nitrogen carrier gas into dodecane. Three contacting conditions were investigated, bubble flow, slug flow and annular flow, the latter corresponding to conditions existing in the wetted wall column. High mass transfer efficiencies were observed in all cases, but evaluation of mass transfer coefficients were complicated by end-effect mass transfer ($E_E = 0.90-0.95$). The results however indicated that in slug flow, mass transfer rates were very much smaller than those for bubble flow or under wetted

wall contacting conditions. The slug flow conditions observed were not fully developed.

III. THEORETICAL

III-A. Evaluation of Experimental Mass Transfer Coefficients

When mass transfer takes place from a rising slug, it can be considered to have taken place in three distinct regions, namely the formation, the rise and the slug collapse zones as shown in figure 5. The mass transfer taking place in the formation and slug collapse zones has been termed end effect mass transfer while the mass transfer that takes place as the slug rise has been termed rise period mass transfer (58,59). End effect mass transfer (58,59) has usually been assumed to be constant and independent of contact height. The fractional approach of the gas phase to equilibrium with the liquid phase is generally expressed in terms of an overall gas phase efficiency, E_{OT} where $E_{OT} = \frac{y_{on}-y_{off}}{y_{on}-y^*}$, y_{off} = mole fraction of soluble component in outlet gas and y^* = mole fraction of soluble component in the gas phase that would be in equilibrium with the liquid phase, the mass transfer efficiencies in each respective period E_F , E_Z and E_C being defined as in figure 5. If, as was found in this study, the values of y^* do not vary appreciably, it can be considered constant in evaluating the overall mass transfer coefficient K_{OG} . Then, the rate of absorption of hexane from the bulk of the gas to the liquid phase in the rise period can be expressed by the following differential equation :

$$G_m d_y = -K_{OG} A_e F_P (y-y^*) d\theta_Z \quad (III-13)$$

where ; K_{OG} = overall mass transfer coefficient in
g-mole/cm²sec atm

DEFINITION OF MASS TRANSFER EFFICIENCIES

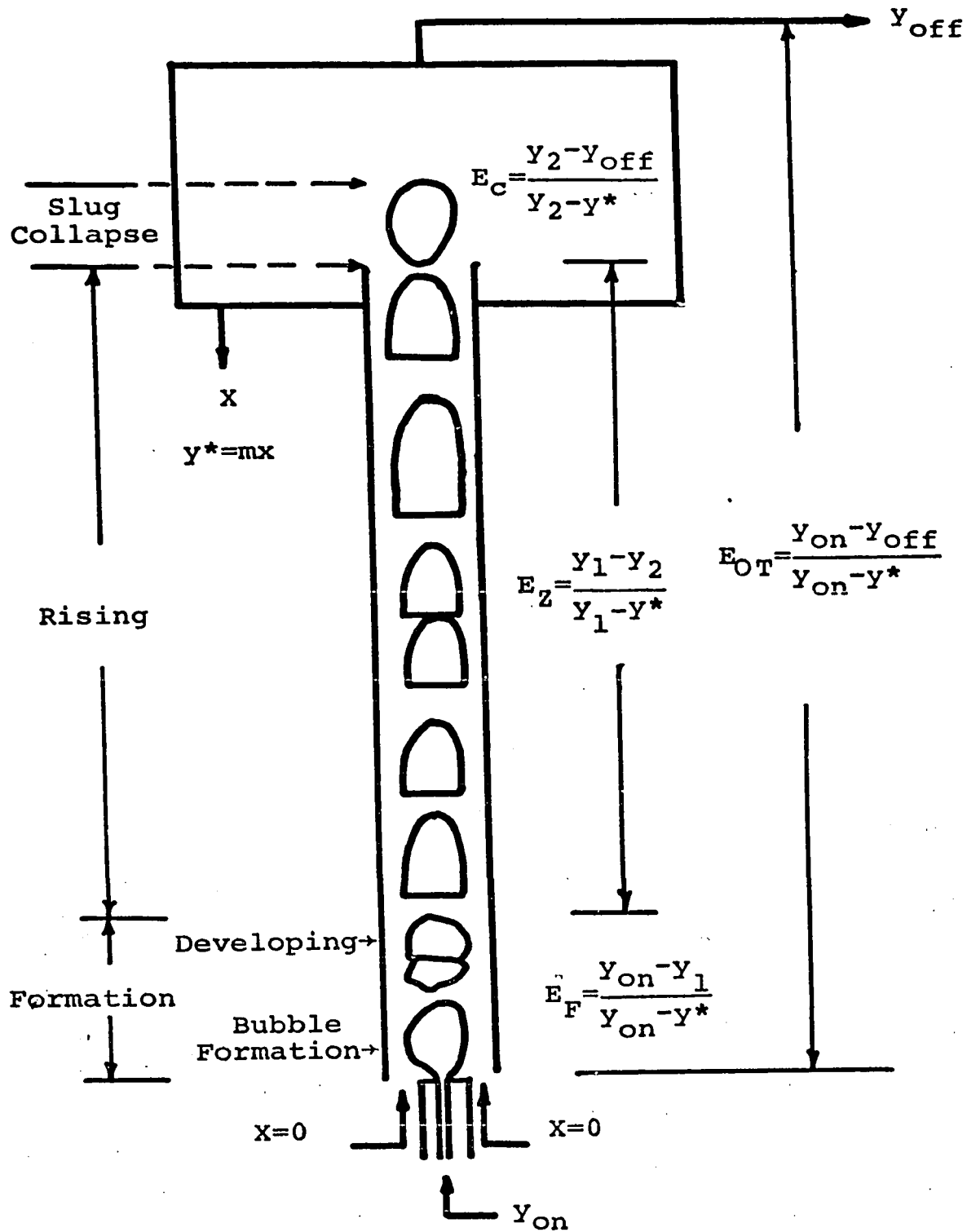


Figure 5

y = mole fraction of hexane in the gas phase

F = slug frequency, slugs/sec

A_e = effective slug surface area to mass transfer, cm^2

G_m = mean molal flow rate, g-mole/sec

P = total pressure, atm

θ_z = contact time, sec

After rearranging and integrating, equation (III-13)

becomes :

$$\int_{y_1}^{y_2} \frac{dy}{y-y^*} = - \int_0^{\theta_z} \frac{K_{OG} A_e F P}{G_m} d\theta_z \quad (\text{III-14})$$

where y_1 and y_2 are the mole fraction of hexane in the gas stream at the inlet and outlet of the mass transfer section, figure 5. For constant y^* , equation III-14 becomes :

$$\ln \frac{y_1 - y^*}{y_2 - y^*} = \int_0^{\theta_z} \frac{K_{OG} A_e F P}{G_m} d\theta_z$$

$$\text{or} \quad -\ln(1-E_z) = \int_0^{\theta_z} \frac{K_{OG} A_e F P}{G_m} d\theta_z \quad (\text{III-15})$$

In practice, only E_{OT} can be measured directly and when end effects are present, they have to be allowed for. Hamielec (57) has shown that for constant y^* , the following relationship holds :

$$-\ln(1-E_{OT}) = -\ln(1-E_z) - \ln(1-E_E) \quad (\text{III-16})$$

where ; $E_E = E_F + E_C - E_F \times E_C$

When y^* is not constant, equation (III-16) requires modification. It can be shown that for lean gas and with high formation end effect mass transfer as can be assumed to take place in this study, the change in liquid composition during the rise period under all flow conditions of this study was found to be sufficiently small and y^* can be taken as constant and equal to y_{off}^* , see appendix 2-A3.

Hence

$$E_{OT} = \frac{Y_{on} - Y_{off}}{Y_{on} - y_{off}^*}$$

$$E_F = \frac{Y_{on} - Y_1}{Y_{on} - y_{off}^*}$$

$$E_Z = \frac{Y_1 - Y_2}{Y_1 - y_{off}^*}$$

$$E_C = \frac{Y_2 - Y_{off}}{Y_2 - y_{off}^*}$$

y_{off}^* being calculated from the relationship $y_{off}^* = mx_{off}$ where x_{off} is the cup mixing liquid composition at the liquid outlet and m the slope of the equilibrium line evaluated using Raoult's Law, appendix 6-D. Then from equations (III-15) and (III-16) with $P \approx 1$ atmosphere

$$-\ln(1-E_{OT}) = \int_0^{\theta_z} \frac{K_{OG} A_e F}{G_m} d\theta_z - \ln(1-E_E) \quad (III-17)$$

In equation (III-17), as A_e is unknown and not constant, the integral at the R.H.S. can not be evaluated. However, by plotting $-\ln(1-E_{OT})$ against residence time θ_z in the rise zone, the point value $\left(\frac{K_{OG} A_e F}{G_m} \right)$ at the top of the absorbers can be evaluated from the slope of the curve :

$$\frac{K_{OG} A_{eF}}{G_m} = \frac{d\{-\ln(1-E_{OT})\}}{d\theta_z} \quad \text{at any } H \quad (\text{III-18})$$

θ_z is equal to $\frac{(H - h_o - w)}{U_s}$ where h_o and w are respectively the formation bubble length at the orifice and the length of the developing zone, see appendix 4-D.

Further, if E_E can be taken as constant, that is independent of the absorber length, the number of mass transfer units NTU and mean value $(\frac{\overline{K_{OG} A_{eF}}}{G_m})$ over the rise zone for any H will then be :

$$\begin{aligned} \text{NTU} &= \int_0^{\theta_z} \frac{K_{OG} A_{eF}}{G_m} d\theta_z = \left(\frac{\overline{K_{OG} A_{eF}}}{G_m} \right) \theta_z \\ &= -\ln(1-E_{OT}) + \ln(1-E_E) \end{aligned}$$

$$\frac{\overline{K_{OG} A_{eF}}}{G_m} = \frac{1}{\theta_z} \{-\ln(1-E_{OT}) + \ln(1-E_E)\} \quad (\text{III-19})$$

With E_E being calculated from the intercept of the $-\ln(1-E_{OT})$ against θ_z curve at $\theta_z = 0$.

From equation (III-18) and (III-19), if the slug frequencies are known, the product of the mass transfer coefficient and slug effective area $\overline{K_{OG} A_e}$ and $K_{OG} \overline{A_e}$ can be calculated. Further, if A_e is not equal to the slug surface area A_s , equations (III-18) and (III-19) can be rearranged to give

$$\begin{aligned} K_{OG} a &= \left(\frac{K_{OG} A_{eF}}{G_m} \right) \frac{1}{\left(\frac{A_s}{V_s} \right)} \frac{1}{22414} \quad \text{where } a = \frac{A_e}{A_s} \\ \overline{K_{OG} a} &= \left(\frac{\overline{K_{OG} A_{eF}}}{G_m} \right) \frac{1}{\left(\frac{\overline{A_s}}{V_s} \right)} \frac{1}{22414} \quad \text{where } \overline{a} = \frac{\overline{A_e}}{\overline{A_s}} \end{aligned}$$

$\left(\frac{A_s}{V_s}\right)$ and $\left(\frac{\bar{A}_s}{\bar{V}_s}\right)$ are the point and mean slug surface area to volume ratios and can be evaluated experimentally.

III-B. Theoretical Prediction of Overall Mass-Transfer Coefficients

B-1. Introduction

As there was an appreciable resistance to mass transfer in both gas and liquid phases in this study, it was necessary to consider the resistance in each phase separately. In general, mass transfer between a single gas bubble and surrounding liquid can be considered to be divided into the following three steps :

- (1) mass transfer from the gas to the interface
- (2) mass transfer through the interface
- (3) mass transfer from the interface to the liquid

The resistance to mass transfer at the interface is normally assumed to be negligible, the overall mass transfer resistance can be related to the individual gas and liquid phase resistance by means of the two resistance theory as :

$$\frac{1}{K_{OG}} = \frac{1}{k_G} + \frac{m}{k_L} \quad (\text{III-20})$$

where K_{OG} , k_G and k_L are respectively the overall, individual gas and liquid mass transfer coefficients over a contact area A_e .

The application of the two resistance theory has been discussed by previous authors (60-62) and was considered valid by King (61) under the following conditions :

- (1) m must be constant
- (2) the magnitude of k_G at any point must be independent of the relative magnitude of k_L and vice versa
- (3) the ratio (mk_G/k_L) must be constant

In this study, the paraffin oil solution could be considered ideal and m constant. The individual mass transfer coefficients, being taken to be independent of each other, were found to vary as described by the penetration theory and hence the ratio (mk_G/k_L) would be also approximately constant.

From equation (III-20), King (28) further showed from the penetration theory that

$$\left(\frac{k_G}{k_L}\right) = \left(\frac{D_g}{D_L}\right)^{\frac{1}{2}} \frac{MW}{\rho_L \circ R T} = \phi \quad (\text{III-21})$$

where ; MW = molecular weight of liquid solution
 g/mole

$\circ R$ = gas constant (atm) (cm³) / (g-mole) (°K)

$$\text{and} \quad \frac{\left(\frac{1}{k_G}\right)}{\left(\frac{1}{K_{OG}}\right)} = \frac{1}{1 + m\phi} \quad (\text{III-22})$$

$$\frac{\left(\frac{m}{k_L}\right)}{\left(\frac{1}{K_{OG}}\right)} = \frac{m\phi}{1+m\phi} \quad (\text{III-23})$$

$m\phi$ has been termed as the resistance parameter by King (28). From equation (III-22) and (III-23), the approximate fraction of overall mass transfer resistance in the gas and liquid phases over the range of physical properties studied

in this research were calculated, see Table 1 below :

Table 1

Relative Mass Transfer Resistance in The Gas and Liquid Phases

<u>System</u>	<u>ϕ</u>	<u>Gas Phase</u>	<u>Liquid Phase</u>
n-Hexane-Helium-Heavy Paraffin Oil	1.879	0.347	0.653
n-Hexane-Nitrogen-Heavy Paraffin Oil	1.023	0.494	0.506
n-Hexane-Freon-14-Heavy Paraffin Oil	0.758	0.569	0.431
n-Hexane-Helium-Light-Paraffin Oil	0.968	0.508	0.492
n-Hexane-Nitrogen-Light Paraffin Oil	0.527	0.655	0.345
n-Hexane-Freon-14-Light Paraffin Oil	0.391	0.719	0.281

In slug flow, the liquid flow behaviour at upper and lower regions of the slugs would differ, see figure 2 and separate equations had to be written for mass transfer taking place in the two regions. In the upper region, mass transfer takes place due to liquid flow around the surfaces of the slug while in the bottom region, mass transfer can be considered to take place due to wake induced motion at the rear of the slug :

$$\text{For upper region } \frac{1}{(K_{OG})_f A_f} = \frac{1}{(k_G)_f A_f} + \frac{1}{(k_L)_f A_f}$$

$$\text{For lower region } \frac{1}{(K_{OG})_b A_b} = \frac{1}{(k_G)_b A_b} + \frac{1}{(k_L)_b A_b}$$

$$\text{thus } K_{OG} = \frac{1}{A_e} \{ (K_{OG})_f A_f + (K_{OG})_b A_b \} \quad (\text{III-24})$$

where $A_f = A_s - A_b$ with A_s and A_b being the slug total and

bottom surface area.

The wake effect as mentioned previously at the rear of the slug did not extend to the bottom surface of the slug and the bottom surface mobility was relatively small, $(K_{OG})_b$ as studied by previous workers (27,63-65) can be expected to be small when compared with $(K_{OG})_f$. In addition, A_b was generally only a small fraction of A_s ; for example in 0.793 cm diameter absorber, (A_b/A_s) is 0.2, 0.15 and 0.09 for 0.5, 0.8 and 1.5 cm long slugs respectively. Hence, equation (III-24) can be further approximated as

$$K_{OG} \approx \frac{1}{A_s} (K_{OG})_f A_f$$

$$\text{or } K_{OG} = \frac{A_f}{A_s} \left\{ \frac{1}{\frac{1}{(k_G)_f A_f} + \frac{m}{(k_L)_f A_f}} \right\} \quad (\text{III-25})$$

B-2. Liquid-Phase Mass-Transfer Coefficients

For a solute penetrating into a liquid layer, Higbie (13) has shown that for short contact time the individual liquid phase mass transfer coefficients is equal to

$$k_L' = 2.0 \left(\frac{D_L}{\pi t_c} \right)^{1/2} \quad (\text{cm/sec})$$

$$\text{OR} \quad = 2.0 \frac{\rho_L}{MW} \left(\frac{D_L}{\pi t_c} \right)^{1/2} \quad (\text{g-mole/sec cm}^2) \quad (\text{III-26})$$

where t_c is the contact time between the liquid elements and the interface.

If the interfacial velocity is constant and known, t_c can be expressed as S/U_i or

$$k_L = 2.0 \frac{\rho_L}{MW} \left(\frac{D_L U_i}{\pi S} \right)^{\frac{1}{2}} \text{ (g-mole/sec cm}^2\text{)} \quad (\text{III-27})$$

where S is the distance travelled by the liquid elements.

In cases when U_i is not constant but varies with S, as for the slug and liquid interfaces, equation (III-27) can be written as

$$(k_L)_f = \frac{2.0}{A_f} \left(\frac{\rho_L}{MW} \right) \sum_j^n \left(\frac{D_L U_{ij}}{\pi \Delta L_S} \right)^{\frac{1}{2}} (\Delta A_f)_j \text{ (g-mole/sec cm}^2\text{)} \quad (\text{III-28})$$

where ;
$$U_{ij} = \frac{(U_i)_j + (U_i)_{j+1}}{2}$$

$$\Delta L_S = \frac{L_S}{n}$$

$$(\Delta A_f)_j = (A_f)_{j+1} - (A_f)_j$$

U_i for the slug and liquid interfaces of this study can be evaluated from equations (II-6) and (II-7) as proposed by Street and King respectively. While the results of U_i from these equations compared fairly well with each other, see Table 2-2 of appendix 2-B, King's equation was relatively simple and employed for the evaluations of U_i .

In order to account for the stretching effect of the liquid layer around the slug surface, Heuven and Beek (11) showed theoretically that for short penetration depths,

$$(k_L)_f = \frac{2.0}{A_f} \left(\frac{\rho_L}{MW} \right) \left(\frac{D_L}{\pi} \right)^{\frac{1}{2}} \left\{ \int_0^{S_I} \left(\frac{dA_f}{dS_I} \right)^2 U_i dS_I \right\}^{\frac{1}{2}} \text{ (g-mole/cm}^2\text{sec)} \quad (\text{III-29})$$

with S_I being the length of the interface from the slug head.

In this study, the peretration depths PD calculated from the equation $PD = 0.36(D_L t_c)^{1/2}$ as reported by Danckwerts (53)

were small compared to the liquid film thicknesses. As

$\left\{ \int_0^{S_I} \left(\frac{dA_f}{dS_f} \right)^2 U_i dS_I \right\}^{1/2}$ was approximately equal to $\left\{ \int_0^{L_s} \left(\frac{dA_f}{d\ell} \right)^2 U_i d\ell \right\}^{1/2}$,

equation (III-29) then becomes :

$$(k_L)_f = \frac{2.0}{A_f} \left(\frac{\rho_L}{MW} \right) \left(\frac{D_L}{\pi} \right)^{1/2} \left\{ \int_0^{L_s} \left(\frac{dA_f}{d\ell} \right)^2 U_i d\ell \right\}^{1/2} \text{ (g-mole/cm}^2\text{sec)} \quad \text{(III-30)}$$

Further, $\left(\frac{dA_f}{d\ell} \right)$ was found to be approximately constant, equations (III-28) and (III-29) can then be assumed to be equivalent.

R.6

B-3. Gas-Phase Mass-Transfer Coefficient

No convenient equation or correlation are available for the evaluation of the individual mass transfer coefficient k_G in a slug or single bubble. Aerov and coworkers (66) reported that the penetration theory described the mass transfer from a moving drop for the case with high peclet number, $(U_s r_i / D_g) (> 10^2)$ and where the resistances of the continuous and disperse phases were commensurable. The values of peclet number for this study were found to be about 120. If, due to the external liquid flow, figure 2, the gas inside the rising slug can be assumed to circulate, a finite velocity would exit at the gas-liquid boundary leading to the surface condition, $(U_i)_{\text{liquid}} = (U_i)_{\text{gas}}$ (67). Under these circumstances, fresh gas elements might be expected to be brought continually to the interface and the following equation similar to equation (III-28) can be used to evaluate the k_G values,

$$(k_G)_f = \frac{2.0}{A_f} \left(\frac{1}{ORT} \right) \sum_j \left(\frac{D_g U_{ij}}{\pi \Delta L_s} \right)^{1/2} (\Delta A_f)_j \text{ (g-mole/cm}^2\text{sec atm)} \quad \text{(III-31)}$$

B-4. Evaluation of Overall Gas-Phase Mass-Transfer Coefficients by Diffusion Model

As an alternate method, the overall gas-phase mass-transfer coefficient can be estimated from solutions of diffusion equations. Groeber (68) has presented solutions for the heat transfer from symmetrical bodies initially at an uniform temperature and then suddenly changed to a different environment. These solutions have been used by Poutanen (21) to solve analogous problems of mass transfer from a bubble into a continuous phase having resistance to the diffusion.

If the slug is considered to be made up of two parts, the spherical segment and cylindrical body, the diffusion equations for the mass transfer inside the different parts can then be solved by analogy to Groeber's derivations and if the liquid film mass transfer coefficients are known, the average mass transfer coefficients of the slug can be approximated as

$$K_{OG} = (1/A_f) \{ (K_{OG})_r A_r + (K_{OG})_c A_c \} \quad (\text{III-32})$$

where A_r and $(K_{OG})_r$, A_c and $(K_{OG})_c$ are the surface area and average overall mass transfer coefficients of the spherical segment and cylindrical body respectively

4-a. Diffusion from a Sphere to a Continuous Phase

The mass transfer in a non-stagnant spherical bubble can be given by the following differential equation :

$$\frac{\partial y}{\partial t} = D_E \left(\frac{\partial^2 y}{\partial r_i^2} + \frac{2}{r_i} \frac{\partial y}{\partial r_i} \right) \quad (\text{III-33})$$

where $D_E = \bar{w} D_g$ and $\bar{w}$ is the correction factor that takes into account the increase in molecular diffusivity due to circ due to circu-

lation within the sphere. The boundary conditions for equation (III-33) with resistance to diffusion in the continuous phases are :

$$y = y_i \quad \text{at } r_i = r_o \quad t = 0$$

$$D_E \left(\frac{\partial y}{\partial r_i} \right)_{r_i=r_o} = -k_L' (x_i - x) \quad (k_L' : \text{cm/sec})$$

OR

$$\left(\frac{\partial y}{\partial r_i} \right)_{r_i=r_o} = - \frac{k_L \text{ MW}}{D_E \rho_L m} (y_i - y^*) \quad (k_L : \text{g-mole/cm}^2 \text{sec})$$

The radius r_o of the spherical segment is about 0.265 cm for slugs in the 0.793 cm I.D. absorber and k_L is the liquid film mass transfer coefficients calculated by the penetration theory from equation (III-29). Solution of equation (III-33) is similar to those of Jacob (69) and Poutenan (21) with y reducing from y_1 to y_2 is:

$$E = \frac{y_1 - y_2}{y_1 - y^*}$$

$$= \sum_{j=1}^{\infty} \frac{6 (\sin \psi_j - \psi_j \cos \psi_j)^2}{\psi_j^3 (\psi_j - \sin \psi_j \cos \psi_j)} \{1 - \exp(-\psi_j^2 D_E t / r_o^2)\} \quad (\text{III-34})$$

where E is the mass transfer efficiency and ψ_j are the roots of the auxiliary equations

$$\frac{k_L r_o \text{ MW}}{D_E \rho_L m} = 1.0 - j r_o \cot(j r_o) \quad (\text{III-35})$$

which had been solved by Jacob (69) for $\frac{k_L r_o \text{ MW}}{D_E \rho_L m}$ ranging from 0.0002 to 50.

Let
$$B_j = \frac{6(\sin \psi_j - \psi_j \cos \psi_j)^2}{\psi_j^3 (\psi_j - \sin \psi_j \cos \psi_j)} \quad (\text{III-36})$$

$$A_j = 1 - \exp(1 - \psi_j^2 D_E t / r_o^2)$$

The values for the first two roots, ψ_1 and ψ_2 and constants B_1 and B_2 together with A_1 and A_2 are given in the following Table 2-1 for numerous values of $(k_L M W r_o) / (D_E \rho_L m)$

Table 2-1
Values of ψ_j , B_j and A_j

$t = 0.1 \text{ sec}$

$\frac{k_L r_o M W}{D_E \rho_L m}$	ψ_1	B_1	A_1	ψ_2	B_2	A_2
0.200	0.759	0.996	0.143	4.538	0.0001	0.9961
0.100	0.542	0.996	0.076	4.516	0.00002	0.9952
0.080	0.486	0.996	0.062			
0.060	0.422	0.996	0.046			
0.040	0.345	0.996	0.032			
0.010	0.173	0.996	0.008	4.496	2×10^{-7}	0.9944
0.008	0.155	0.996	0.006			
0.006	0.134	0.996	0.005			
0.001	0.055	0.996	0.001	4.494	2×10^{-9}	0.9944

As the maximum values of $(k_L r_o M W) / (D_E \rho_L m)$ in this study was found to be less than 0.1 ($\bar{w}=1.0$) equation (III-34) can be approximated as :

$$E \approx 1 - \exp(-\psi_1^2 D_E t / r_o^2)$$

or
$$-\ln(1 - E) = \psi_1^2 D_E t / r_o^2$$

since
$$-\ln(1 - E) = \left(\frac{K_{OG} A F}{G_m} \right) r^2$$

$$\therefore (K_{OG})_r \approx \left(\frac{G_m}{FA} \right)_r (\psi_1^2 D_E / r_o^2) \quad (\text{III-37})$$

A-2. Diffusion From the Cylinder into A Continuous Phase

The same procedure can be used for solving the radial diffusion from a cylinder into a continuous phase with resistance to diffusion at the interface. The diffusion equation is:

$$\frac{\partial y}{\partial t} = D_E \left(\frac{\partial^2 y}{\partial r_i^2} + \frac{1}{r_i} \frac{\partial y}{\partial r_i} \right) \quad (\text{III-38})$$

with boundary conditions,

(i) $y = y_i$ at $r_i = r_d$ $t = 0$

(ii) $D_E (\partial y / \partial r_i)_{r_i=r_d} = -k_L' (x_i - x) \quad (k_L' : \text{cm/sec})$

or $(\partial y / \partial r_i)_{r_i=r_d} = - \frac{k_L MW}{D_E \rho_L m} (y_i - y^*) \quad (k_L : \frac{\text{g-mole}}{\text{cm}^2 \text{sec atm}})$

The solution of equation (III-38) with the boundary conditions is by analogy to Groeber's derivation (68) as :

$$E = \sum_{j=1}^{\infty} \frac{\psi_1^2}{\lambda_j^2} \frac{J_1^2(\lambda_j)}{J_0^2(\lambda_j) + J_1^2(\lambda_j)} \{1 - \exp(-\lambda_j^2 D_E t / r_d^2)\} \quad (\text{III-39})$$

λ_j are the roots of the auxiliary equations

$$\left(\frac{k_L r_d MW}{D_E \rho_L m} \right) = \frac{J_0(j r_d)}{J_1(j r_d)} \quad (\text{III-40})$$

$$\text{If let } AA_j = \frac{4}{\lambda_j^2} \frac{J_1^2(\lambda_j)}{J_0^2(\lambda_j) + J_1^2(\lambda_j)} \quad (\text{III-41})$$

and from the results of λ_1 , λ_2 , AA_1 and AA_2 as shown in Table (3), equation (III-39) can be written as :

$$E \approx 1 - \text{Exp}(-\lambda_1^2 D_E t / r_d^2)$$

$$\text{or } -\ln(1 - E) = (K_{OG} AF / G_m) c t$$

$$(K_{OG})_c = (G_m / AF)_c (\lambda_1^2 D_E / r_d^2) \quad (\text{III-42})$$

Table 3
Values of λ_j and AA_j

$\frac{k_L r_d MW}{D_E \rho_L m}$	λ_1	AA_1	λ_2	AA_2
0.50	0.940	0.9954	3.96	0.004000
0.10	0.443	0.9998	3.86	0.000210
0.05	0.315	0.9999	3.85	0.000089

Therefore, from equation (III-32), (III-37) and (III-42), the average overall mass-transfer coefficients of the slug, K_{OG} , can then be calculated when mass transfer within the slug takes place due to the diffusion and that from the slug surface to the liquid takes place by the penetration model.

IV. EXPERIMENTAL-APPARATUS AND PROCEDURE

IV-A. Introduction

Apart from modifications to the gas and liquid phase inlet section, the apparatus and procedures were similiar to those used previously (12). The modification was carried out to reduce mass transfer at slug formation according to the design used by Scott and Banerjee (26). A general variation of gas and liquid phase properties was achieved by using different carrier gases and heavy and light paraffin oils. The carrier gases were helium, nitrogen and Freon-14, details of the variations in physical properties of both phases together with the range of flow rates employed are given in Table 1. The possible range of flow rates was limited at the lower level by the onset of intermittent flow characteristics as indicated by fluctuations in pressure drop measurements and at the upper level by incomplete saturation of the carrier gas.

IV-B. Apparatus

A schematic diagram of the apparatus is shown in figure 6 and equipment specifications are given in appendix 5-E. Three main operations were involved, the saturation of the inert carrier gas, the mass transfer between the two phases, analysis of the vapor phase and recovery of the used paraffin oils.

Inert carrier gas from the gas cylinder (1) was passed through a calibrated rotatmeter, flow rates being adjusted by means of a flow controller. The carrier gas was then passed

Table 4

Operating and System Variables

	Gas Phase		Liquid Phase	
Inlet Hexane Concentration, m.f.	Y_{in}	0.023 - 0.073		
Volumetric Flow Rate, cc/min	G	165 - 326 *	Q_L	30 - 60
Density gm/cc	ρ_g	0.2885 - 3.885×10^{-3}	ρ_L	0.8586 - 0.8806
Viscosity cp.	μ_g	0.15 - 0.19×10^{-3}	μ_L	40 - 140
Diffusivity cm^2/sec	D_g	0.0447 - 0.2744	D_L	$1.15 - 3.55 \times 10^{-6}$
$R_V = G/Q_L$		2.75 - 10.85		
Interfacial tension dynes/cm	σ	35.0 - 37.0		
Tube Diameter, cm	D_p	0.594, 0.793 and 1.0		
Absorber Height, cm	H	5.0 - 50.0		

* Mean volumetric gas flow rates.

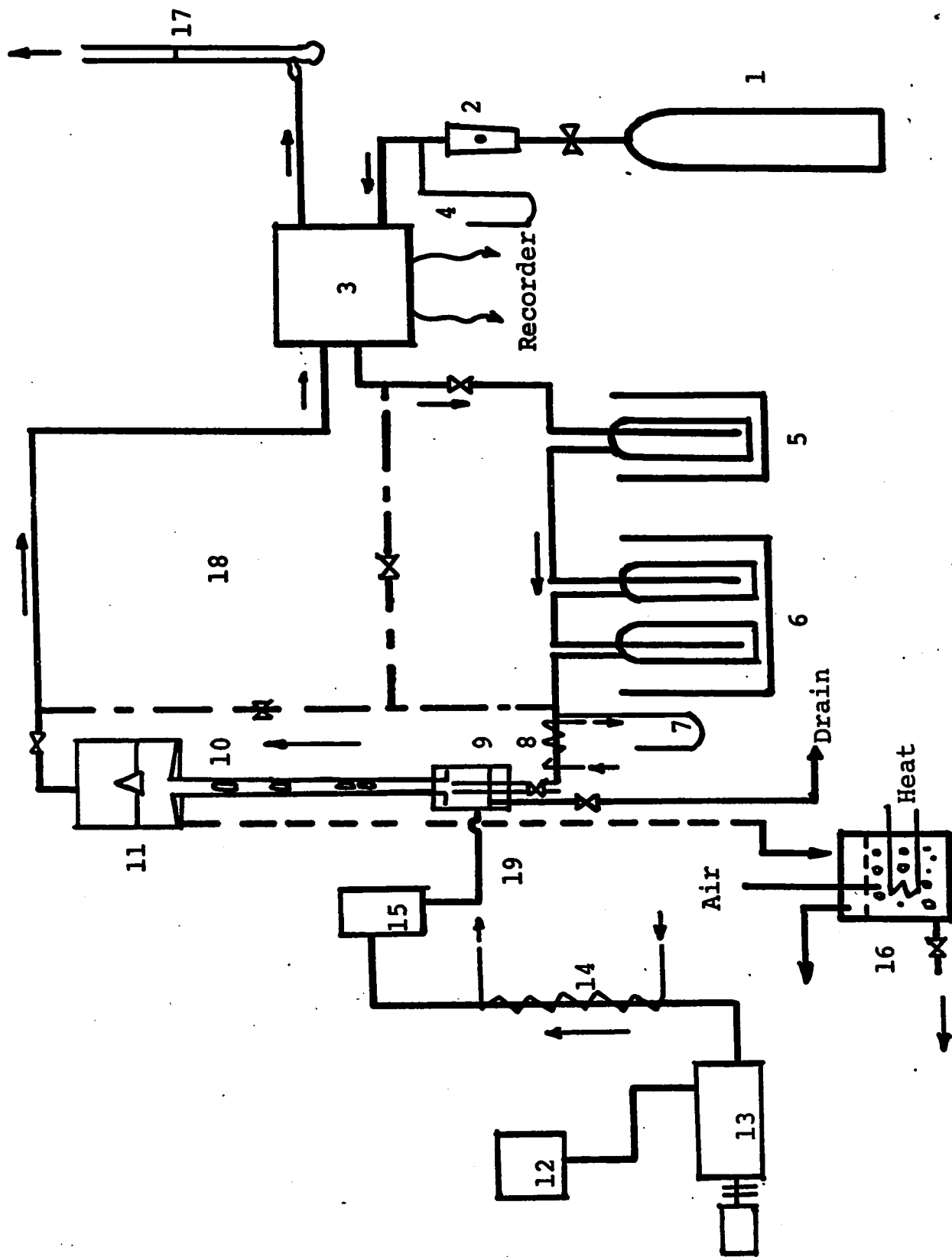


Figure 6. SCHEMATIC LAYOUT OF APPARATUS

EQUIPMENT LIST

(Figure 6)

1. carrier gas cylinder
2. rotameter
3. thermal conductivity cell
4. manometer (mercury)
5. ambient temperature saturator
6. low temperature saturator
7. manometer (merian oil s.p.0.827)
8. heat exchanger
9. entrance section
10. mass transfer section
11. gas-liquid separator
12. pulsation dampener
13. micrometer pump
14. heat exchanger
15. paraffin oil head tank
16. paraffin oil recovery
17. rotameter calibration
18. by-pass line
19. liquid flow inlet

through three saturators containing n-hexane, the first two saturators were maintained at room temperature and the remaining saturators at 4°C to -15°C depending on the inlet gas phase concentration of hexane required. Saturation of the gases with hexane was checked by condensing the hexane in dry ice traps, see appendix 5-B. The saturators were each made up of a glass column, 6" I.D. and 12" in length, clamped between by two brass plates as shown in figure 7. Saturators were maintained 4/5 full of hexane, hexane being removed periodically from the low temperature saturators.

On leaving the saturators, the gas mixture was brought to room temperature (8) before entering the entrance section of the absorber (9) where concurrent contacting took place between the gas and liquid phases. The liquid flow rates (19) were controlled by means of a calibrated micrometer pump. The paraffin oil was cooled (14) and pulsations dampened (15) before entering the absorber. The absorber was made up of different lengths of glass tubing varying from 5 to 50 cm and three tubes were used with inside diameters 0.594, 0.793 and 1.0 cm respectively. The lengths of glass tubing were fitted between the entrance and outlet sections (7)(1) as illustrated in figure 8. The gas inlet was a 0.1 cm I.D. capillary tube fitted to the lower part of the entrance section. The capillary was placed as close as possible to the bottom of the absorber tube, see figure 8. Two types of inlet section (i) and (ii) were used and both gave comparable results in reducing slug formation mass transfer. In the outlet section, an

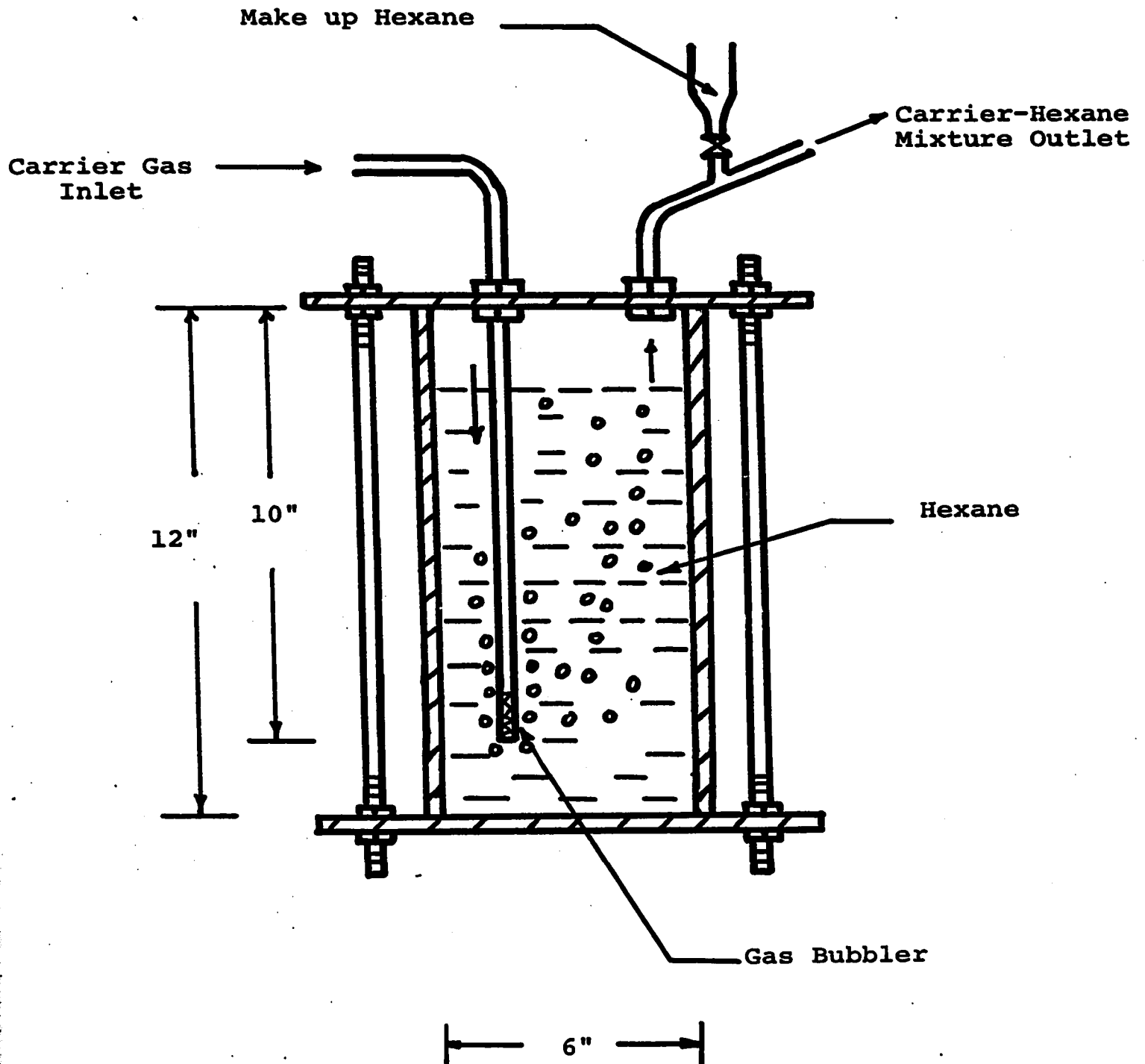


Figure 7 HEXANE SATURATOR

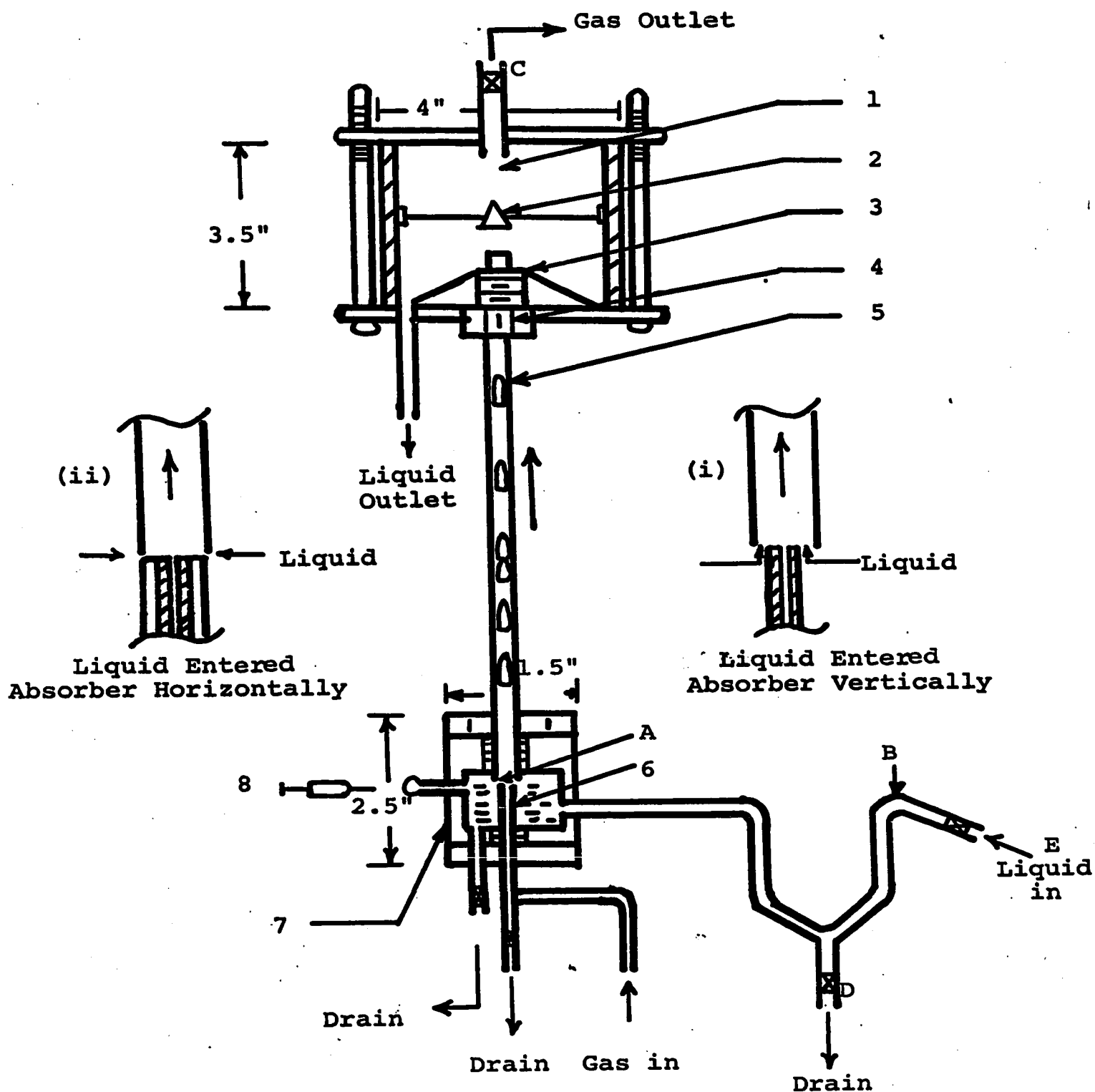


Figure 8 ABSORBER

1. Gas-Liquid Separator	5. Glass Tubing
2. Inverted Cup	6. Capillary Tube
3. O-Ring	7. Entrance Section
4. Fitting	8. Syringe

inverted cup (2) was used to prevent carry over of liquid into the gas phase. All runs were carried out at ambient temperature and pressure conditions.

After leaving the absorber, the gas phase then returned to the thermal conductivity cell and outlet concentration was determined from thermal conductivity measurements. A full description is given in appendix 5-A. The outlet liquid was collected and hexane stripped from the paraffin oil by bubbling nitrogen through the oil at 30°C. The oil was finally degassed under vacuum of 10" Hg and reused. A check was made using fresh and recycle paraffin oil and similar results were obtained.

IV-C. Photographic Study

A photographic study was carried out to measure the slug frequencies, slug rise velocities, slug separation distances, slug shapes and sizes. A detailed layout of the photographic equipment used is shown in figure 9. A 16 mm Red Lake Hycam camera and Kodak 4-X reversal film were used, frame speed being 1,000 frames per second. Possible distortion was reduced by placing a plexiglass block around the absorber tube. The degree of distortion was tested by measuring the width of a small rod of known dimensions placed at the center of the tube. The distortion was in the order of 2 to 3 per cent, see appendix 5-D. The camera was fitted with a timing light generator which enabled accurate evaluation of slug rise velocity. The lighting consisted of two 1,000 watt (120 volts) lamps. The films were developed and studied with a L-W photo analyser. Photographic equipment specifications are given in appendix 5-E.

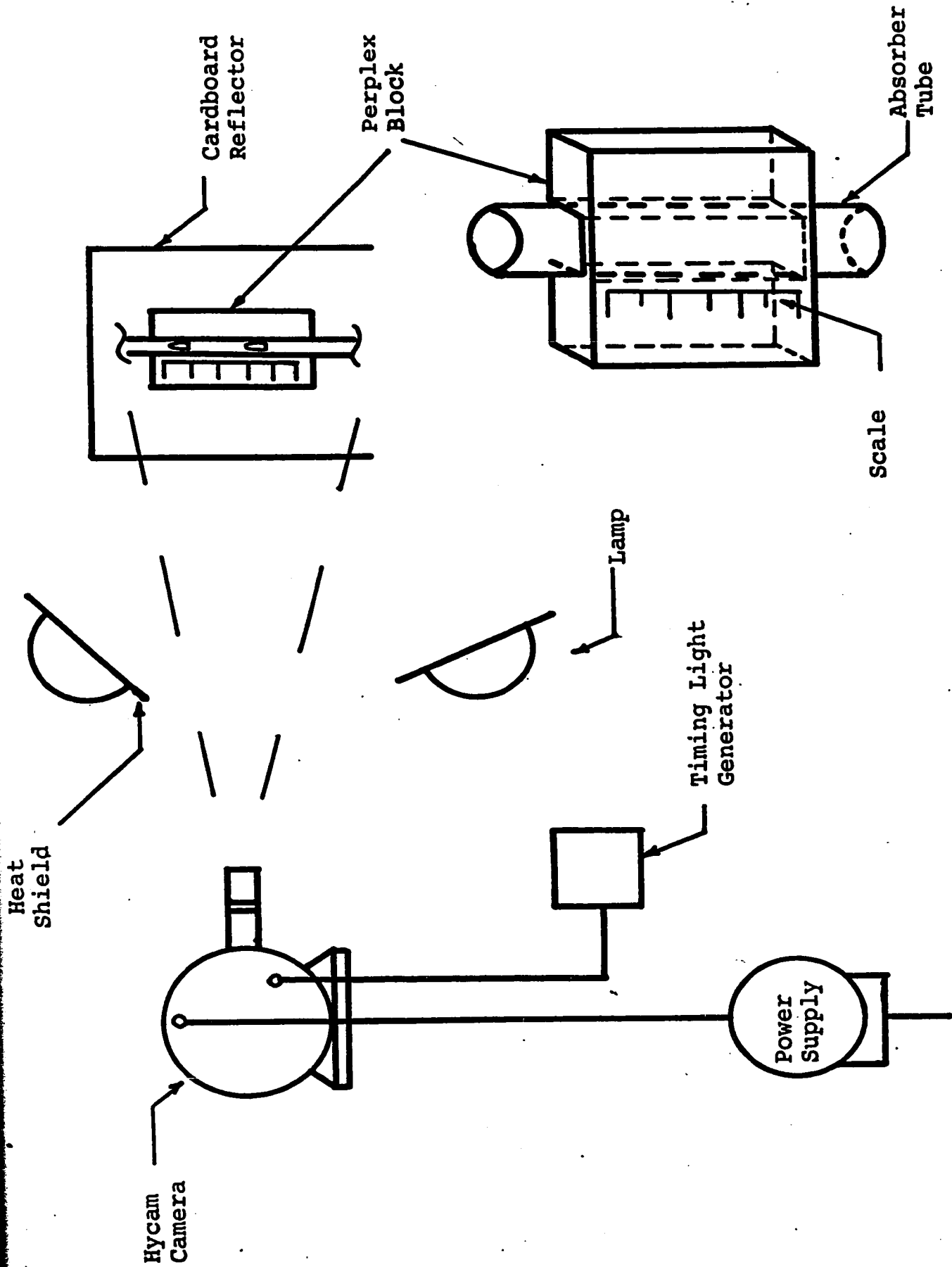


Figure 9. LAYOUT OF PHOTOGRAPHIC EQUIPMENTS

IV-D. Procedure

D-1. Mass Transfer Measurement

In starting an experimental run, hexane-free carrier gas was first passed through the absorber and both sides of the cell utilizing the by-pass line (18), figure 6. Then, after standardizing the potentiometer, the T.C.cell reading was set to zero by means of balancing adjustment in the power supply unit. The initial flow rate was given by a calibrated rotameter. The carrier gas was then diverted to the saturators, brought to room temperature and introduced into the absorber where mass transfer took place. The paraffin oil flow was then started. Exit gas from the absorber returned to the T.C.cell while the used paraffin oil was collected for purification. The run was allowed to reach steady state as indicated by the imbalance of the T.C.cell. At steady state, the millivolt reading of the cell, carrier gas and paraffin oil flow rates, absorber length, temperature of the saturator, pressure drops were recorded together with the barometric pressure and room temperature. The outlet gas rates with different inlet gas phase hexane compositions were also measured using the soap and bubble technique.

On completion of a run, the paraffin oil feed was stopped and the gas stream diverted back to the by-pass line and a duplicate run was carried out repeating the same procedure. For each tube diameter, a series of runs were made at different gas flow rates, liquid flow rates and gas phase concentrations. The absorber length was also varied to determine

the effect of contact time on mass transfer and flow characteristics. When changing carrier gas and paraffin oil, care was taken to completely purge the apparatus before starting a new series of runs.

D-2. General Flow Characteristics

2-a. Void Fraction

The gas phase void fraction in each tube length absorber was determined from knowledge of the total volume of the absorber and the liquid hold-up in the absorber. The liquid hold up was determined by simultaneously closing valves E and C, the liquid trapped was then allowed to drain through D, collected and its volume measured, see figure 8. This volume included liquid in the inlet line A-B which was determined and subtracted to give the actual liquid hold up. This was done by allowing the liquid to rise slowly to the position A and then closing the valve E. The liquid trapped was then drained and measured.

2-b. Slug Surface Area and Volume

These were determined by means of high speed photography. A 25 mm lens was used and 25 feet length of film employed with the frame speed of 1,000 f/sec. Slug images on the films were projected onto a calibrated screen and the slugs traced, tracings were taken for each run at different positions in the absorber. Three absorber lengths were studied, 15, 25 and 40 cm. The slug surface areas and volumes were calculated numerically assuming radial symmetry, see appendix 2-A.

2-c. Slug Frequencies

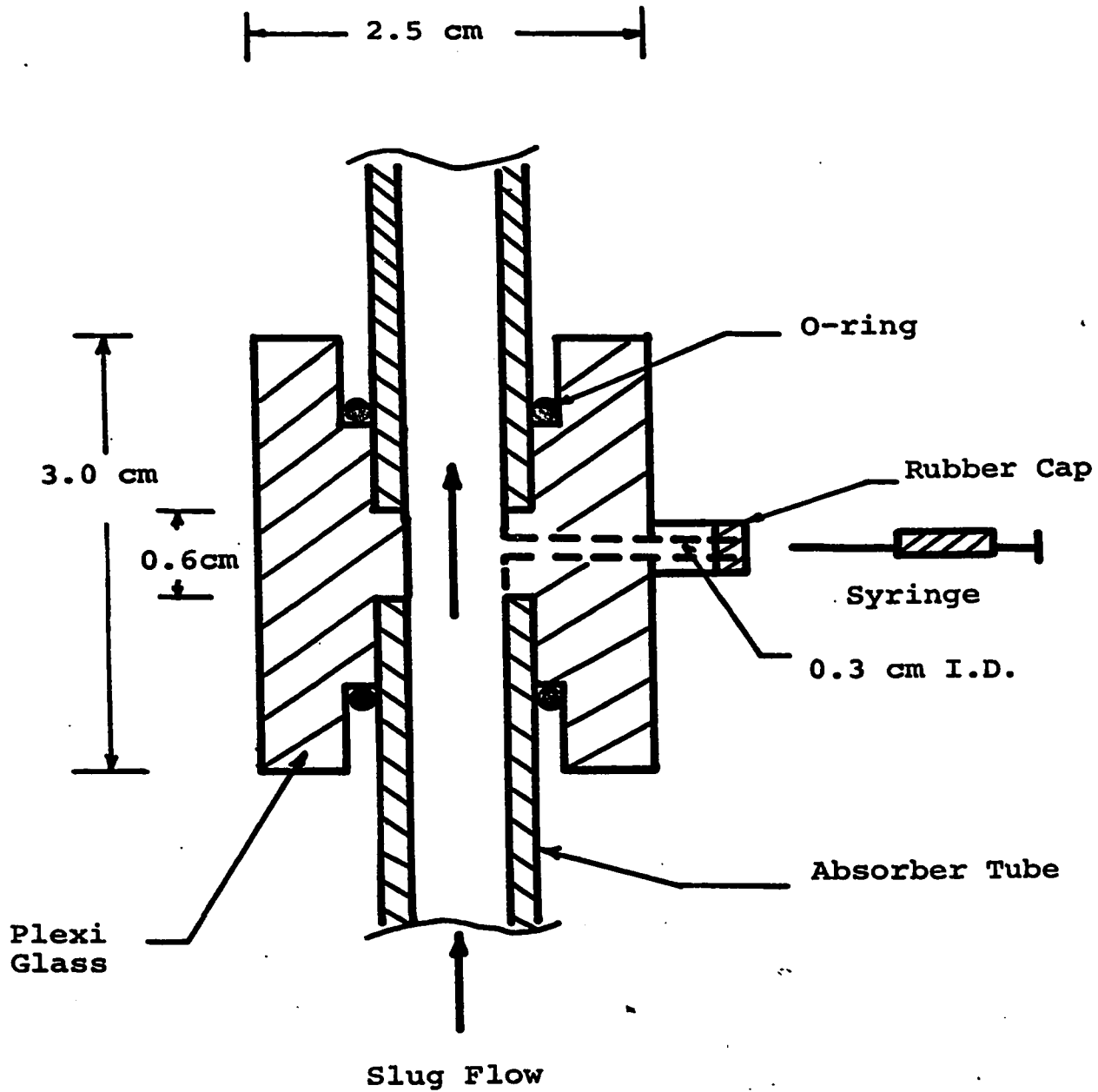
The slug frequencies were measured by determining the number of slugs passing through a reference point in the absorber for ten foot length of film and the time determined by counting the total number of timing light marks appearing on the film. The timing light generator was set at 1,000 points per sec. and the reading checked with an oscilloscope. Slug frequencies for absorber lengths other than 15, 25, and 40 cm were measured approximately by means of a stroboscope.

2-d. Rise Velocities

The slug rise velocities and separation distances were measured with the aid of a microscope, magnification x10. The film was pulled manually through the eyepiece of the microscope and examined. The distance travelled by the noncoalescing slugs at any position in the absorber from one location to another was measured. The time taken for the slug to travel this distance was again determined by means of the timing light marks on the film. The separation distances between slugs were also read off the scale directly. When pairing of slugs took place as they rose up the absorber i.e. $Z > 5$ cm, specific velocity measurements were made to determine the influence of the wake on the trailing slugs.

2-e. Liquid Mixing

Liquid mixing characteristics were studied by the injection of red merian oil having the same specific gravity as the paraffin oil. The oil was injected with a syringe at two points, in the entrance section and at a point along the absorber, see figures 8 and 10.



MID-COLUMN DYE INJECTION POINT

Figure 10

V. RESULTS AND DISCUSSION

V-A. General Slug Flow Characteristics

A-1. Introduction

The following variables were measured in determining the slug flow characteristics; pressure drop, gas phase void fraction, slug frequency, slug shape and size, slug separation distance, slug rise velocity and liquid mixing profiles. The results obtained are tabulated in appendix 1 and liquid mixing characteristics described in ~~section V-A-2~~. The majority of the runs were carried out with mass transfer taking place, only a limited number of runs being made with pure carrier gas and paraffin oil. Three mean gas rates 165, 245 and 326 cc per min and three liquid rates, 30, 45 and 60 cc per min were employed. It was found that at low gas rates or high liquid rates, consistent flow patterns could not always be obtained with absorber length greater than 30 cm. Under these conditions, the flow patterns changed from continuous chained bubble flow to an intermittent slug type of flow. This behaviour was characterized by excessive pressure drop fluctuations and a break in the pressure drop versus absorber length curves, figure 11. In addition to ensure complete saturation of the gas phase an upper limit of 326 cc per min was placed on the gas flow rate, see appendix 5-B.

A-2. Flow Pattern

The slug flow patterns observed in these studies were

VARIATION OF TOTAL PRESSURE DROP WITH ABSORBER LENGTH

System : n-Hexane-Nitrogen-Light Paraffin Oil

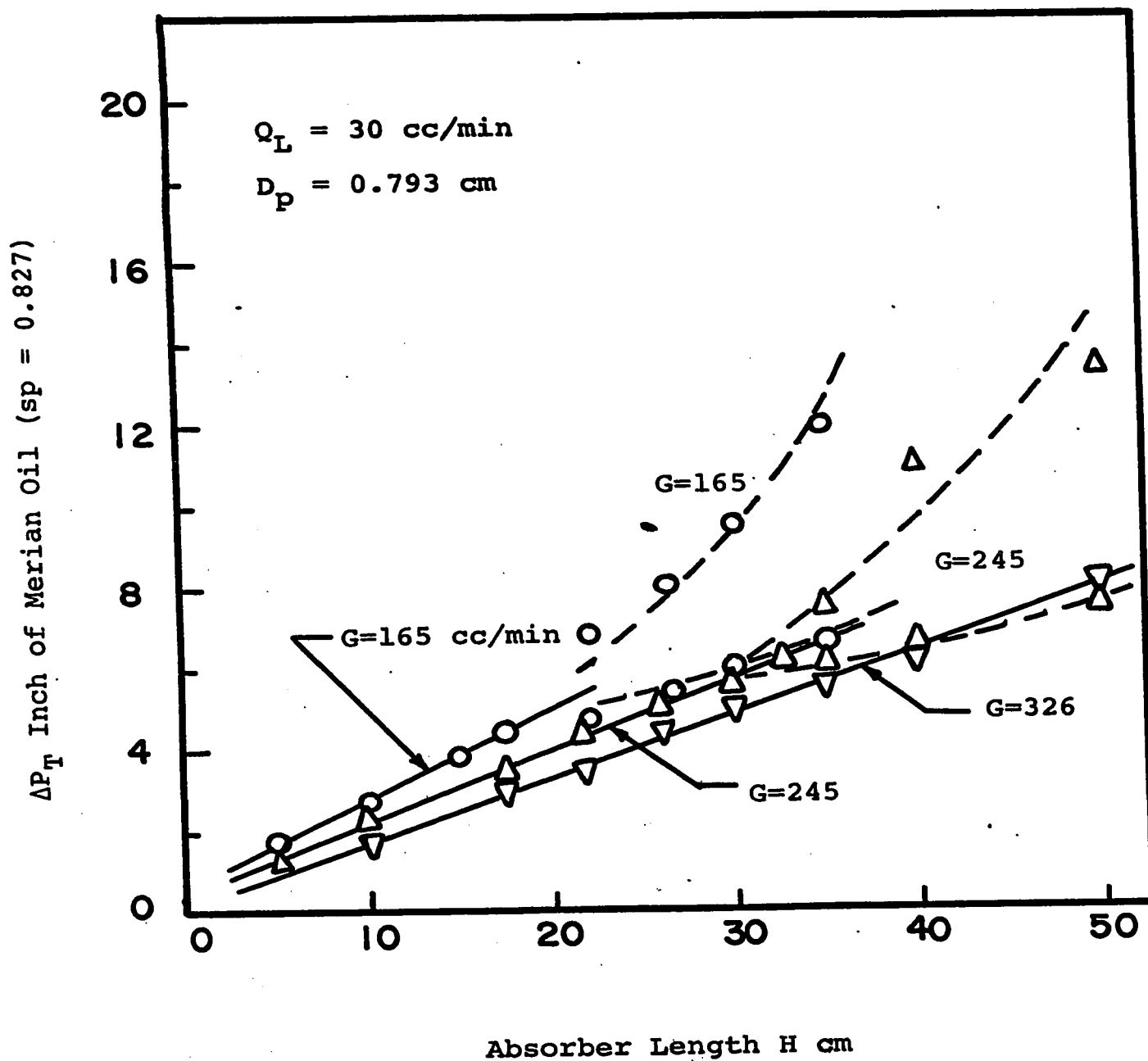


Figure 11

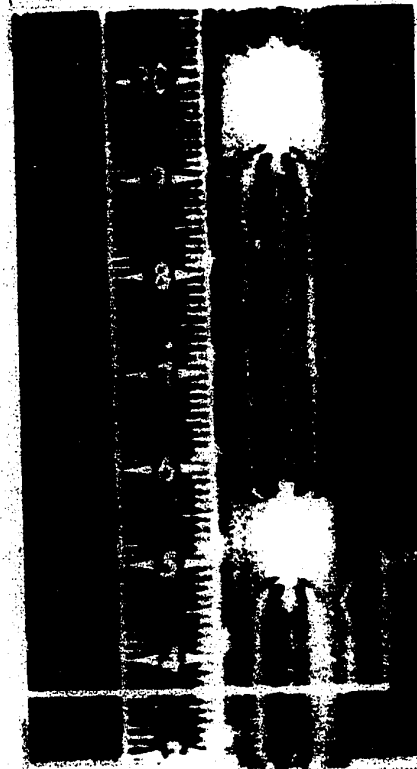
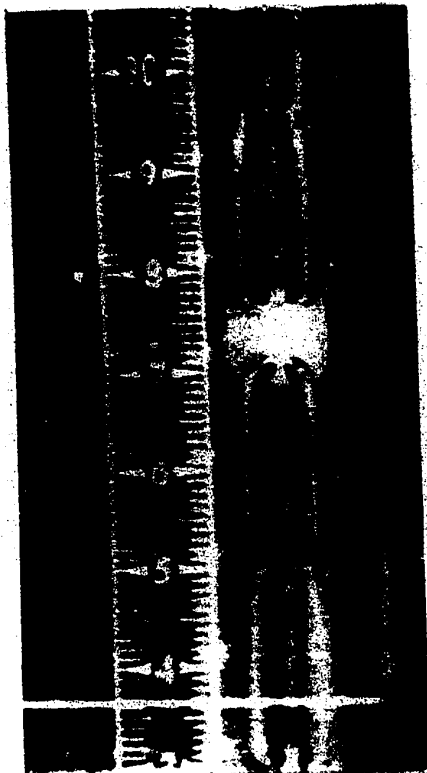
very complex and depended on both operating variables and system variables as well as absorber geometry. In the initial experimental runs, carried out with pure carrier gas and paraffin oil, slugs rose in close proximity to each other with little or no coalescence. The patterns are shown in figure 12, A and C. The situation however was not normally the same when mass transfer took place, the patterns being characterized by slugs which rose up the absorber separated by liquid plugs and the flow was not fully developed. The slugs also showed a tendency to pair and coalesce with increasing absorber length, figure 12, B and D. It was observed that with the light paraffin oil slug sizes were considerably smaller than the sizes obtained with the heavy paraffin oil.

Slug coalescence resulted in a continually changing flow pattern along the absorber, the coalescence being the function of slug position and initial absorber length. The following behaviour can be considered typical and is represented schematically in figure 13. At the bottom of the absorber, gas bubbles were formed, coalescing rapidly to produce bullet shaped slugs. These zones are considered as formation and developing zones and extended over a distance of approximately 1.4 and 1.5 cm respectively, see appendix 4-D. The slugs then rose up the absorber, tended to pair and sometimes coalesced before leaving the absorber. It was found that the slug separation distance determined whether pairing of slugs took place and was found to be about $0.25 D_p$. Careful observation of the photographs showed that as the slugs paired, the nose of the trailing slug was slightly distorted becoming

A

B

WITH MASS TRANSFER



Light Paraffin Oil

$H = 20 \text{ cm}$

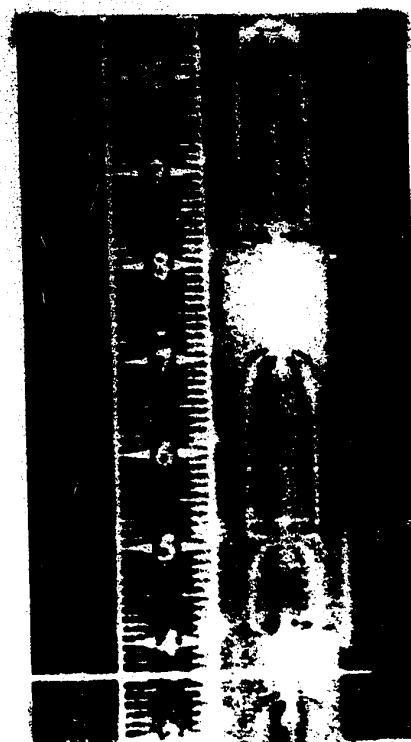
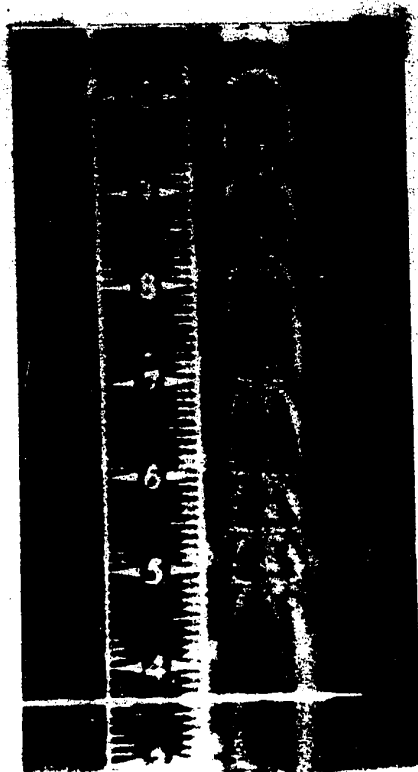
$G = 245 \text{ cc/min}$

$Q_L = 30 \text{ cc/min}$

C

WITHOUT MASS TRANSFER

D



Heavy Paraffin Oil

Figure 12

SCHEMATIC REPRESENTATION OF SLUG BEHAVIOUR
IN THE PRESENT OF MASS TRANSFER

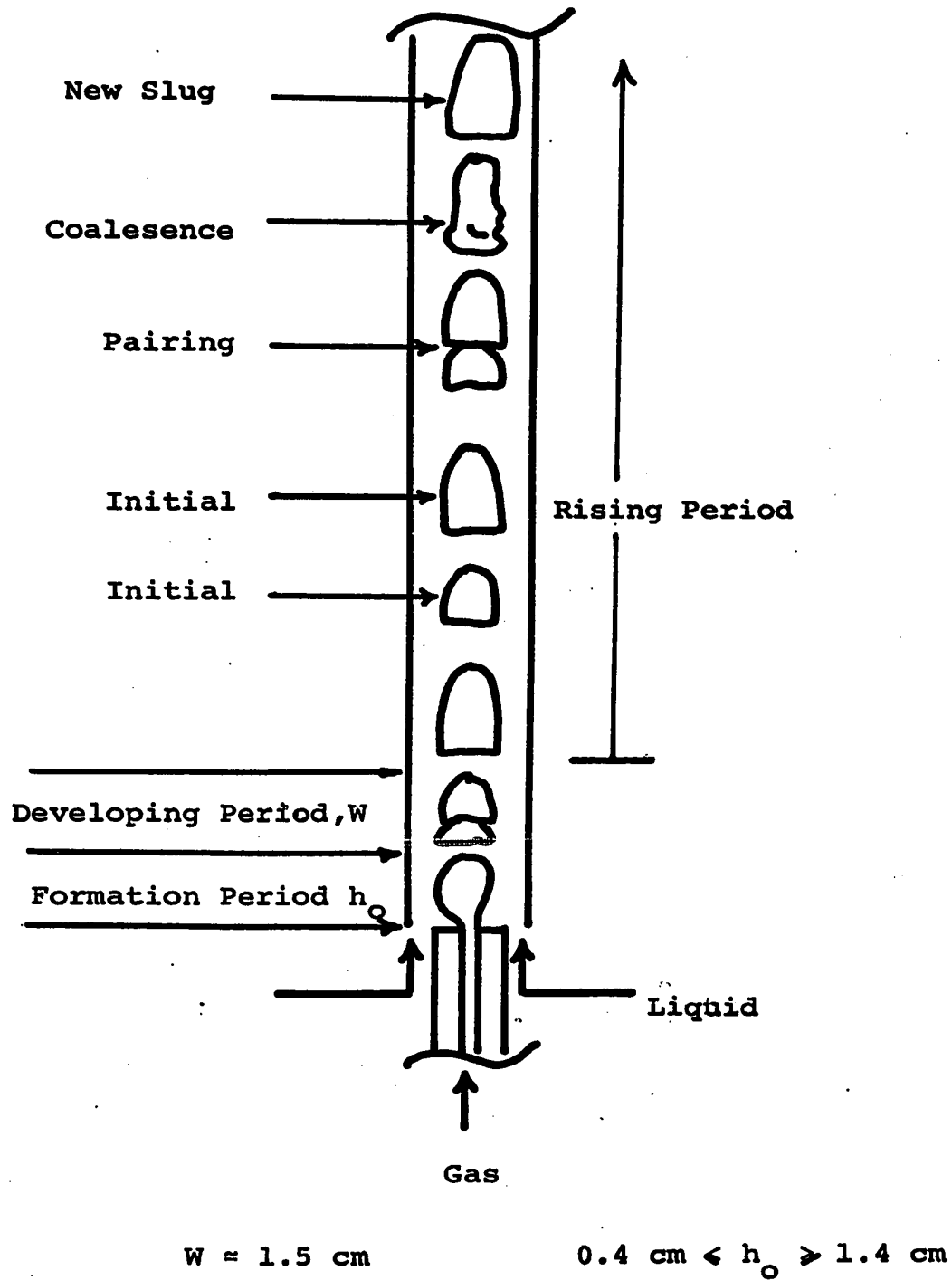


Figure 13

eccentric on one side or the other. This was then followed by an increase of trailing slug rise velocity until pairing took place. For individually rising slugs, the shapes, the sizes and the rise velocities were fairly constant.

One other definite flow pattern was also observed, occurring at low gas rates and high liquid rates. Small slugs similiar in shape to spherical caps, chained together with very little coalescence while rising up the absorber, an effect of mass transfer was not apparent. Griffith and Wallis (3) regarded this flow pattern as a transitional flow between the bubble and slug flows.

The direction of mass transfer also influenced flow patterns. When nitrogen was used to strip hexane from liquid solvent containing 0.02-0.07 mf. of hexane, variations in flow rates and absorber geometries effected only the slug lengths and shapes but not the overall flow patterns, these patterns being similiar to those found with no mass transfer taking place.

Mass transfer would be expected to have affected liquid phase and interfacial physical properties such as density, surface tension and viscosity which would in turn affect the relative motions of the slugs. Densities of both phases and interfacial surface tensions, however, only varied slightly (<5%) as the hexane composition varied from zero to 0.08 mf , appendix 6-B. Liquid viscosity μ_L however could be affected to a much larger extent than ρ_L or σ by the increasing of hexane composition since the viscosity of hexane is only 0.2569 cp which is small compared with those of pure paraffin

oil (≥ 40 cp). Consequently, liquid phase viscosities continually decreased along the absorber which would then tend to promote slug coalescence. This would also account for the effect of the direction of mass transfer as when hexane was stripped from the liquid phase, liquid viscosities would increase and flow patterns tend towards the pattern observed when no mass transfer took place. Liquid mixing in the liquid phase, see section V-A-8, was also affected by flow pattern and as mixing was incomplete, a viscosity gradient might have been established in the liquid zones which could also influence the movement of gas slugs. Further studies in this area are required.

In practice, it was impossible to determine the effect of the variation of inlet composition on flow characteristics, i.e. ΔP_T and α . This was due to the mass transfer taking place in the formation and developing zones which tended to equalize the liquid phase bulk concentrations at the beginning of the rise zone. As a result, there was a sudden decrease in both ΔP_T & α which was independent of the actual inlet composition, figures 14 and 15.

As shown in figure 16, the flow patterns also showed a decrease of unit pressure drop and increase of hold up ratio with $R_V = G/Q_L$ as observed by Govier (47,48), figure 4. This is considered to be the characteristics of the vertical slug flows (47,48) and the data obtained in the present study lay in the region characteristic of vertical slug flow .

TOTAL PRESSURE DROP VS INLET GAS PHASE COMPOSITION

System : n-Hexane-Nitrogen-Paraffin Oil

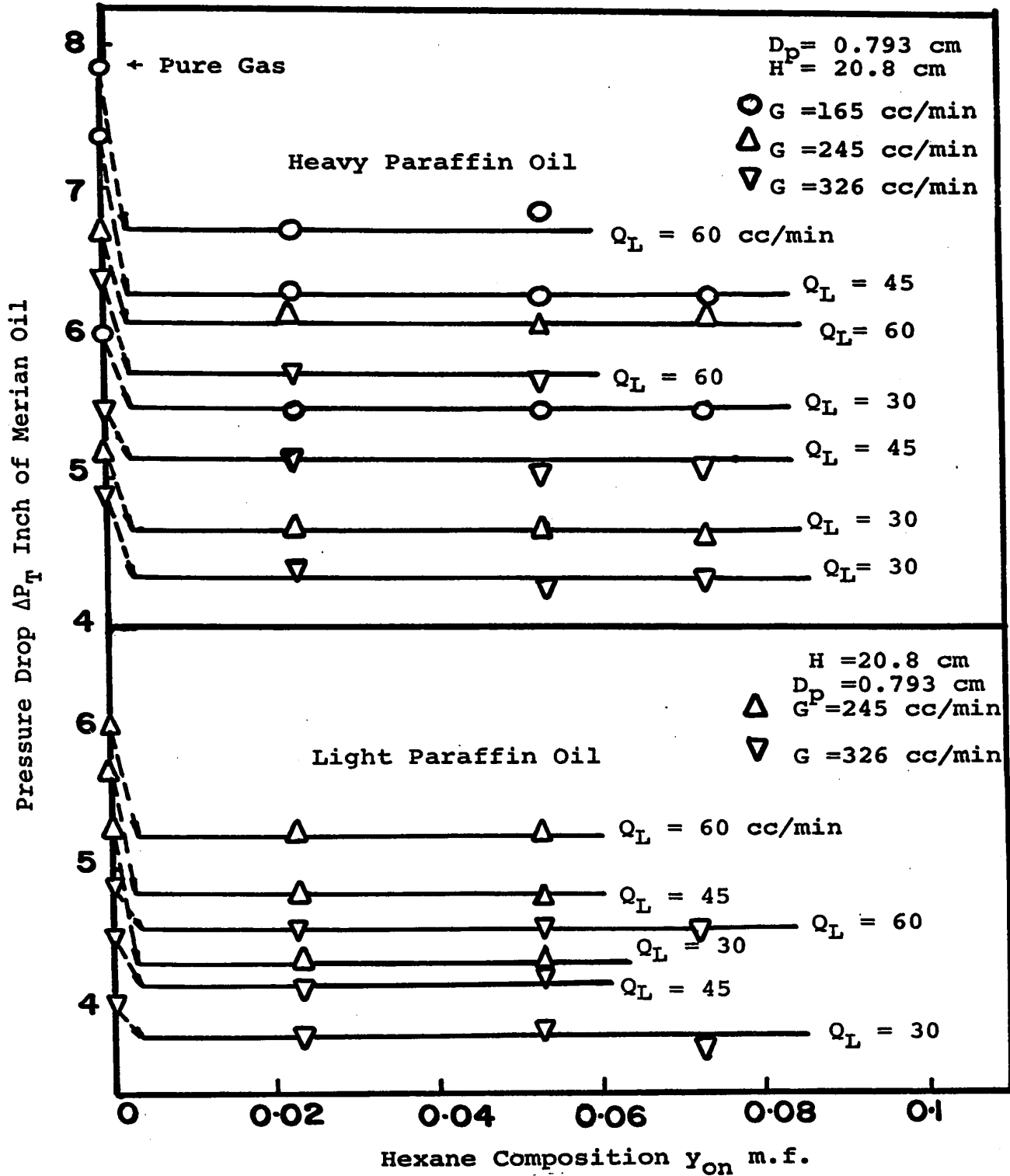


Figure 14

EFFECT OF INLET GAS PHASE COMPOSITION

ON GAS PHASE VOID FRACTION

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

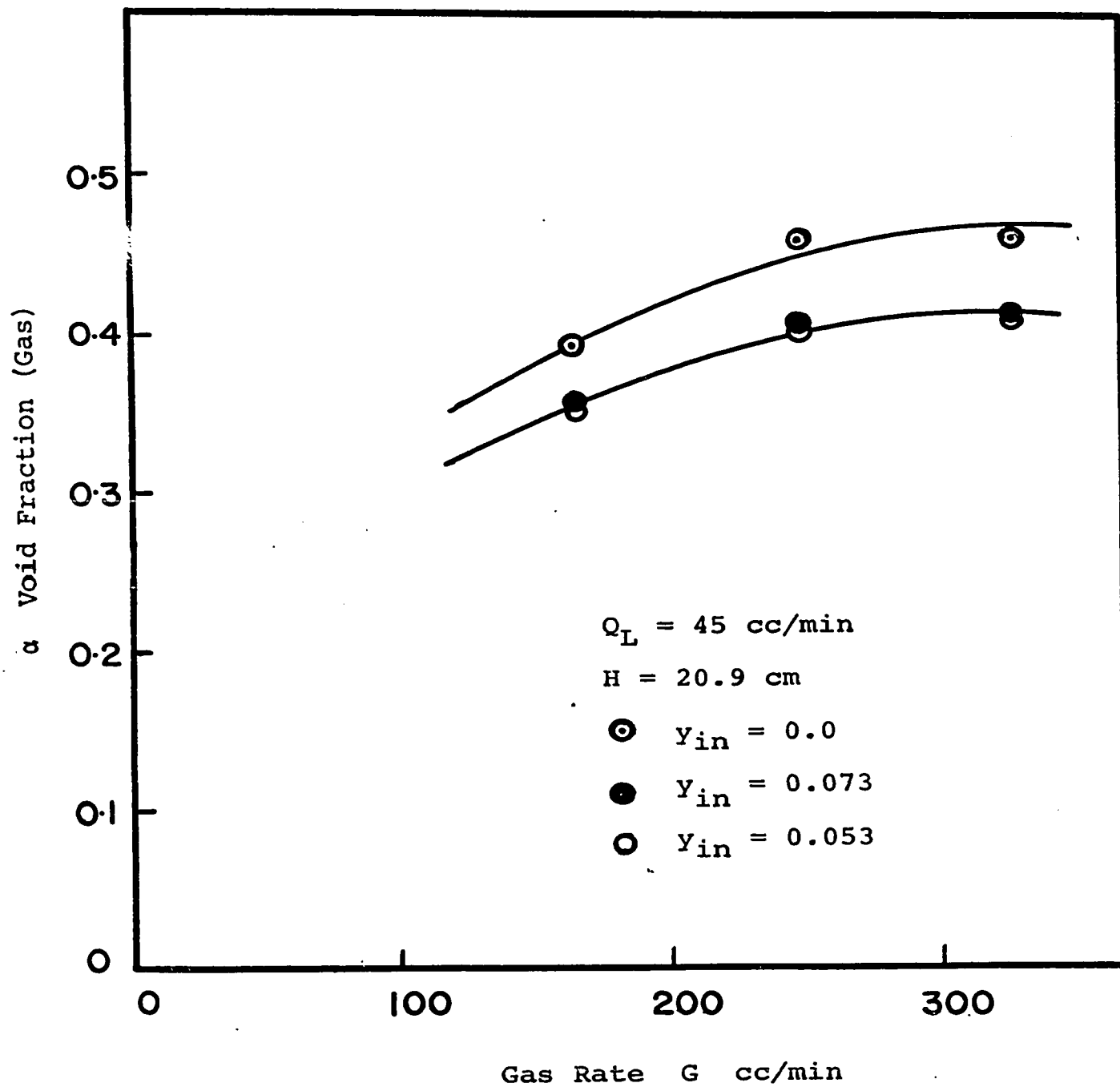


Figure 15

VARIATION OF UNIT PRESSURE DROP AND HOLD

UP RATIO WITH R_V

System : n-Hexane-Nitrogen-Light Paraffin Oil

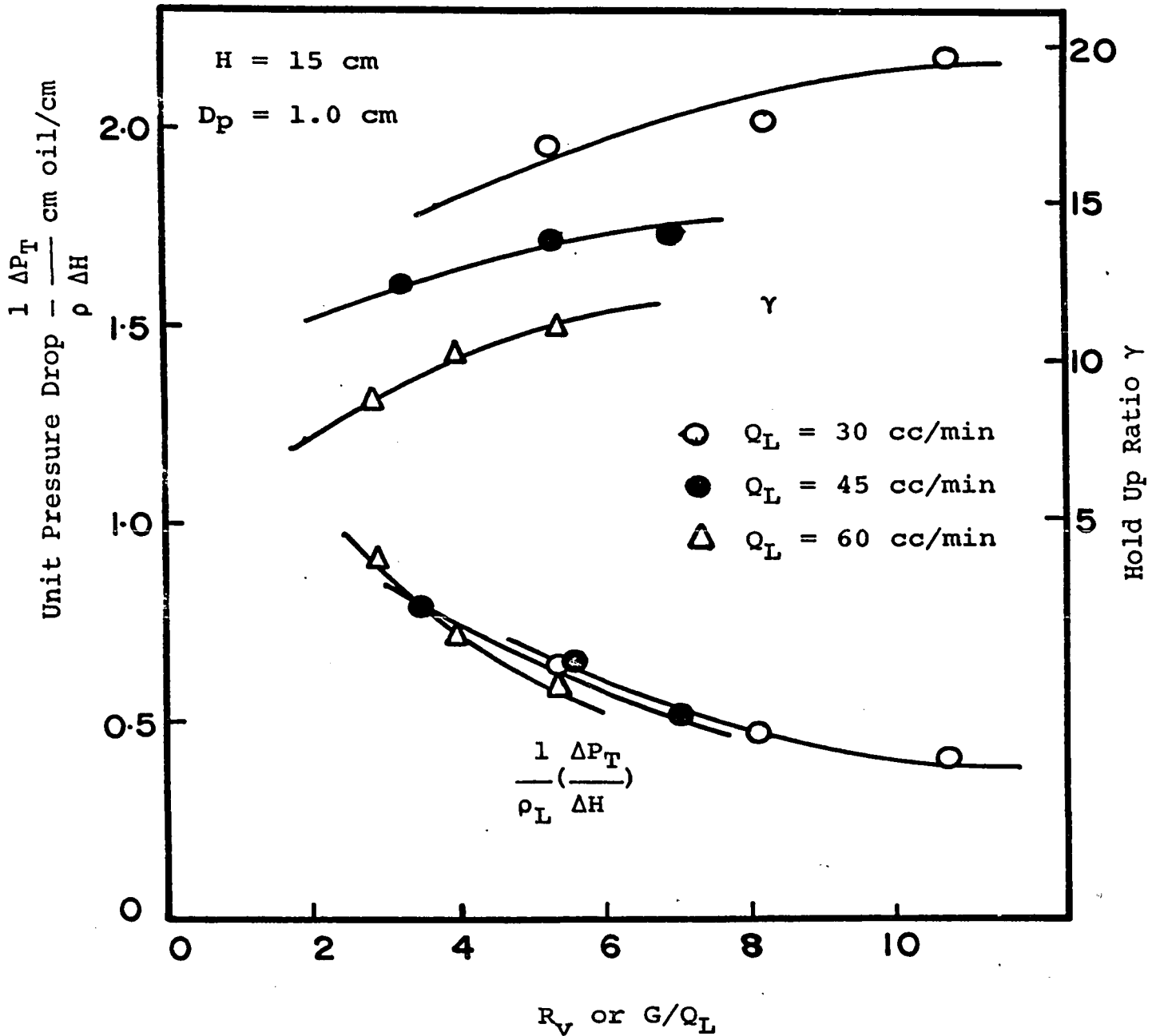


Figure 16

A-3. Slug Frequencies

Under unstable flow conditions, slug frequencies were found not only to be the function of liquid phase viscosity, gas and liquid rates, gas phase density and tube diameter but also of slug position Z and absorber length H . With increase in contacting length, Z , slug frequencies decreased due to slug coalescence, at first quite rapidly but slowed down as the slug travelled through rise the zone becoming generally constant for $Z > 15\text{cm}$. This was particularly apparent for the data obtained with the heavy paraffin oil. With light paraffin oil the variations were less pronounced, see figure 17. It was not possible to predict generally at what point slug coalescence would take place. The degree of slug coalescence f_c however lay generally in the 0.75-1.0 range but at $H = 40\text{ cm}$, $G = 326\text{ cc/min}$ and $Q_L = 60\text{ cc/min}$, with the n-hexane-nitrogen-light paraffin oil system values as low as 0.45 were observed. f_c was defined as F/F_0 , where F =point frequency and F_0 = initial frequency at $Z = 5.0\text{ cm}$.

When the mean frequency $\bar{F}$ defined as the average of the point frequency values for any absorber length was plotted against the absorber length H , in figures 18 and 19, a definite effect of H on frequency was observed. The frequencies first decreased with increasing H until a minimum was reached at absorber length of approximately 25 cm at which point frequencies started to increase again with H . The effect was particularly pronounced for the heavy oil. This variation of $\bar{F}$ with H is further illustrated in figure 20 in photographs taken of the rising slugs. In addition, as indicated in figure 21, with increasing absorber diameter D_p , slug frequencies decreased. The decrease was

VARIATION OF SLUG FREQUENCIES ALONG THE ABSORBER

System : n-Hexane-Nitrogen-Paraffin Oil

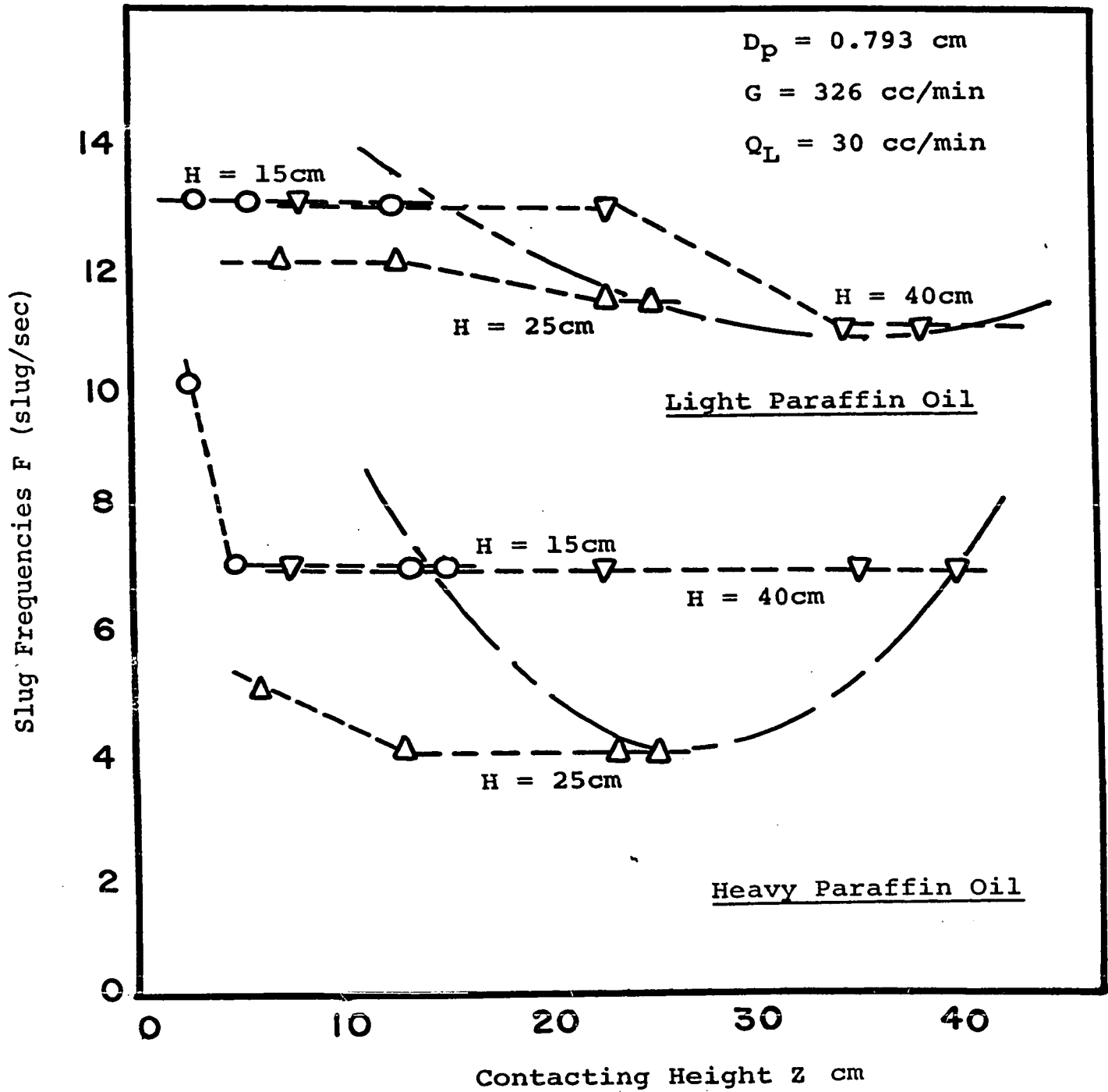


Figure 17

VARIATION OF MEAN SLUG FREQUENCIES WITH ABSORBER LENGTH

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

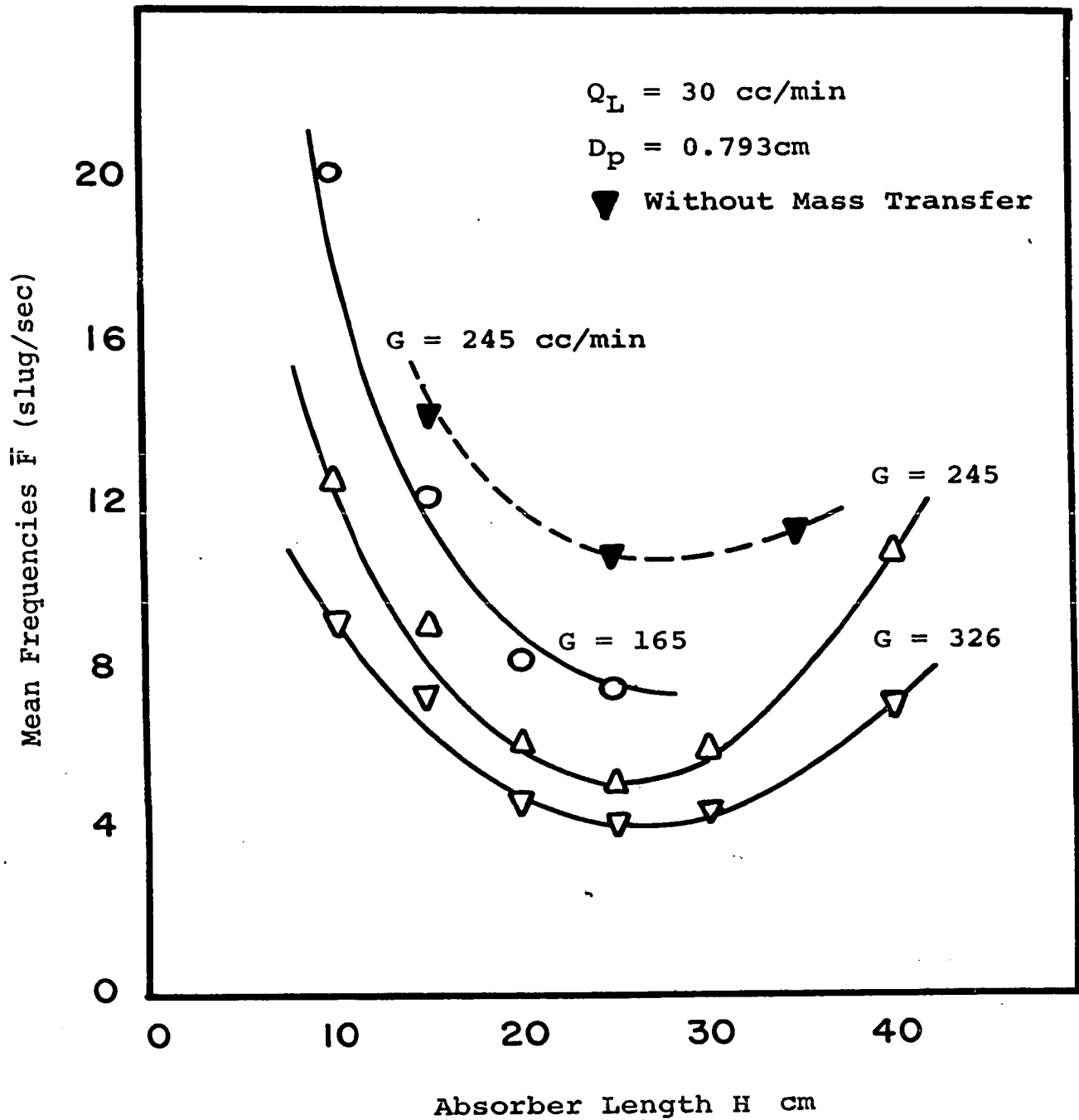


Figure 18

VARIATION OF MEAN SLUG FREQUENCIES WITH ABSORBER LENGTH

System : n-Hexane-Nitrogen-Light Paraffin Oil

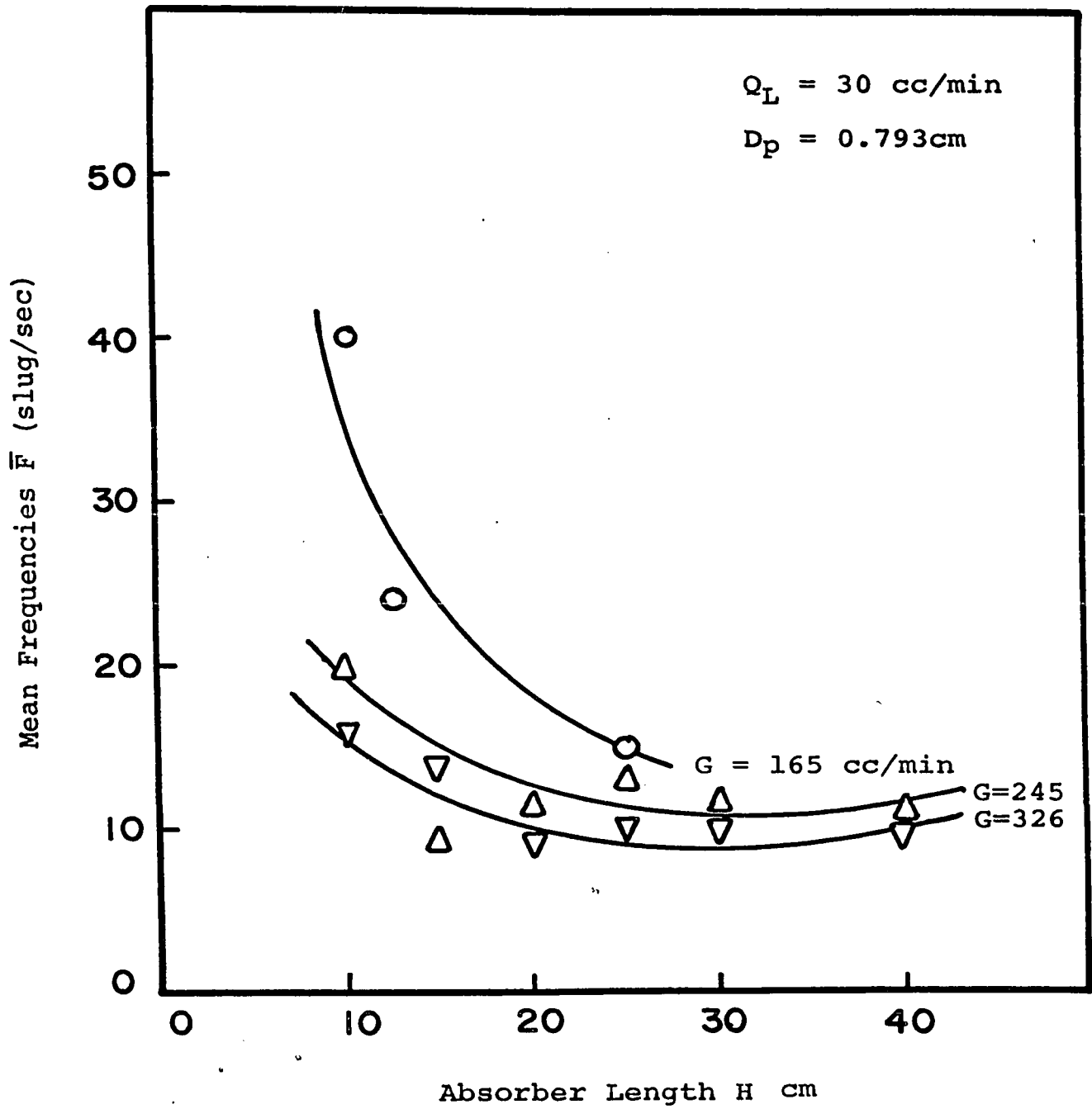
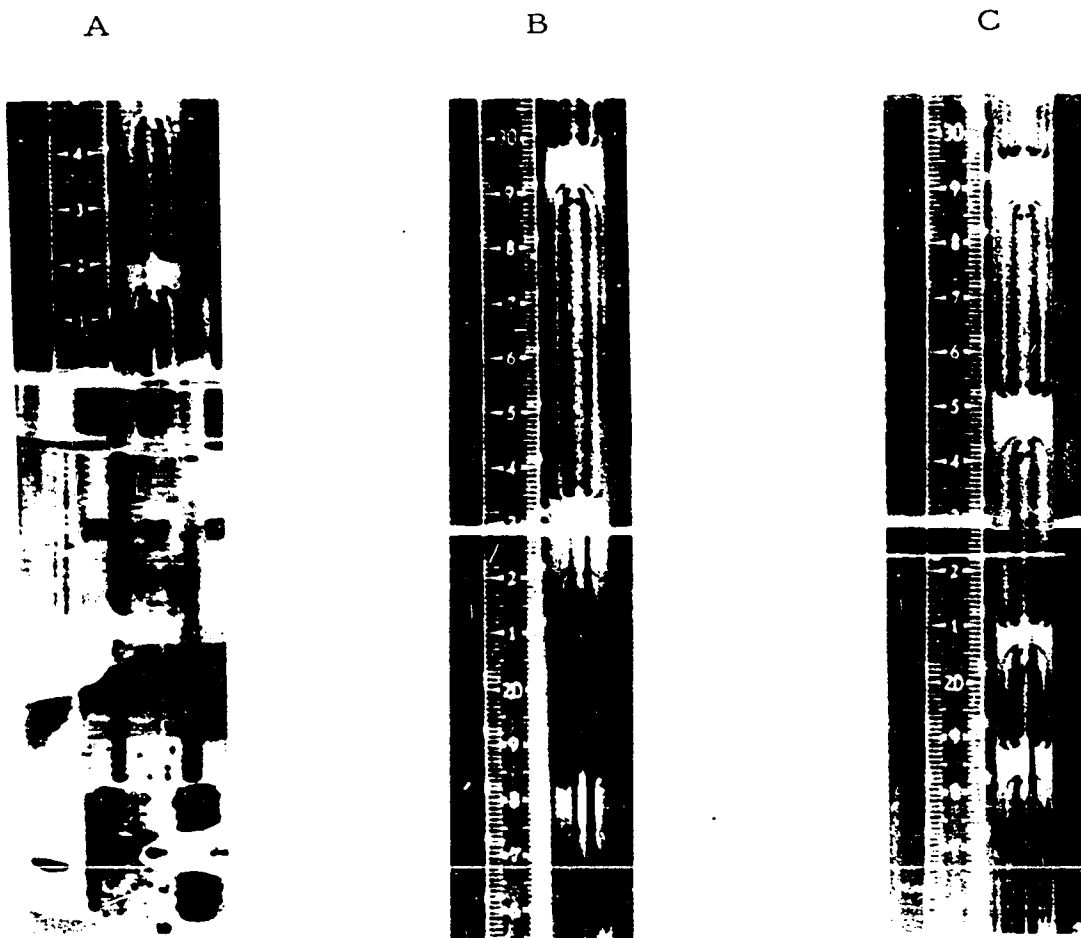


Figure 19



VARIATION OF SLUG SIZE WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

$$G = 326 \text{ cc/min}$$

$$Q_L = 30 \text{ cc/min}$$

$$D_p = 0.793 \text{ cm}$$

Absorber Length :

$$A : H = 10 \text{ cm}$$

$$B : H = 25 \text{ cm}$$

$$C : H = 40 \text{ cm}$$

Figure 20

VARIATION OF MEAN SLUG FREQUENCIES
WITH ABSORBER DIAMETER
 System : n-Hexane-Nitrogen-Paraffin Oil

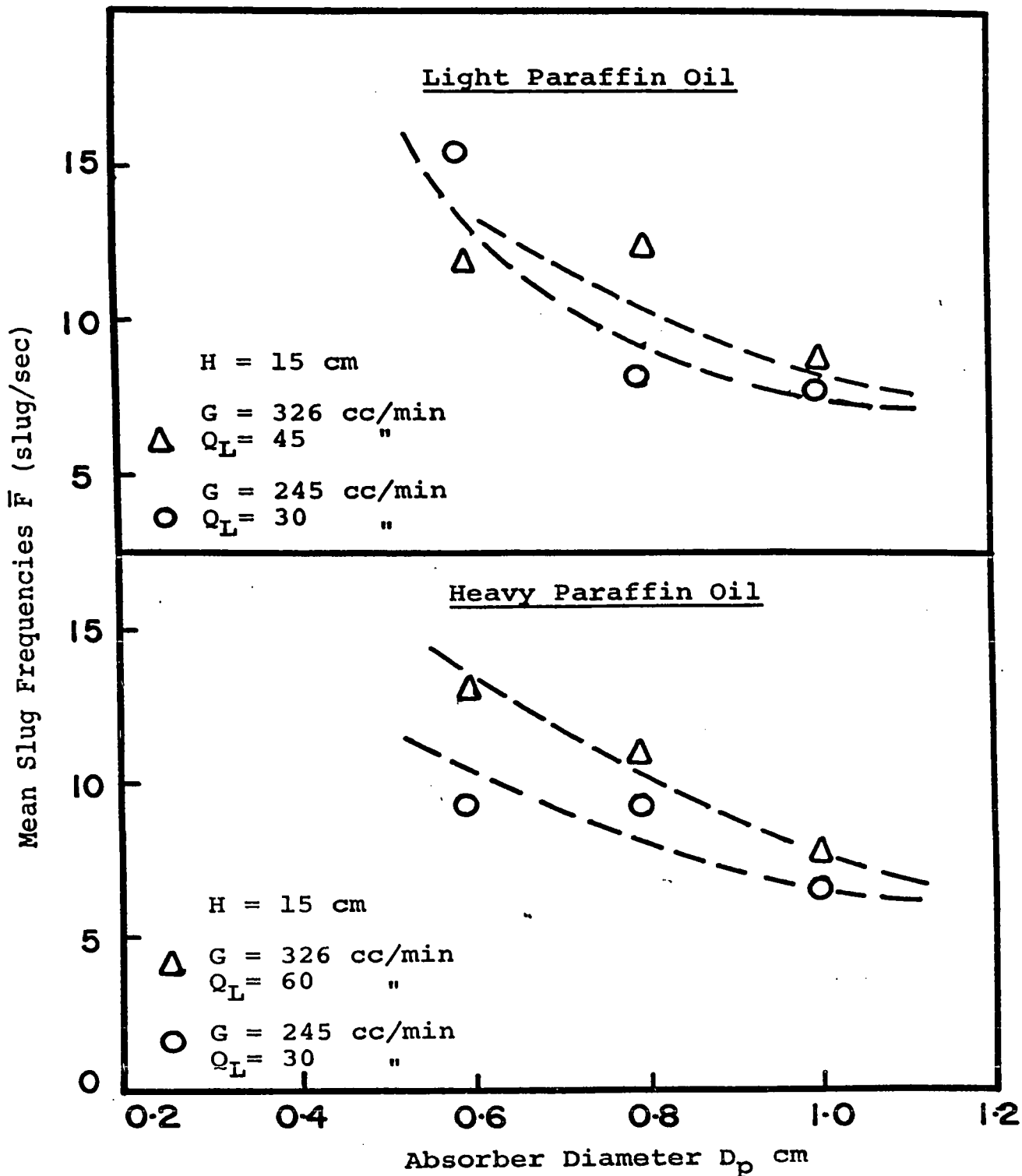


Figure 21

at first rapid but tended to slow down at the largest D_p . Slug frequencies were also found to decrease with increase in gas phase density ρ_g see figure 22. These results were consistent with the results reported by Brown, Sullivan and Govier (47) who investigated the effect of ρ_g on flow patterns for the air-water system in a 1.5 inch vertical tube.

Due to the variation in flow pattern with changes in both gas and liquid flow rate, it was not possible to determine the exact effect of fluid flow rates, G and Q_L on slug frequencies. Figures 17 and 18 show that the mean frequency decreased with increasing G for $Q_L = 30$ cc/min. However, at some liquid rates, as in figure 23, the variations of $\bar{F}$ were unpredictable, e.g., with heavy paraffin oil, frequencies at $Q_L = 60$ cc/min first decreased with increase in G but then started to increase at the high gas rate. Increase in Q_L at constant G also tended initially to decrease slug frequencies but at higher Q_L the trend was reversed. Consequently any correlation similar to that proposed by Scott and Gregory (70) for horizontal fully developed slug flow was not possible.

A-4. Void Fraction

The effect of H on slug frequencies was also confirmed by the gas phase void fraction α measurements as in figure 24 which exhibited a maximum for absorber lengths in the neighbourhood of H equal to about 25 cm. This was essential as at constant gas and liquid rates, when frequencies decreased, the slug sizes would increase which would then increase the gas phase void fraction. As expected, in figure 25, α also

VARIATION OF MEAN SLUG FREQUENCIES
WITH GAS PHASE DENSITY

System : n-Hexane-Nitrogen-Paraffin Oil

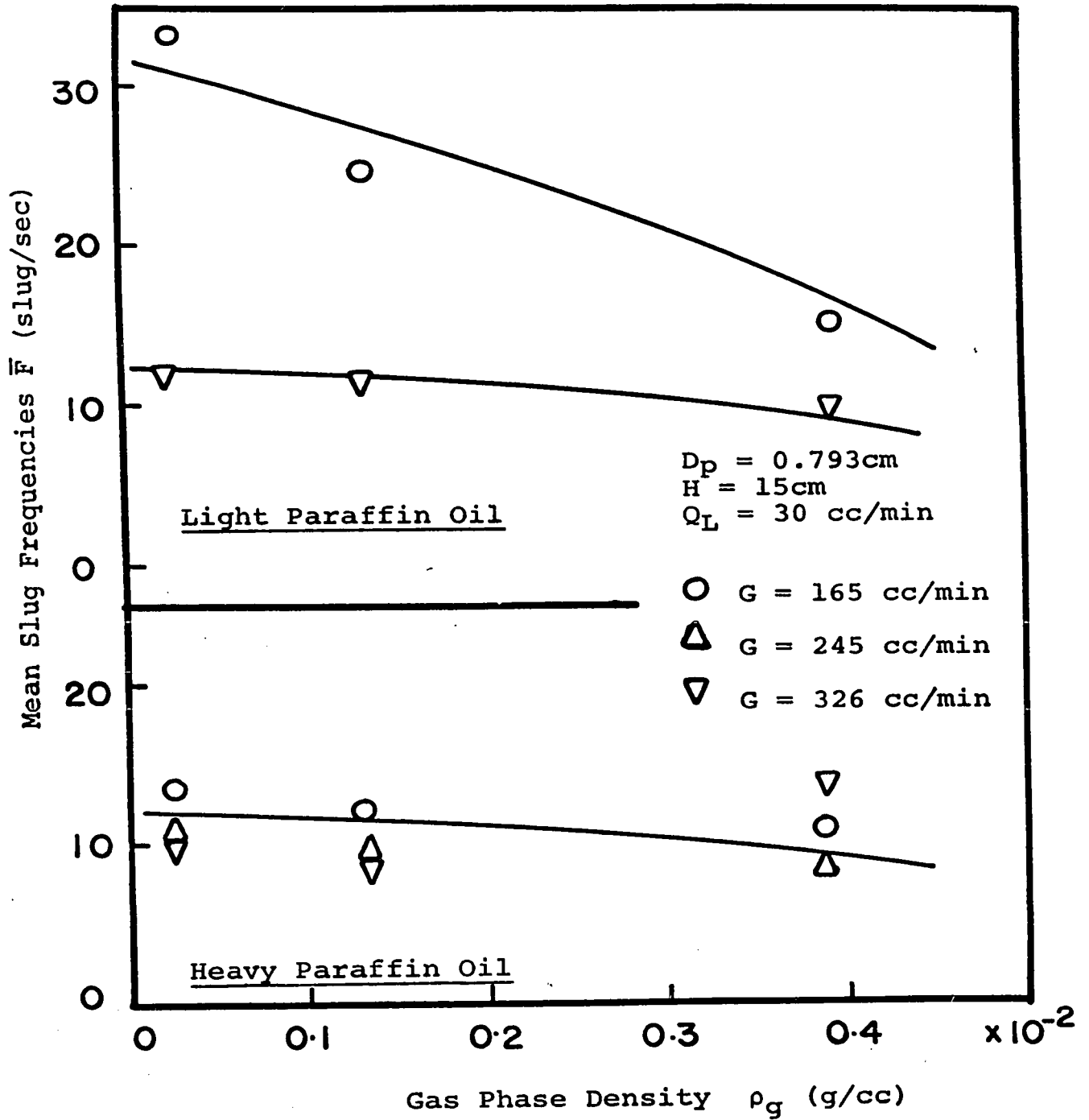


Figure 22

EFFECT OF GAS AND LIQUID RATES
ON MEAN SLUG FREQUENCIES

System : n-Hexane-Nitrogen-Paraffin Oil

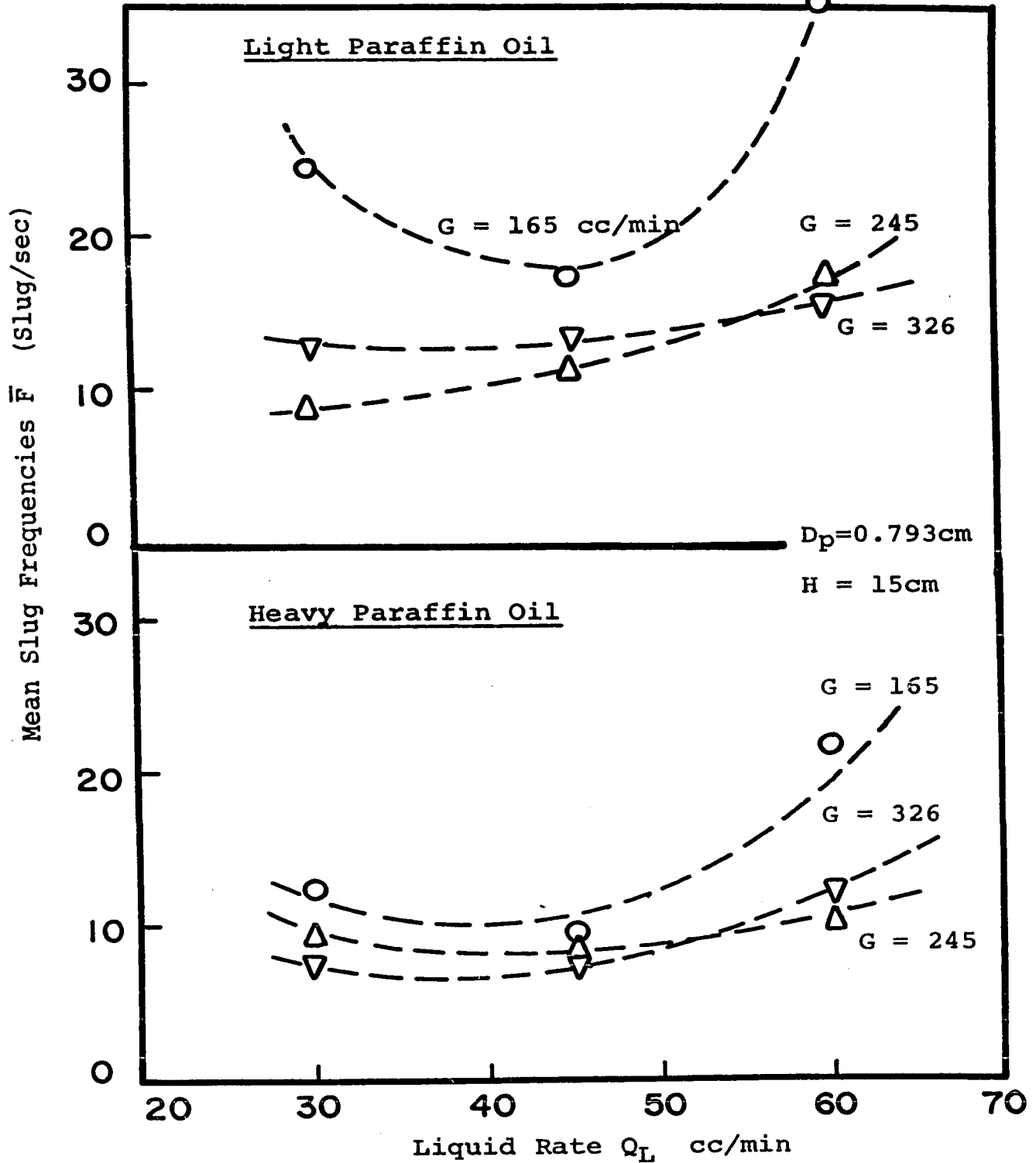


Figure 23

VARIATION OF GAS PHASE VOID FRACTION WITH ABSORBER LENGTH

System : n-Hexane-Nitrogen-Paraffin Oil

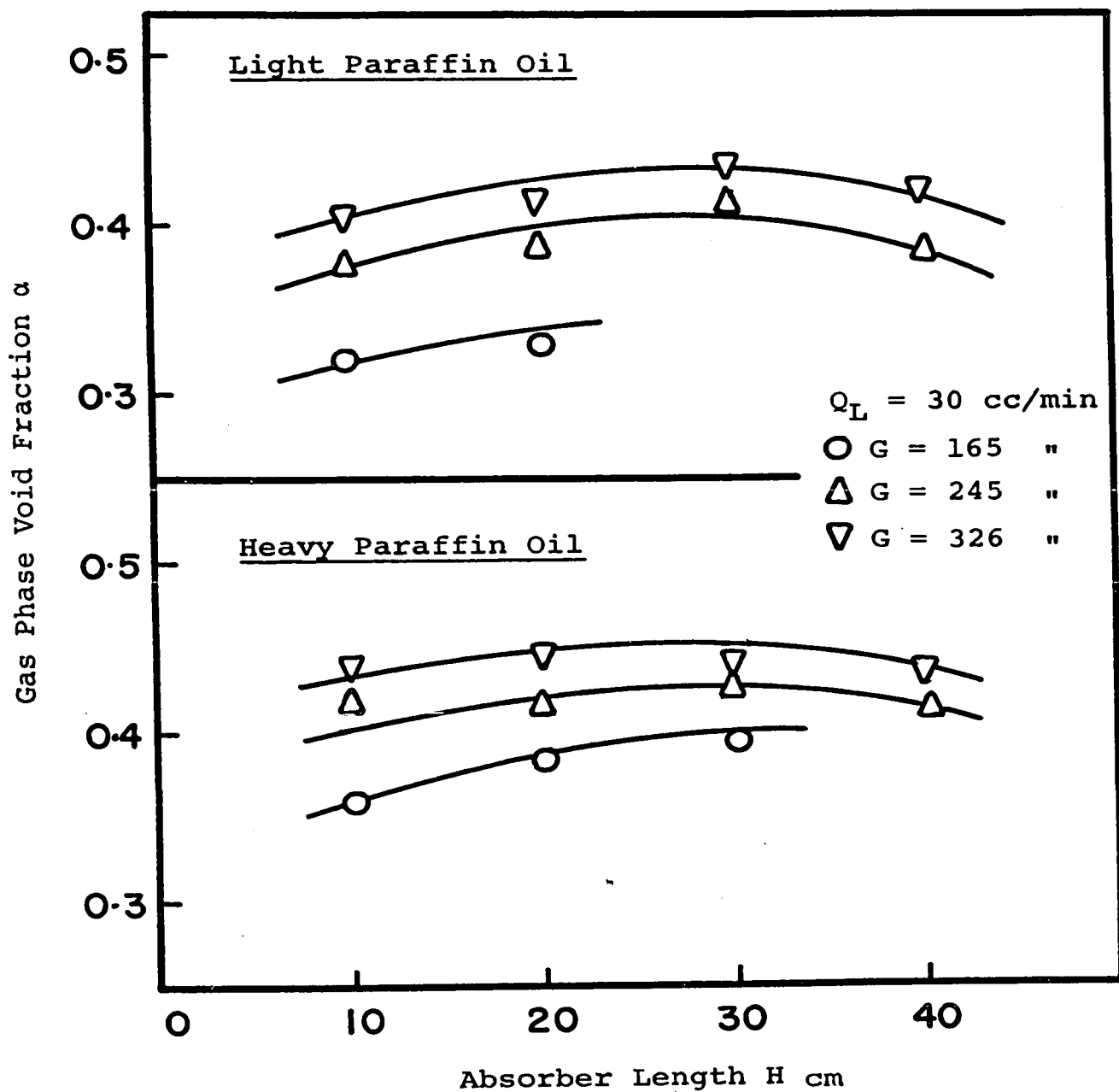


Figure 24

EFFECT OF ABSORBER DIAMETER, GAS AND LIQUID

FLOW RATES ON GAS PHASE VOID FRACTION

System : n-Hexane-Nitrogen-Light Paraffin Oil

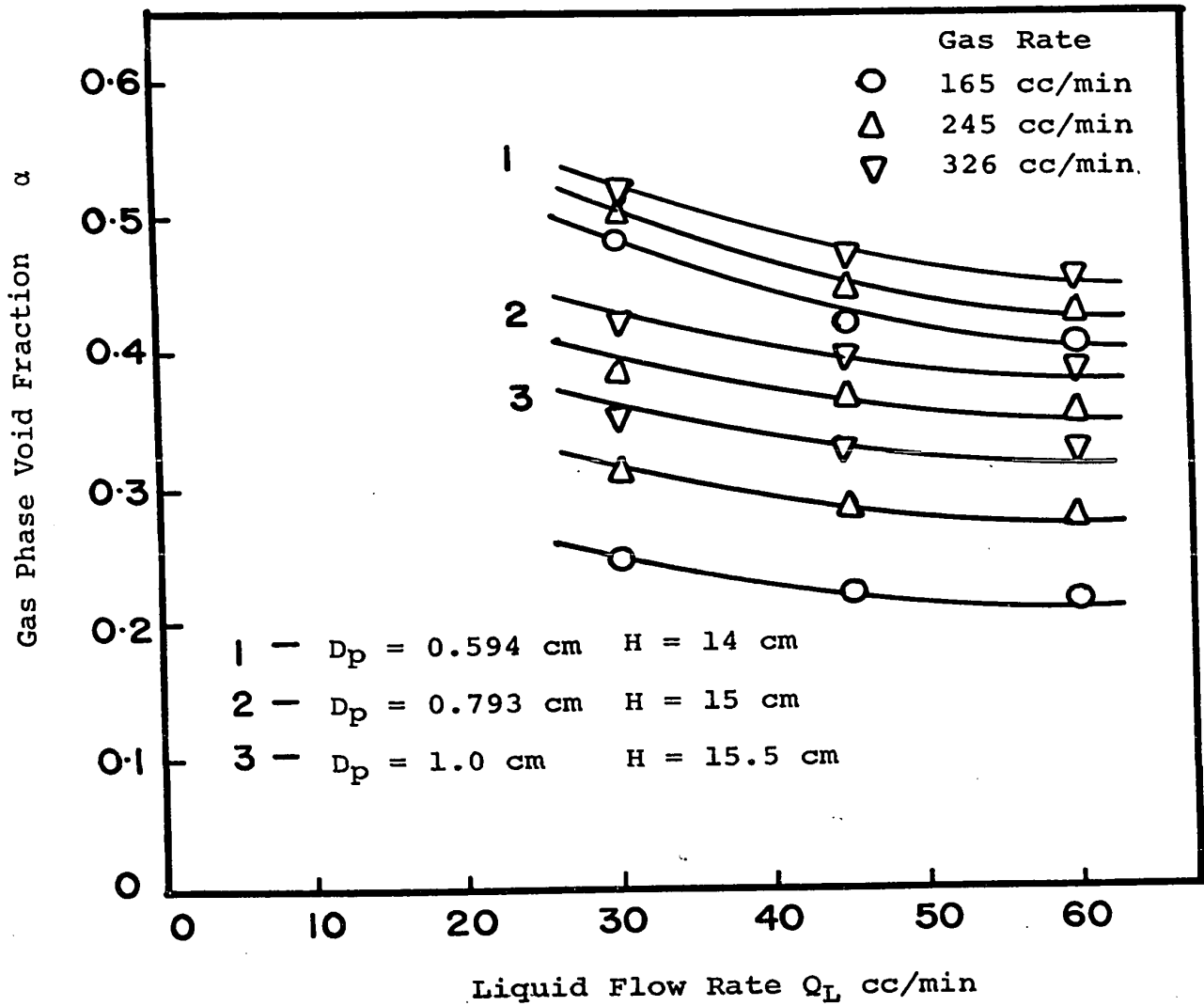


Figure 25

increased with increase in G but decreased as Q_L and D_p were increased.

From the results of α , as noted previously, the pressure drop ΔP_g of the slug flows due to the weight of contents in the absorber could be calculated and related to the total pressure drop ΔP_T of the slug flows by equation (II-10) as

$$\begin{aligned}\Delta P_T &= \Delta P_g + \Delta P_w \\ &= \rho_L(1-\alpha)H + \rho_g\alpha H + \Delta P_w\end{aligned}$$

Where ΔP_w is the pressure drop due to wall friction.

As reported by previous workers (5,45,46), ΔP_g at high gas rate and long absorber was found to be generally greater than the experimentally measured ΔP_T with the results that the magnitude of ΔP_w became negative. This was considered as described previously to be the result of liquid backflow in the regions between the tube walls and slug surface, which results in wall shear stresses acting opposite to the usual sense.

A-5. Slug Shape, Slug Length and Slug Separation Distance

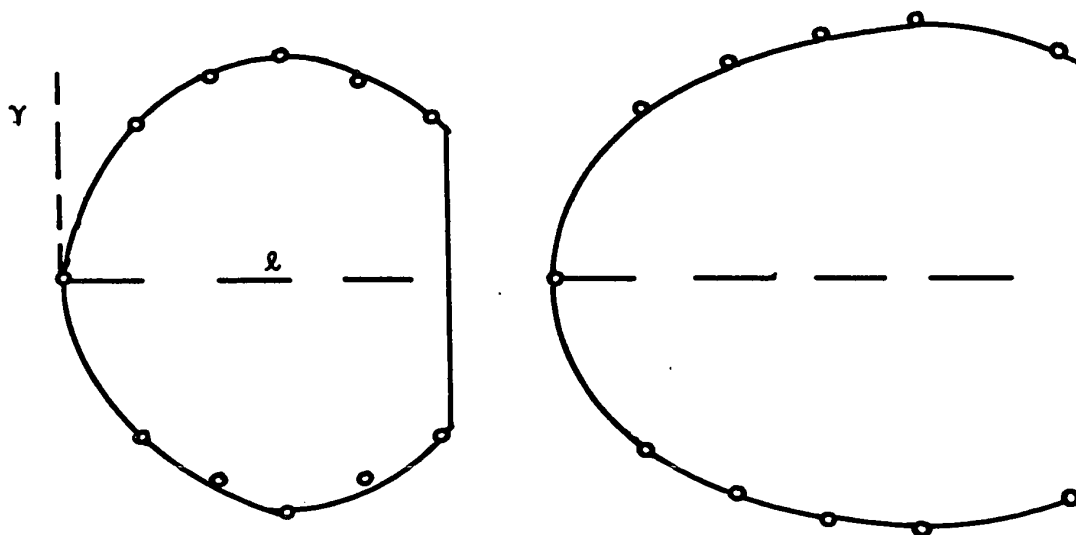
5-a. Slug Shape

It was found that the slug shape was influenced mainly by gas and liquid flow rates and absorber diameter. At low gas rates and high liquid rates, the slugs were generally less than 1.0 cm in length and approximated spherical caps, figure 26. Under these conditions, the slugs tended to chain together while rising up the absorber with no coalescence. In the majority of the runs, slug lengths were greater than

SCHEMATIC REPRESENTATION OF SLUG SHAPES

Scale $\begin{array}{|c|c|c|c|} \hline 0 & 0.1 & 0.2 & 0.3 \\ \hline \end{array}$ cm $D_p = 0.793$ cm

Spherical Caps Slug Length < 1.0 cm



Bullet Shaped Slug Length > 1.0 cm

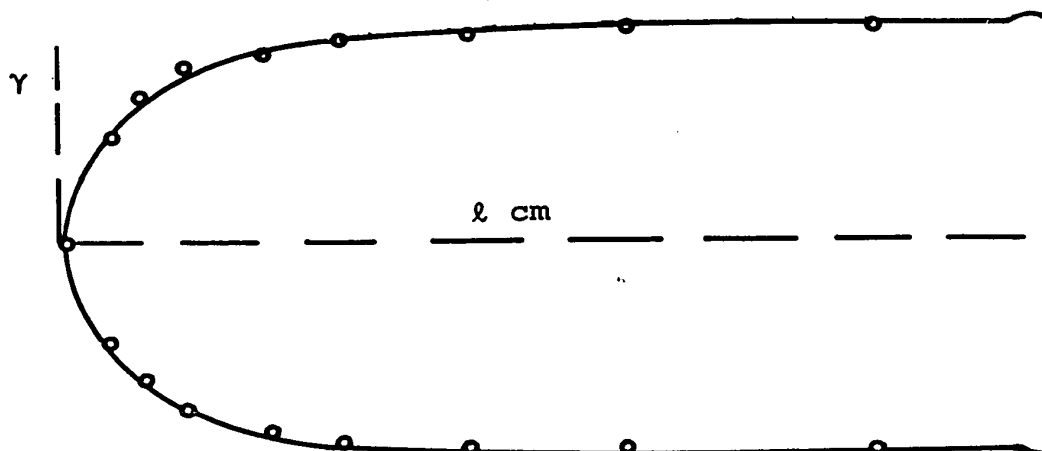


Figure 26

1.0 cm and the slugs characteristically bullet shaped, comprising a spherical frontal nose and cylindrical tail, see figure 26. The bottom of the slug was slightly curved convex as shown.

The radial distance r_i of the bullet shaped slugs increased with increase in absorber diameter D_p , figure 27. In addition, r_i was found to decrease slightly with liquid viscosity μ_L but was virtually independent of the gas and liquid flow rates. In comparing the shapes of the slug frontal zones, the nose radius was not satisfactorily represented by Taylor equation, $r_o = 0.75R$. The actual frontal radius of the slugs was in all cases much smaller than $0.75R$. Values of the parameters $(\frac{\rho_L g R^2}{\sigma}) \times (1 - \frac{\delta_o}{R})^2$ and $\frac{\rho_L^2 g D_p^3}{\mu_L^2}$ proposed by Brown (32) and White and Beardmore (33) were calculated and they were in the order of 2.5 and 10^4 respectively, indicating that the viscosity and surface tension effects could not be neglected (appendix 4-A). Also the values of the group $2R\{14.5(\rho_L^2 g)/\mu_L\}^{1/3}$ were calculated and found to be around 31. This value is much smaller than the minimum value of 60 proposed by Brown (32) as a criterion for potential flow around the slug nose to take place. The deviations of slug nose radii from the Taylor equation can therefore be considered to be due to the effect of μ_L and σ on slug shape. In an attempt to account for the effect of μ_L on r_o a plot was made of r_i/R_c versus l/R_c as has been suggested in the literature (32), where l is the vertical distance from the slug head and $R_c = R - \delta_o$ with δ_o as noted previously being the

VARIATION OF SLUG RADII r_i WITH SLUG AXIAL DISTANCE l

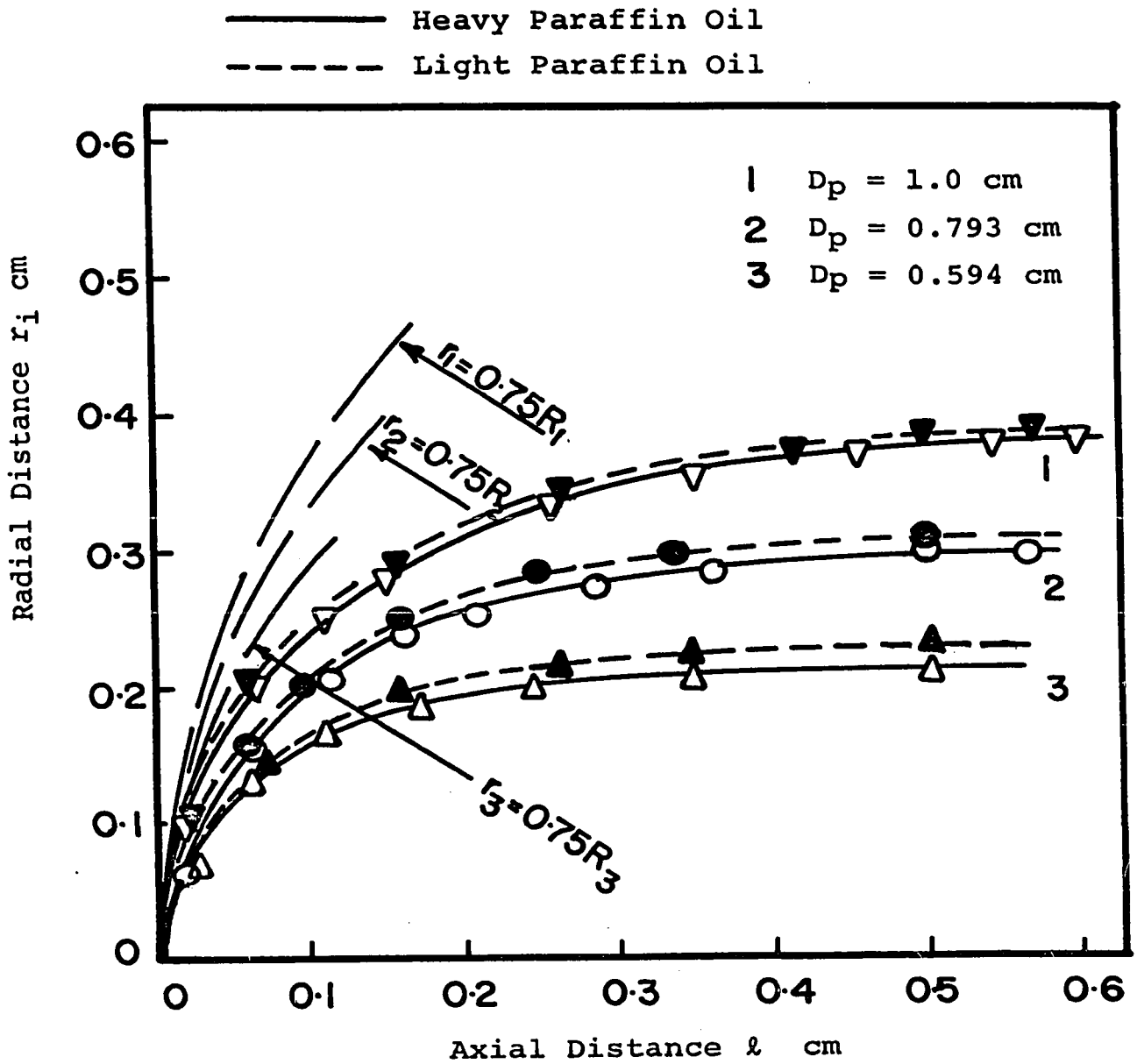


Figure 27

equilibrium laminar liquid film thickness at the trailing end of the slug. A single curve for all the data was obtained as shown in figure 28. The nose radii of the slugs were well represented by radii, $r_o = 0.855 R_c$ compared to the previous result of $r_o = 0.75 R_c$ by Brown (32). This can be attributed to the effects of viscous flow around the slug nose and surface tension in the relatively small diameter tubes used.

5-b. Slug Lengths and Separation Distances

It was found that the slug length was not a unique function of the operating variables, system variables and absorber geometries, a wide variation in slug lengths being observed, see figures 29A and 29B. The mean slug length $\bar{L}_s$, however, was found to vary regularly with gas rate, figures 30A and 30B. They showed that there was an approximately linear increase in $\bar{L}_s$ with gas rate over the range studied. The results also showed that with the heavy paraffin oil, slug sizes were almost double the slug sizes formed with the light paraffin oil. $\bar{L}_s$ was in the range of 0.5 to 4.5cm. The results of $\bar{L}_s$ calculated from the frequency data by equation (2-8) of appendix 2-A closely compared with experimentally measured $\bar{L}_s$ values, Table 5.

NORMALIZED SLUG SHAPES

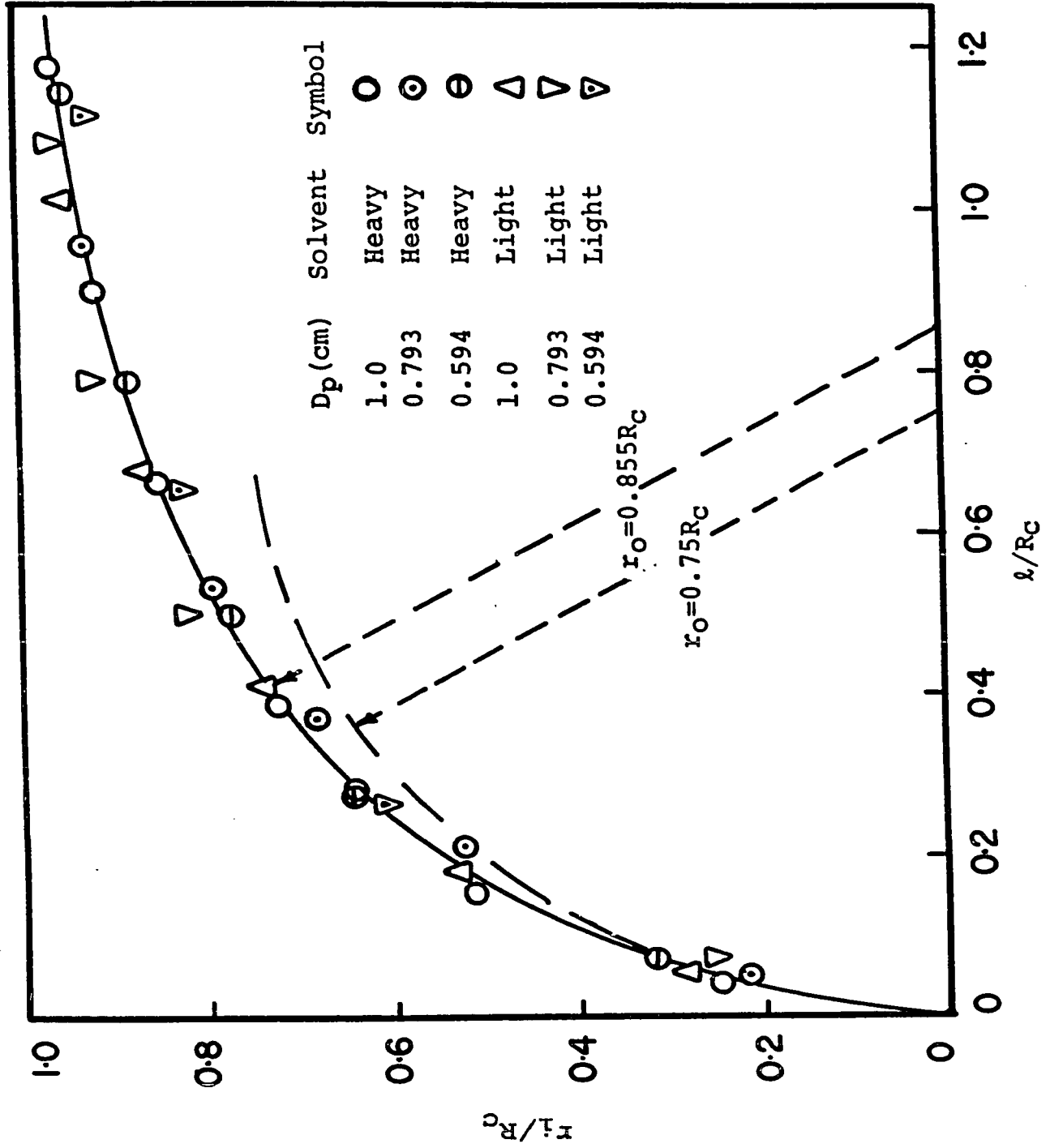


Figure 28

VARIATION OF SLUG LENGTH L_s WITH GAS FLOW RATE G

$H = 15 \text{ cm}$

$Z = 10 \text{ cm}$

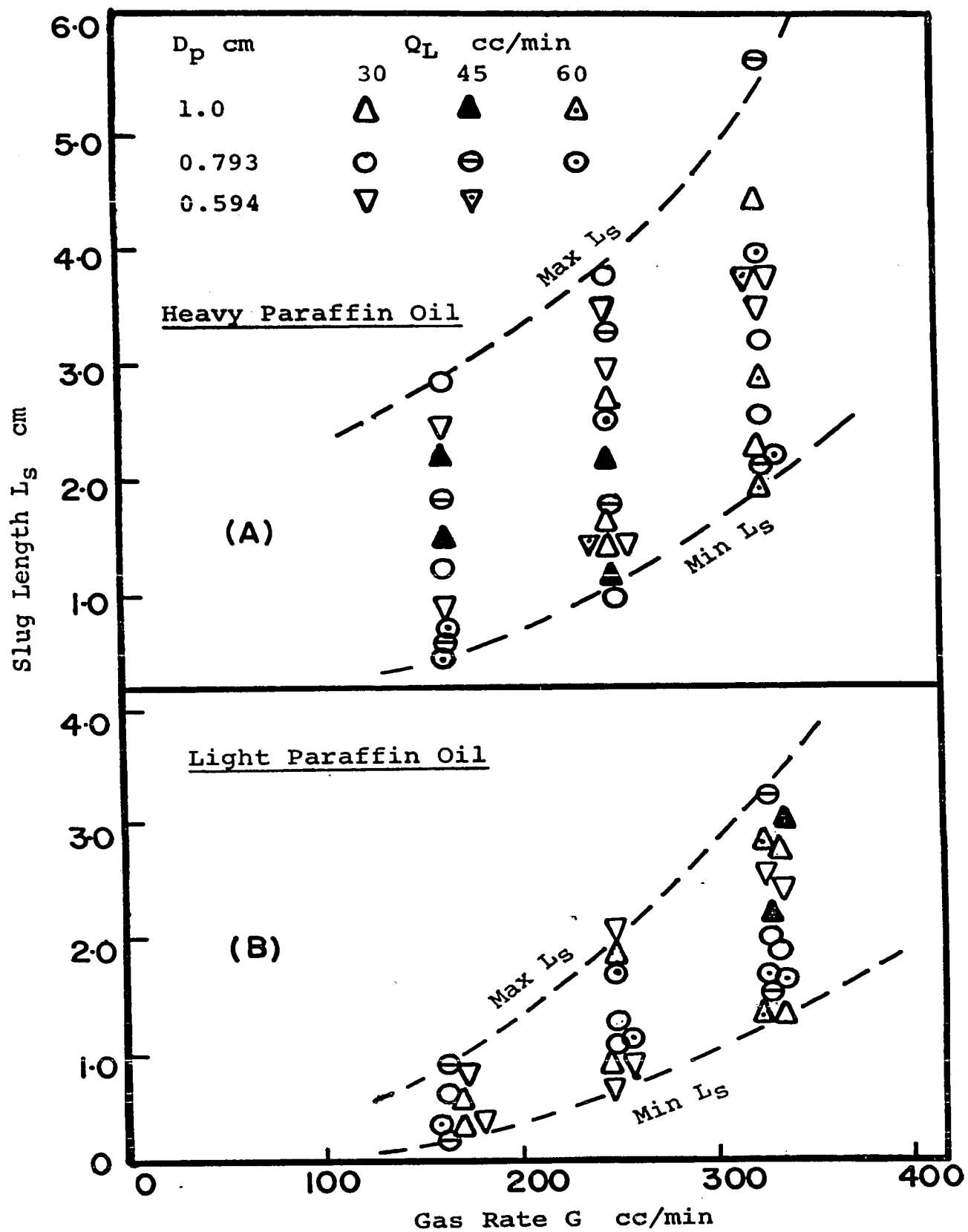


Figure 29

VARIATION OF MEAN SLUG LENGTH $\bar{L}_s$ WITH GAS FLOW RATE G

I ————— n-Hexane-Nitrogen-Heavy Paraffin Oil

II - - - - - n-Hexane-Nitrogen-Light Paraffin Oil

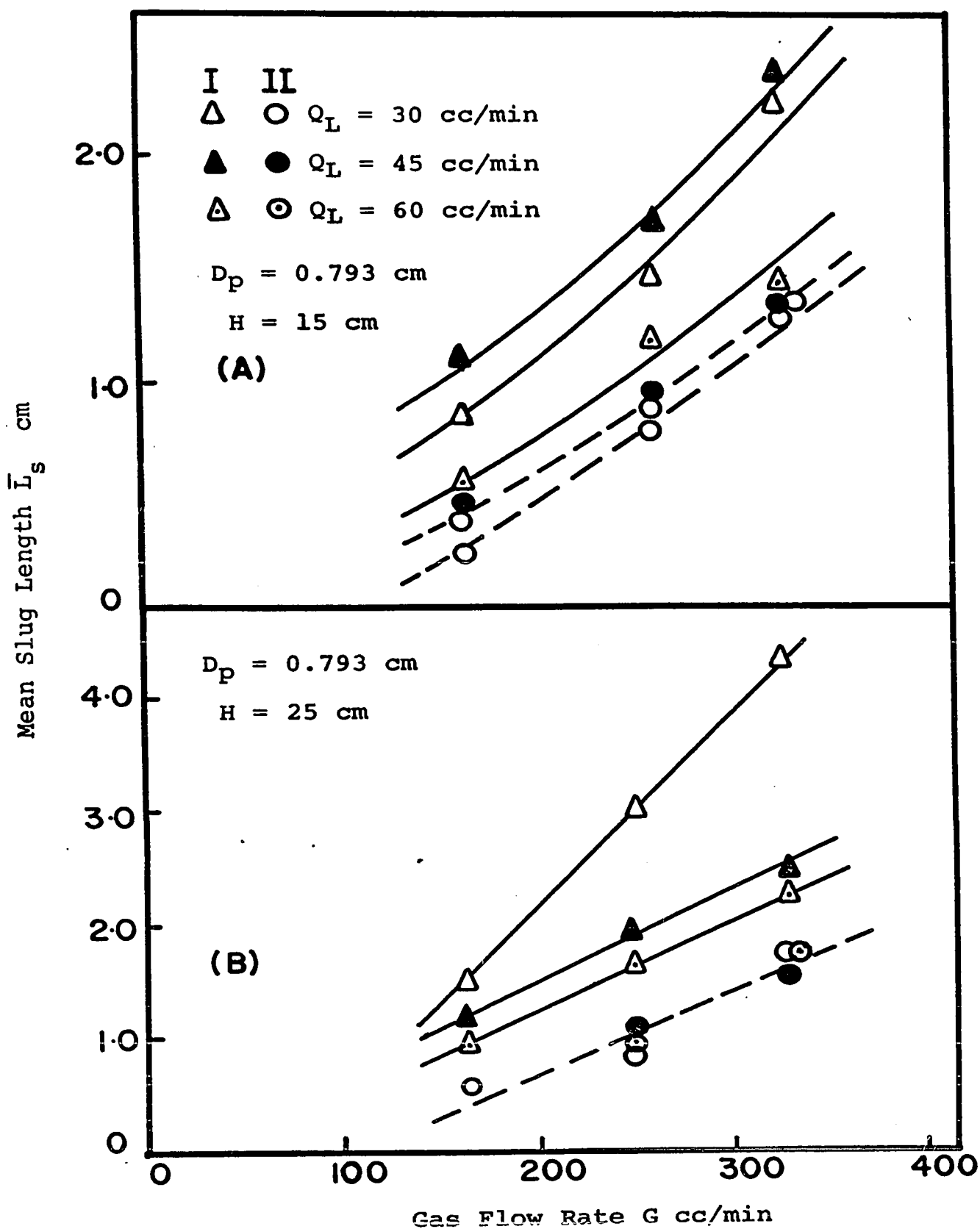


Figure 30

Table 5

Comparison of Calculated and Measured Mean Slug Length $\bar{L}_s$

$$D_p = 0.793 \text{ cm}$$

$$H = 15 \text{ cm}$$

G cc/min	Q_L cc/min	$\bar{L}_s$ meas. cm	$\bar{L}_s$ calc. cm
<u>Heavy Paraffin Oil</u>			
165	30	1.10	0.94
245	30	1.84	1.70
326	30	3.10	2.66
326	60	1.56	1.83
<u>Light Paraffin Oil</u>			
245	30	1.86	1.81
245	60	1.19	0.92
326	30	1.86	1.65
326	60	1.66	1.70

Slug separation distances L_p which determined whether the slugs would pair while rising up the column are shown in figure 31. The L_p values ranged from 0.175 cm to 1.4 cm and largely depended on the absorber diameter D_p . It was found that if two slugs were separated by a distance less than that indicated by line AB, pairing would take place usually accompanied by coalescence. This critical separation distance was about 0.25 absorber diameter and was apparently not affected by fluid flow rates. It would appear therefore that the wake effect in this study only extended to the distance of about 0.25 D_p from the rear of the leading slug, consequently for

VARIATION OF SLUG SEPARATION DISTANCE L_p WITH
ABSORBER DIAMETER D_p

System : n-Hexane-Nitrogen-Paraffin Oil

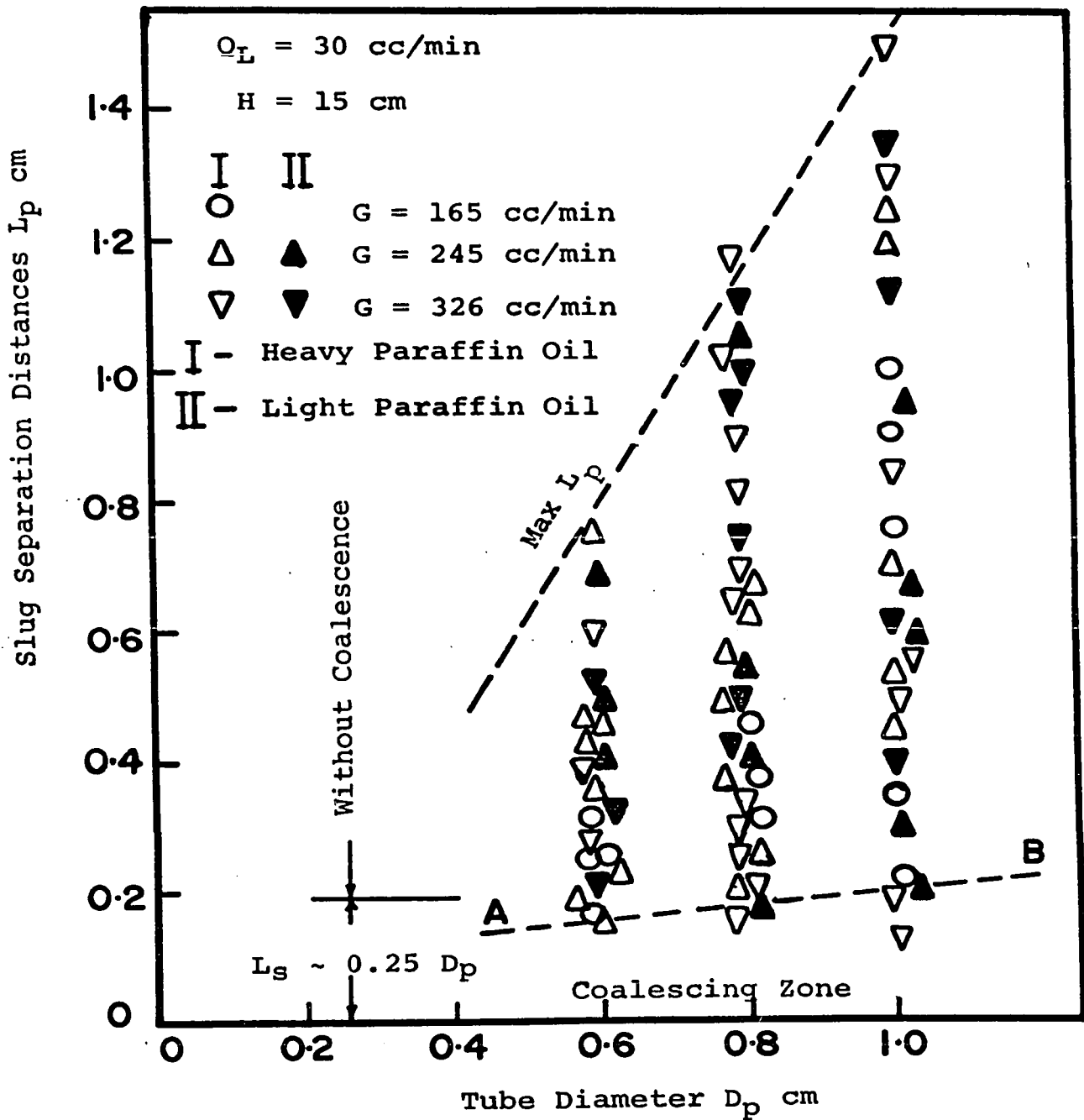


Figure 31

slugs separated by a distance greater than this value, the trailing slug would not be influenced by the wake and therefore no pairing took place. Griffith and Moissis (29) also reported that the wake effect was very much reduced once the viscosity effects were significant and the critical separation distances were found to be less than one tube diameter. As viscous liquids were employed in this study, variations of liquid viscosity from 40 to 142 cp did not show any apparent effect on this critical separation distance. In addition, it was also found that L_p generally increased with increase in the the leading slug length or gas flow rate G , figure 32.

A-6. Slug Surface Areas and Slug Volumes

Slug surface area A_s and volume V_s were evaluated numerically and found to increase almost linearly with the slug length as illustrated in figure 33. It was also found that the volume V_s of long bullet shaped slugs were very well correlated by the empirical formula, $V_s = A_p(a_v L_s - b_v D_p)$ (V-43); which was initially suggested by Dumitrescu (1) for slugs rising in an inviscid liquid. A_p is the cross section area of the absorber while a_v and b_v are constants. The comparison of the predicted and experimental V_s values were illustrated in Table 6.

VARIATION OF SLUG SEPARATION DISTANCE L_p WITH
LEADING SLUG LENGTH L_s

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

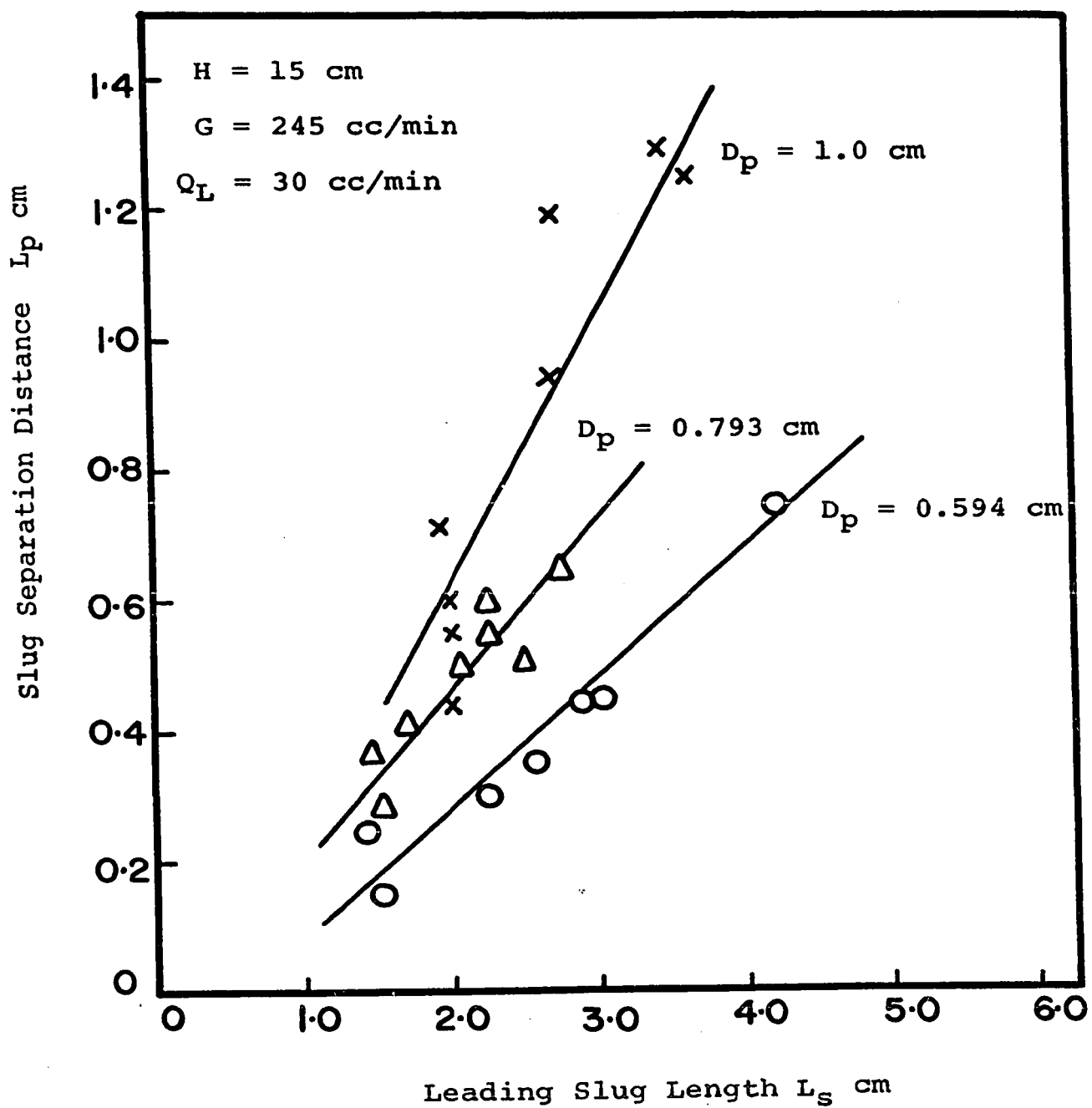


Figure 32

VARIATION OF SLUG SURFACE AREA A_s AND
VOLUME V_s WITH SLUG LENGTH L_s

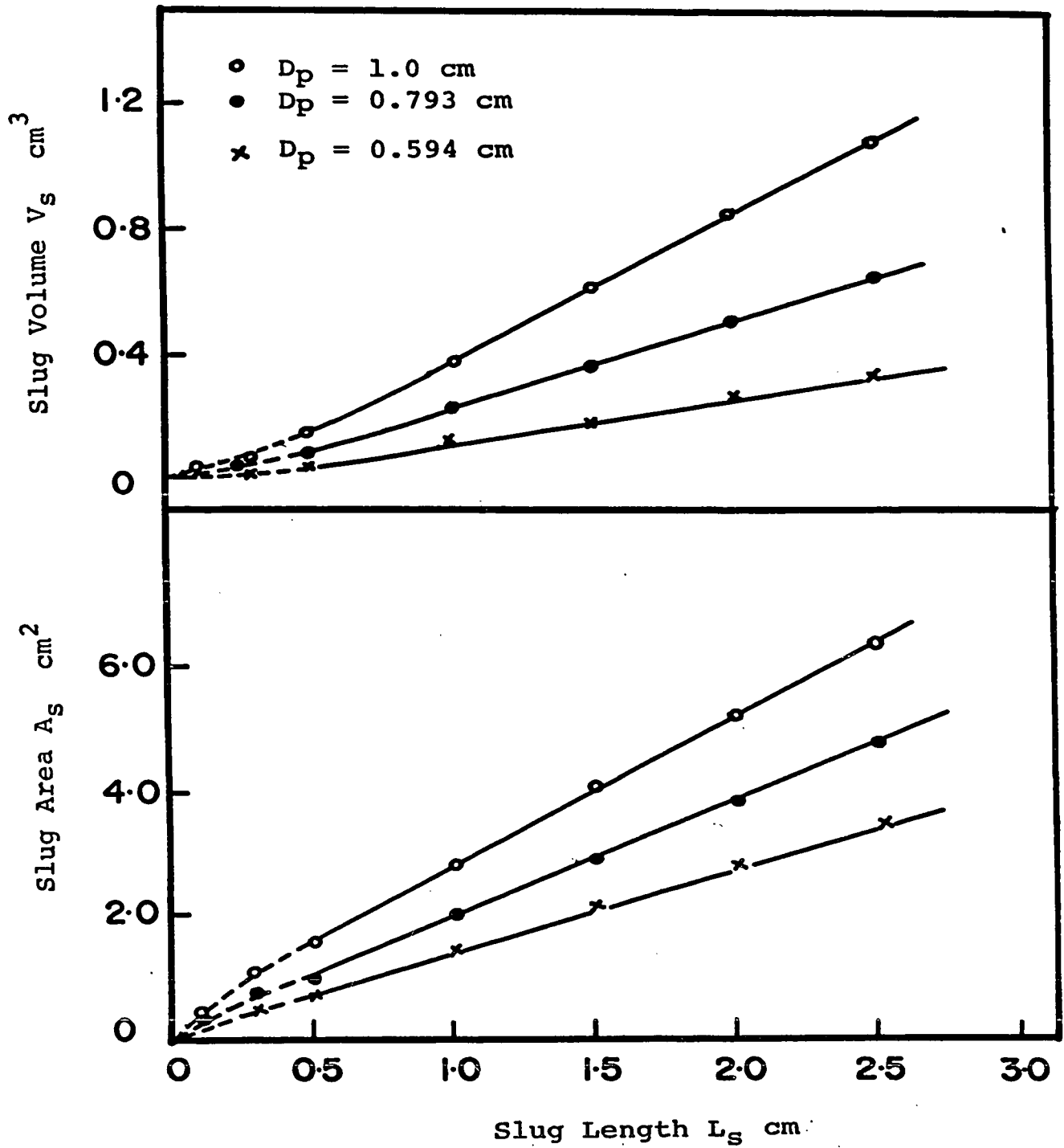


Figure 33

Table 6

Comparison of Predicted and Experimental V_S

D_p cm	L_S cm	V_S cm ³ (measured)	V_S cm ³ (predicted)	Dev. %	a_v	b_v
1.000	0.59	0.193	0.201	4.10	0.596	0.096
	1.00	0.386	0.392	1.58		
	2.00	0.859	0.861	0.20		
	3.00	1.332	1.329	-0.20		
0.793	0.50	0.096	0.098	2.19	0.552	0.096
	1.00	0.233	0.235	0.70		
	2.00	0.507	0.508	0.10		
	3.00	0.782	0.781	-0.08		
0.594	0.50	0.055	0.055	1.63	0.508	0.092
	1.00	0.125	0.126	0.51		
	2.00	0.267	0.267	0.00		
	3.00	0.408	0.408	0.00		

$$\text{Dev.} = \frac{V_S \text{ pred.} - V_S \text{ meas.}}{V_S \text{ meas.}} \times 100\%$$

Surface areas and volumes were affected by both system properties as well as operating variables. The mean slug surface area $\bar{A}_S$ and volume $\bar{V}_S$, calculated by equations (2-4, 2-5, 2-6) of appendix 2-A, were clearly related to the mean slug length $\bar{L}_S$ and frequency $\bar{F}$ and could not be satisfactorily correlated. $\bar{A}_S$ and $\bar{V}_S$ values did however increase with increasing gas flow rate, absorber diameter and absorber length ($H < 25\text{cm}$), gas phase density and liquid viscosity but generally

decreased with increase in liquid flow rate. Although $\bar{A}_S$ and $\bar{V}_S$ were strongly dependent on $\bar{F}$ or $\bar{L}_S$, the ratio $(\bar{A}_S/\bar{V}_S)$ was found to be insensitive to $\bar{F}$ or $\bar{L}_S$, i.e., the values of $(\bar{A}_S/\bar{V}_S)$ for $\bar{L}_S$ values of 0.56, 1.5 and 3.5 cm were 10.9, 8.0 and 7.3 cm^{-1} respectively.

These $(\bar{A}_S/\bar{V}_S)$ ratios were required for calculation of mass transfer coefficients when effective mass transfer areas are unknown and plots of $\ln(\bar{A}_S/\bar{V}_S)$ versus H are shown in figure 34. The ratios decreased at first exponentially with H until it assumed an almost constant value for H greater than 20 cm. Each curve was then considered to be made up of two independent parts. One part was assumed to be independent of H and the other part dependent on H. The ratios were then correlated in the forms such that $(\bar{A}_S/\bar{V}_S) = \Delta(\bar{A}_S/\bar{V}_S)_H + (\bar{A}_S/\bar{V}_S)_C$ in which $\Delta(\bar{A}_S/\bar{V}_S)_H$ and $(\bar{A}_S/\bar{V}_S)_C$ were dependent and independent of H respectively, see appendix 4-B. The dependence of the ratios on gas flow rates, liquid flow rates, absorber diameter and liquid viscosities were determined. The final correlations obtained are given below :

Correlations of $(\bar{A}_S/\bar{V}_S)$

$Q_L = 30 \text{ cc/min}$

$$\begin{aligned} \left(\frac{\bar{A}_S}{\bar{V}_S}\right) &= 18.5 - \{10.7 D_p - 2.25 \times 10^{-2} \mu_L \times (D_p - 1.15) \\ &\quad + 0.46 G_S (1.0 - 0.0025 \mu_L)\} \\ &\quad + 0.49 \times 10^3 G_S^{-2.9} \mu_L^{-0.17} e^{-0.18H} \end{aligned}$$

(V-44)

VARIATION OF $(\bar{A}_S/\bar{V}_S)$ WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Paraffin Oil

$Q_L = 30$ cc/min

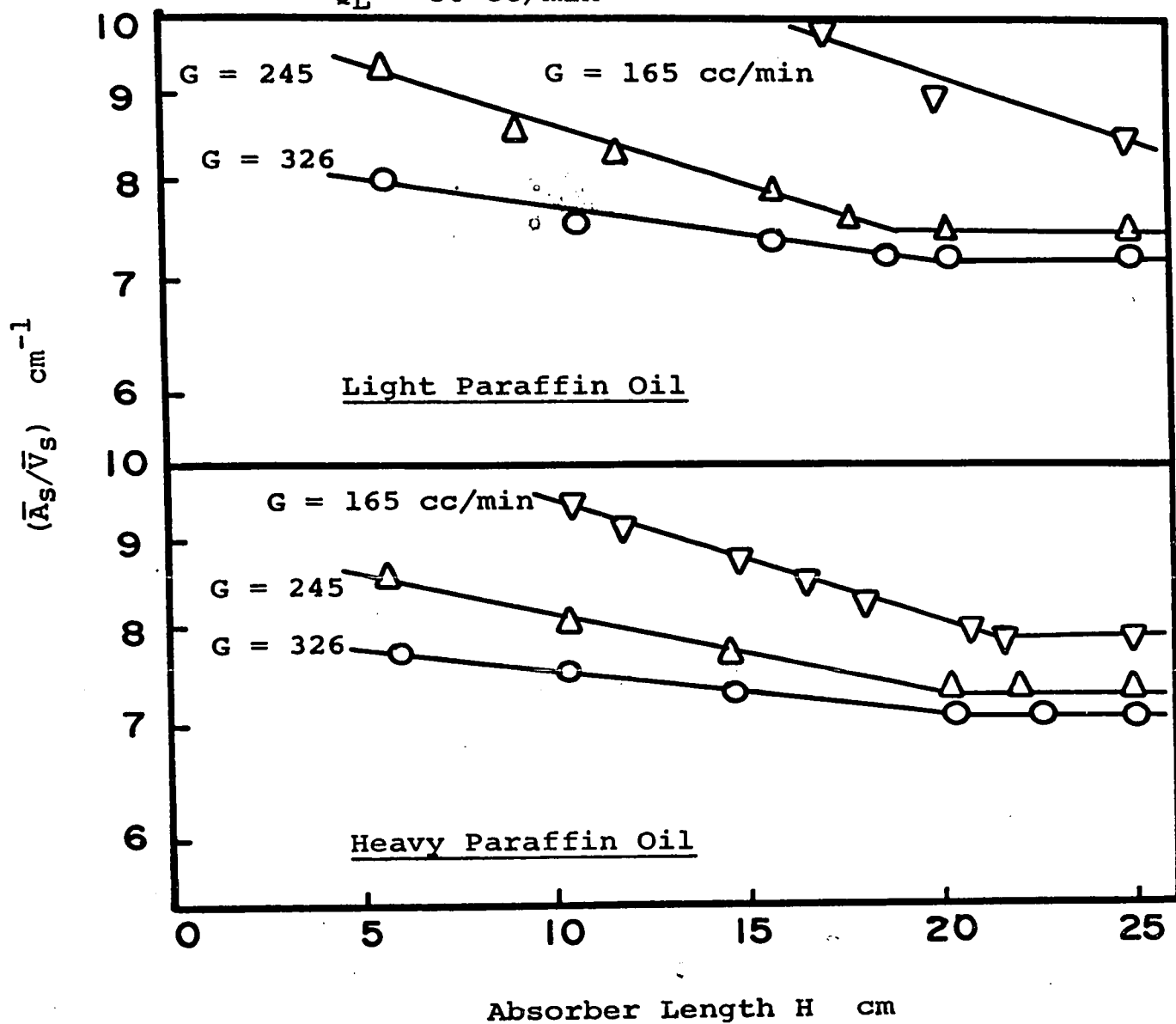


Figure 34

$$Q_L = 45 \text{ cc/min}$$

$$\left(\frac{\bar{A}_S}{\bar{V}_S}\right) = 16.0 - \{8.3 D_p + 9.2 \times 10^{-3} \mu_L + 0.33 G_S (1.0 - 0.0037 \mu_L)\} \\ + 3.32 \times 10^3 G_S^{-2.8} \mu_L^{-0.8} e^{-0.18 H} \quad (V-45)$$

$$Q_L = 60 \text{ cc/min}$$

$$\left(\frac{\bar{A}_S}{\bar{V}_S}\right) = 17.8 - \{9.0 D_p - 1.1 \times 10^{-2} \mu_L (D_p - 1.02) + 0.57 G_S\} \\ + 3.35 \times 10^3 G_S^{-3.9} \mu_L^{-0.4} e^{-0.15 H} \quad (V-46)$$

If $\left(\frac{\bar{A}_S}{\bar{V}_S}\right)$ is assumed to be independent of Q_L :

$$\left(\frac{\bar{A}_S}{\bar{V}_S}\right) = 16.0 - \{8.3 D_p + 9.2 \times 10^{-3} \mu_L + 0.33 G_S (1.0 - 0.0037 \mu_L)\} \\ + 4.3 \times 10^3 G_S^{-4.1} \mu_L^{-0.57} e^{-0.11 H} \quad (V-47)$$

where $G_S = G/60 \text{ (cc/sec)}$

The maximum deviations between the predicted and experimental values were found to be of the order of $\pm 2.5\%$ for the first three correlations and $\pm 6\%$ for the fourth one as in figure 35.

These correlation though based on mean slug frequencies $\bar{F}$, were also found to correlate point ratios (A_S/V_S) when point frequency data were used, Table 7.

COMPARISON OF EXPERIMENTAL AND PREDICTED

$(\bar{A}_S/\bar{V}_S)$ RATIOS

System : n-Hexane-Nitrogen-Paraffin Oil

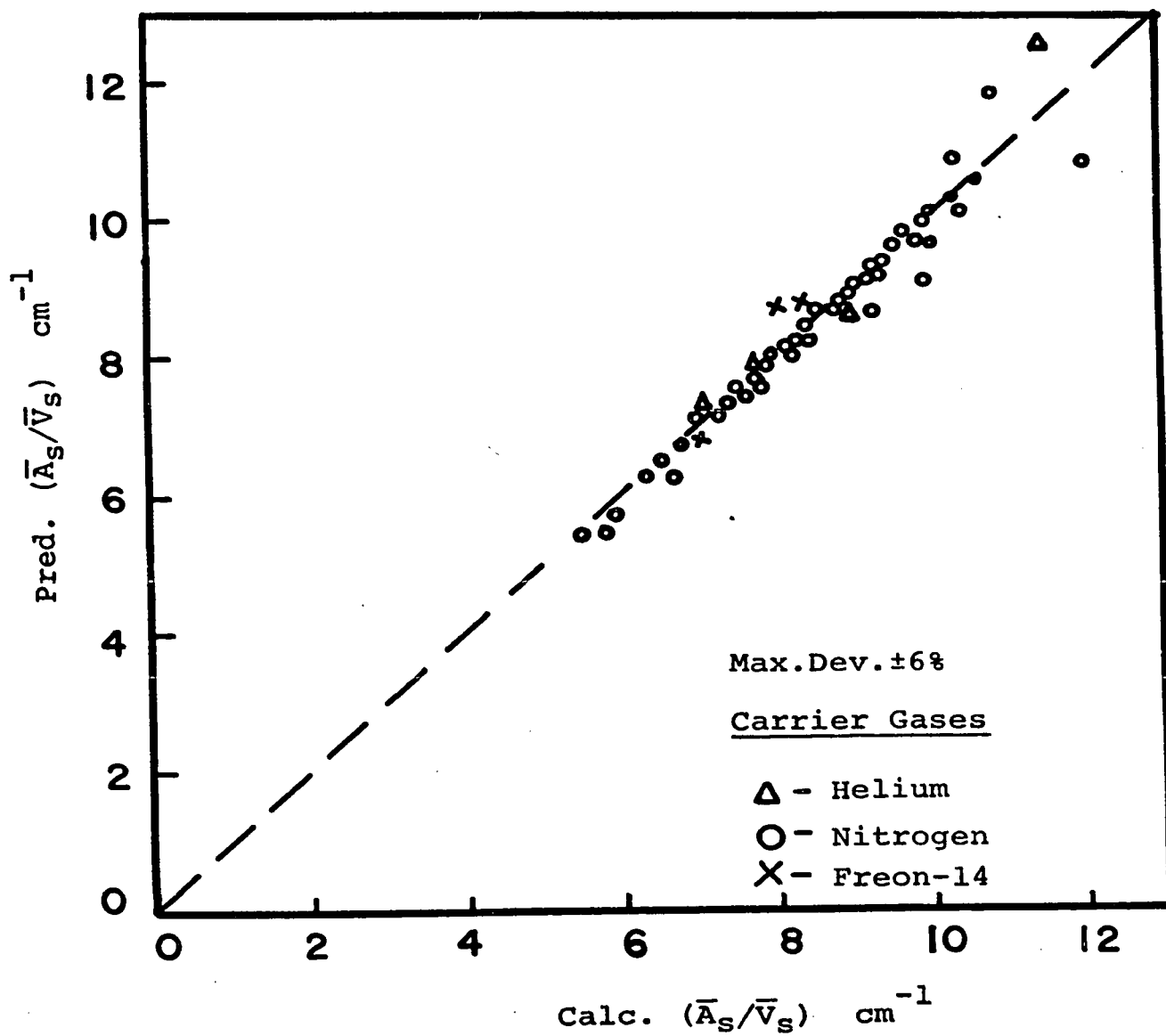


Figure 35 .

Table 7

Comparison of Calculated and Experimental Point $(A_s/V_s)_a$ Values

$D_p = 0.793 \text{ cm}$

H cm	G cc/min	Q_L cc/min	$(A_s/V_s)_{\text{expt.}}$ cm^{-1}	$(A_s/V_s)_{\text{equat. (V-35)}}$ cm^{-1}	Dev %
15	165.0	30.0	10.46	11.02	-5.35
25	165.0	30.0	8.40	9.29	-10.37
15	245.0	30.0	7.54	7.54	0.00
25	245.0	30.0	8.29	8.88	-7.07
15	326.0	30.0	7.61	7.64	-0.43
25	326.0	30.0	7.61	7.67	-0.86
15	165.0	45.0	9.33	9.71	-3.99
25	165.0	45.0	8.59	8.84	-2.89
15	245.0	45.0	7.92	7.92	0.00
25	245.0	45.0	7.92	8.30	-4.71
15	326.0	60.0	7.61	7.61	0.00

$$\text{Deviation} = \frac{(A_s/V_s)_{\text{expt.}} - (A_s/V_s)_{\text{calc.}}}{(A_s/V_s)_{\text{expt.}}} \times 100\%$$

In addition, the correlations also fitted the $(\bar{A}_s/\bar{V}_s)$ data for helium and Freon-14 carrier gases.

A-7. Slug Rise Velocities

Slug rise velocities U_s were found to be virtually independent of slug length as illustrated in figure 36 and consequently the data were not subject to the scatter observed with the frequency and slug length measurements. The velocities of non-coalescing slugs were in the range of 15-40cm

VARIATION OF SLUG RISE VELOCITY U_s WITH SLUG LENGTH L_s

System : n-Hexane-Nitrogen-Paraffin Oil

$Q_L = 30$ cc/min

———— Light Paraffin Oil

----- Heavy Paraffin Oil

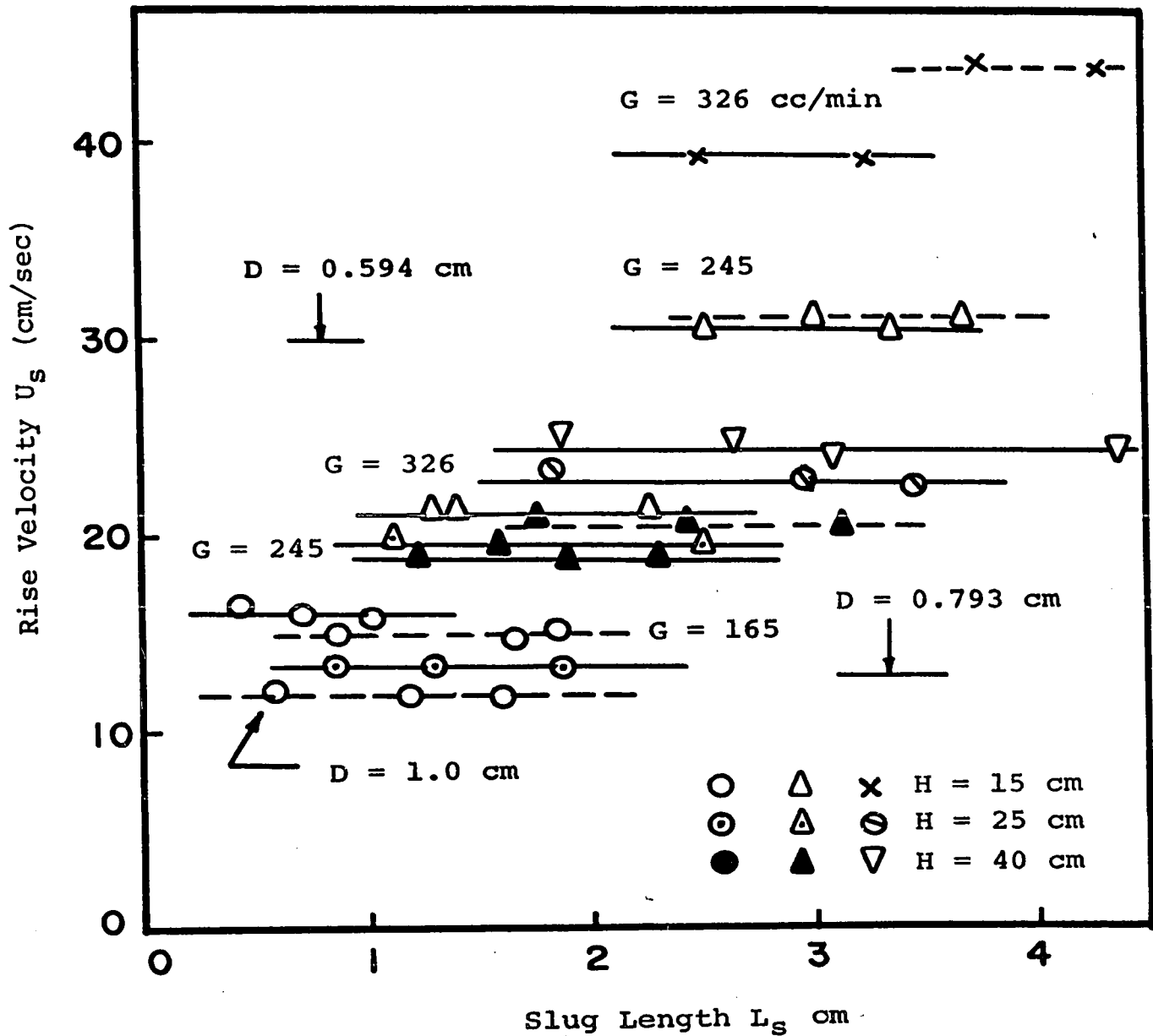


Figure 36

per sec and functions of fluid flow rates, absorber diameter and system properties. In addition, they were also observed to be slightly dependent on the slug position at low values of Z and decreased slightly with increasing the absorber length H , figure 37. The initial dependence of U_s on Z can be attributed to an entrance effect and disappeared as the slugs travelled up the tube for Z greater than about 8 cm. The variations in rise velocity due to the slug expansion were found to be negligible and any slight reduction in slug rise velocity with H would arise due to the changes in gas phase void fraction α which increased with increase in H .

As would be expected, figure 38 and figure 39, rise velocities increased with increasing gas and liquid flow rates but decreased with increase in gas phase density and absorber diameter. Rise velocities also increased with increase in μ_L . The dependence of U_s on ρ_g can be considered to be due to the variations in gas phase void fraction rather than gravitational effects as can be also seen from the relationship $\bar{U}_s = G_s / \alpha A_p$, void fraction increasing with increase in ρ_g . With μ_L , the increase in U_s can be taken to be due to the effect of μ_L on δ_o , the equilibrium laminar liquid film thickness. Increase in μ_L increasing δ_o has been reported previously (9). Similar effects of μ_L have also been reported by Griffith (3) on slug rise velocities in cold and hot water.

A comparison was made of the experimental U_s and those predicted by the correlations of previous workers for fully developed flow. These workers have used equations having the

VARIATION OF SLUG RISE VELOCITY U_s WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Paraffin Oil

$Q_L = 30$ cc/min

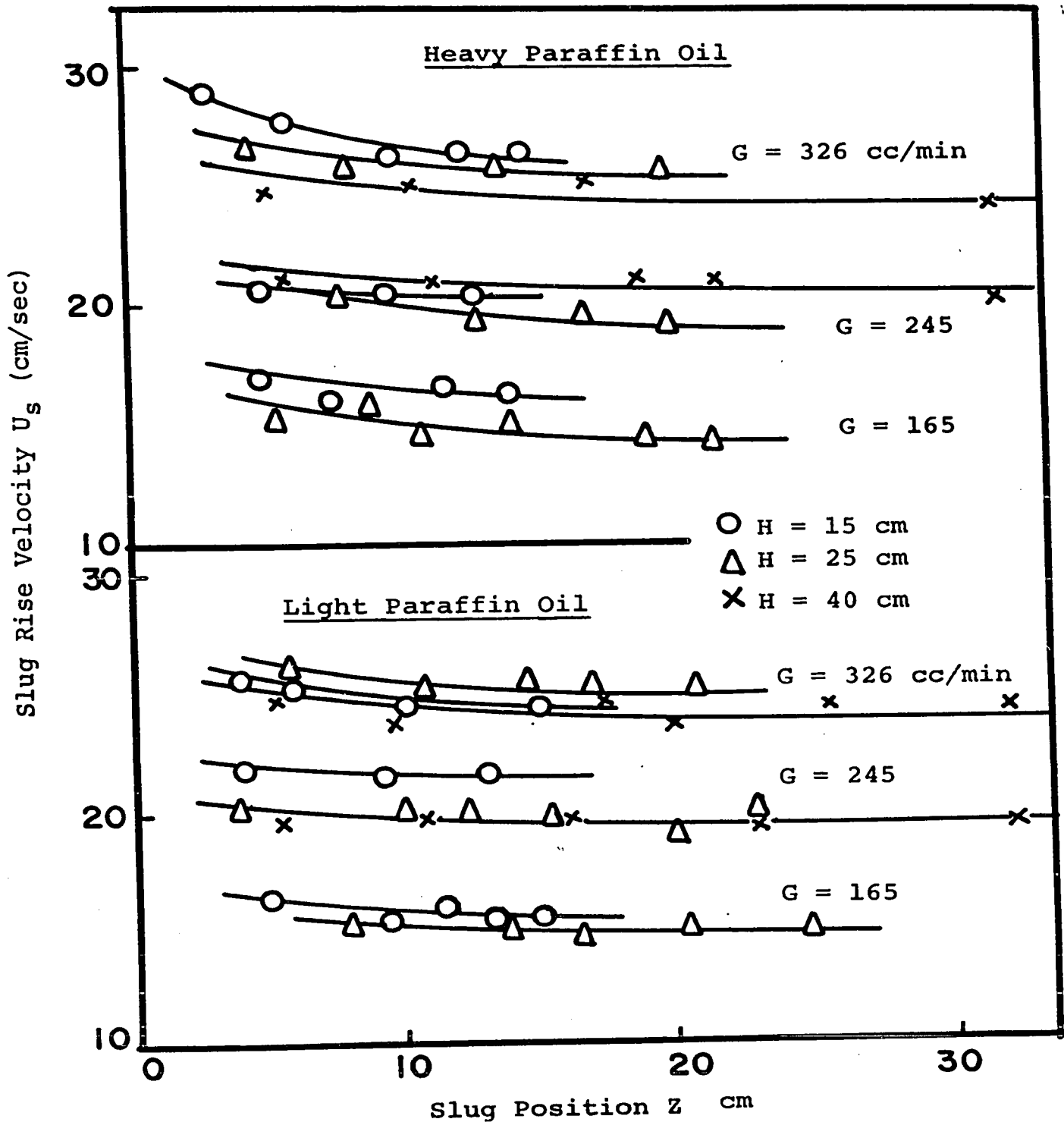


Figure 37

VARIATION OF SLUG RISE VELOCITY U_s WITH LIQUID

RATE Q_L AND GAS PHASE DENSITY ρ_g

System : n-Hexane-Nitrogen-Paraffin Oil

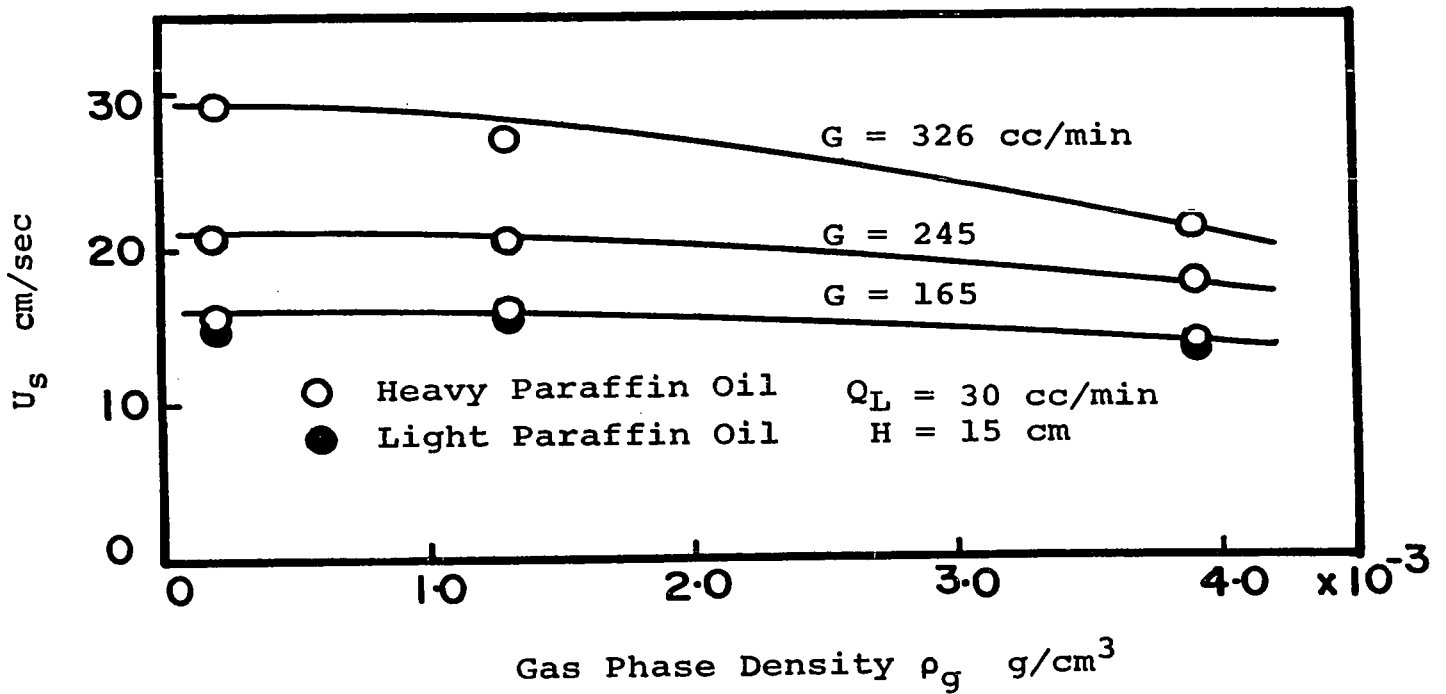
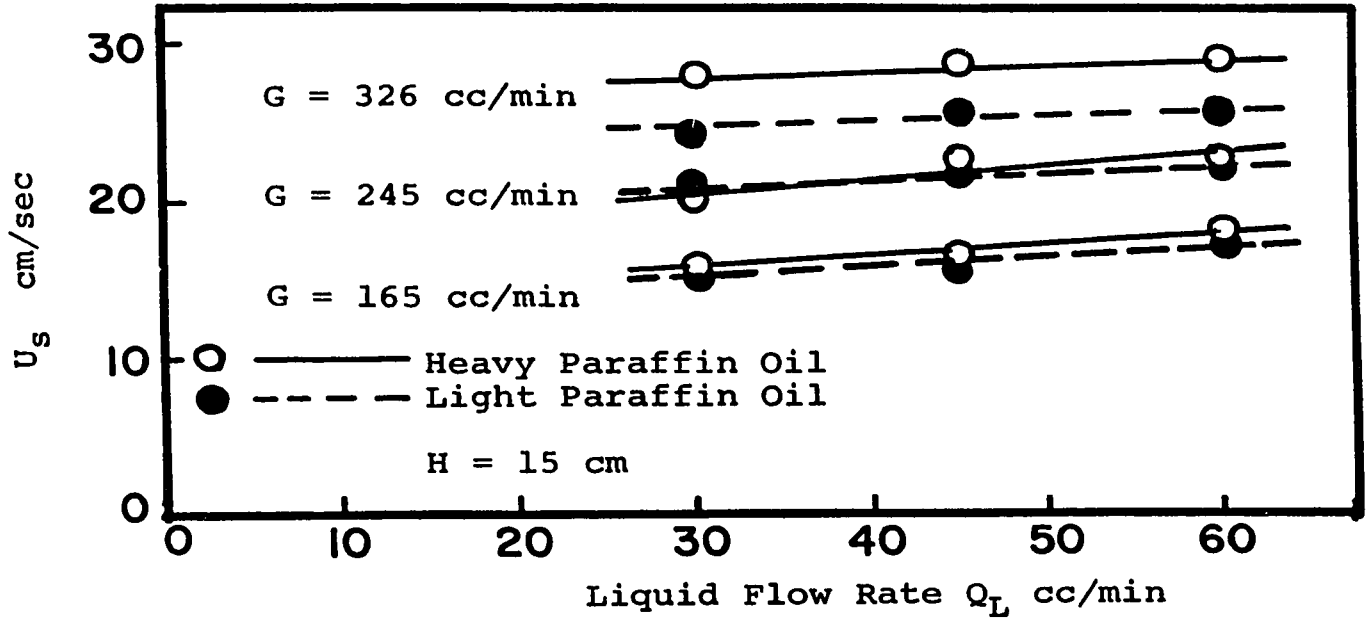


Figure 38

VARIATION OF SLUG RISE VELOCITY U_s WITH ABSORBER

DIAMETER D_p AND LIQUID VISCOSITY μ_L

System : n-Hexane-Nitrogen-Paraffin Oil

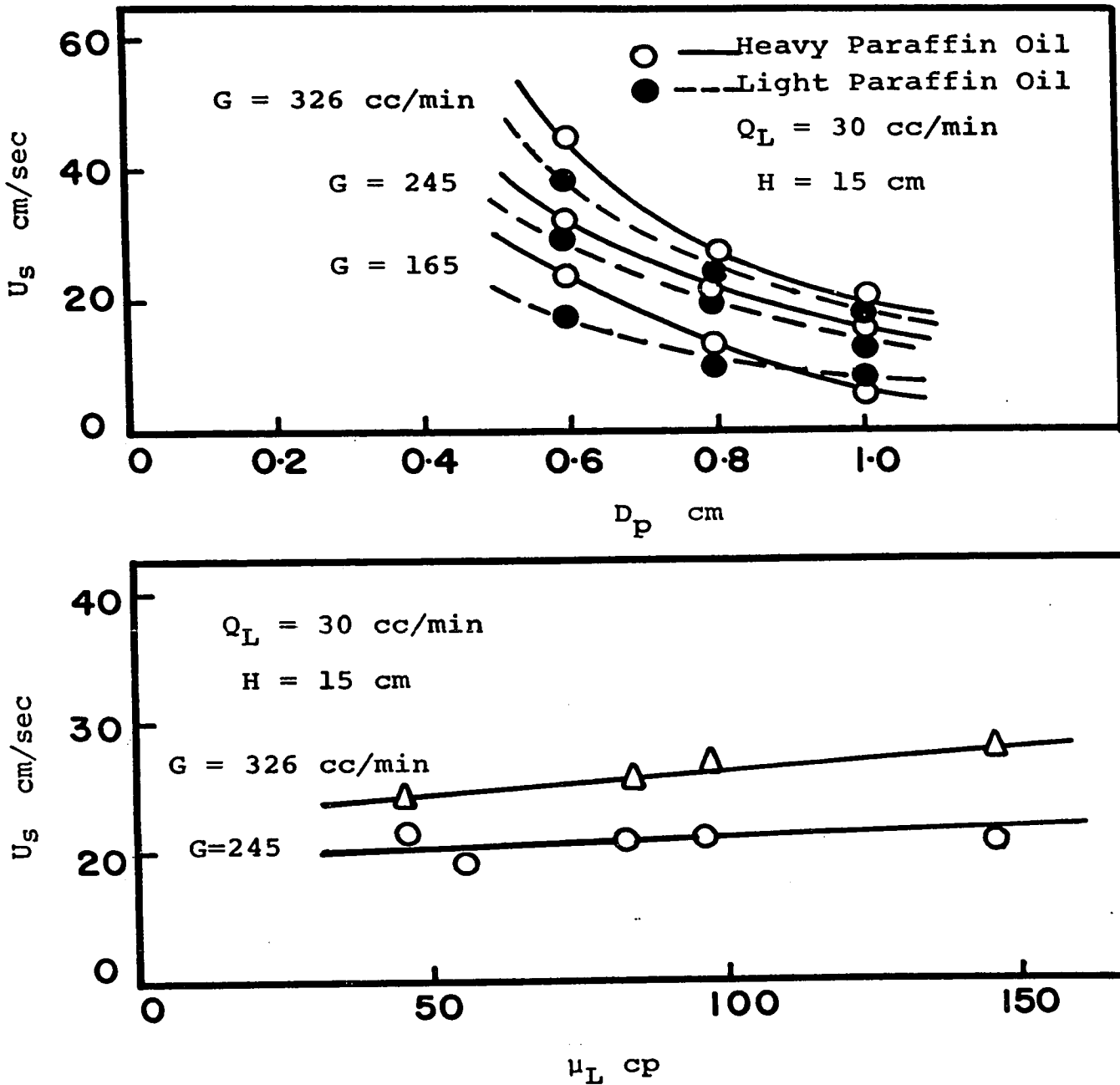


Figure 39

following form :

$$U_s = C_1 U_L + C_0 (g D_p)^{\frac{1}{2}} \quad (\text{II-4})$$

$$\text{with } U_L = \frac{G + Q_L}{A_p \times 60.0}$$

$$\text{or } \frac{U_s}{U_L} = C_1 + \frac{C_0 (g D_p)^{\frac{1}{2}}}{U_L} \quad (\text{V-48})$$

As shown in appendix 4-C, when the experimental (U_s/U_L) were plotted against $(g D_p)^{\frac{1}{2}}/U_L$, the agreement was poor and it showed that in addition to D_p , G and Q_L , the effects of μ_L , σ , ρ_g and H on U_s have to be taken into account.

Slug rise velocities have been found to be a unique function of the slug frontal geometry or radius r_o (5,9) which was in turn the function of σ , μ_L , D_p and U_L (35,36). In unstable slug flows, r_o would be further affected by the variation of G , Q_L and H . As described in appendix 4-C, C_0 in equation (II-4) can be expressed as $4(\zeta\beta)^{\frac{1}{2}}$ where $\zeta = r_o/R_C$, $R_C = R - \delta_o$ and $\beta = (R_C/R)^2$. Further from the work of Street (36), β was found to be the function of the liquid Reynolds number, Froude number, Weber number and $R_v = G/Q_L$. If the effects of H and ρ_g on U_s were accounted for by the dimensionless groups (H/D_p) and (ρ_g/ρ_L) , an empirical correlation for U_s can be written as :

$$U_s = C_1 U_L + \left\{ \kappa_o N_{Re}^{a_o} \left(1 - \frac{1}{R_v}\right)^b N_{Fr}^c N_{We}^d \left(\frac{\rho_g}{\rho_L}\right)^e \left(\frac{H}{D_p}\right)^f \right\} (g D_p)^{\frac{1}{2}} \quad (\text{V-49})$$

C_1 was evaluated by a trial and error method, the minimum deviation being obtained for a value of C_1 equal to 1.2 while

the constant a^0 , b , c , d , e and f by linear regression method. The final correlation for U_s was :

$$U_s = 1.2U_L + \{0.098(1-1/R_v)^{-0.8} N_{We}^{0.5} N_{Fr}^{-0.1} (\rho_g/\rho_L)^{-0.16} (H/D_p)^{-0.1}\} (gD_p)^{\frac{1}{2}} \quad (v-50)$$

with the mean square deviation of 1.86.

In equation (v-50), the fact that C_0 was virtually independent of N_{Re} over the range of this study was not surprising as U_s have been found to vary only slightly as μ_L varied from 40 to 142 cp. The decreasing effects of $(1-1/R_v)^{-0.8}$ which approached to 1.0 as R_v increased have also been reported by Griffith (3), Nicklin (5) and Brown (9). This is because at higher flow rates, δ_0 which affected r_0 becomes virtually independent of U_L (9). The group $N_{We}^{0.5} N_{Fr}^{-0.1}$ increased with decrease in σ and it can be shown that when the values of σ are decreased, C_0 approaches the literature value of 0.35 once the effects of R_v , ρ_g , μ_L and H are allowed for, see figure 4-4 of appendix 4-C.

Although equation (v-50) was obtained from the rise velocities data of non-coalescing slugs, it could be approximated as a general correlation for the mean slug rise velocity $\bar{U}_s$ of all the slugs with $\bar{U}_s = G_s/\alpha A_p$ as U_s values were closely compared with $\bar{U}_s$ values, Table 8.

Table 8

Comparison of U_s and $\bar{U}_s$

$H = 15 \text{ cm}$

$D_p = 0.793 \text{ cm}$

System : n-Hexane-Nitrogen-Paraffin Oil

G cc/min	Q_L cc/min	U_s cm/sec	$\bar{U}_s$ cm/sec
<u>Heavy Paraffin Oil</u>			
165	30	14.00	15.88
	60	20.53	18.76
245	30	21.92	21.86
	60	23.29	22.68
326	30	27.30	26.90
	60	28.76	25.60
<u>Light Paraffin Oil</u>			
165	30	15.40	16.77
	60	17.30	16.88
245	30	19.95	20.58
	60	23.30	22.87
326	30	24.80	27.60
	60	28.02	28.60

Further equation (v-50) also correlated the rise velocity data when no mass transfer took place, figure (4-3) of appendix 4-C. Unfortunately, there were no existing experimental data measured under the similar flow conditions reported in the literature that would have allowed a further check of equation (v-50) to be made.

Some specific rise velocities of the trailing slugs rising in the wakes were also measured and shown in figure 40, as the function of separation distances between the trailing and leading slugs. The trailing slug did in fact as reported by Griffith and Moissis (29) accelerate and catch up with the leading slug.

A-8. Liquid Mixing Characteristics

Liquid and slug Reynold numbers defined as $(D_p U_L \rho_L / \mu_L)$ and $(D_p U_s \rho_L / \mu_L)$ (3) in this study were calculated. The values were found to be less than 10 and 200 respectively indicating that the fluid flow behaviour was characteristically laminar. Nevertheless, due to the relative motion of the slug and liquid phags, induced liquid mixing took place at the rear of the gas slugs.

On injection of the red merian oil into the liquid flow, coloured stream lines were established which were observed to flow around the slugs until reaching the rear of the slugs and then depending on separation distances, the following results were observed, see figure 41. When separation distances were large, mixing of the liquid behind the slugs took place, the degree of mixing being dependent on the liquid phase viscosity. With light paraffin oil, the liquid in this region was relatively well mixed but with heavy paraffin oil, mixing

VARIATION OF TRAILING SLUG RISE VELOCITY U_s

WITH SEPARATION DISTANCE L_p

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

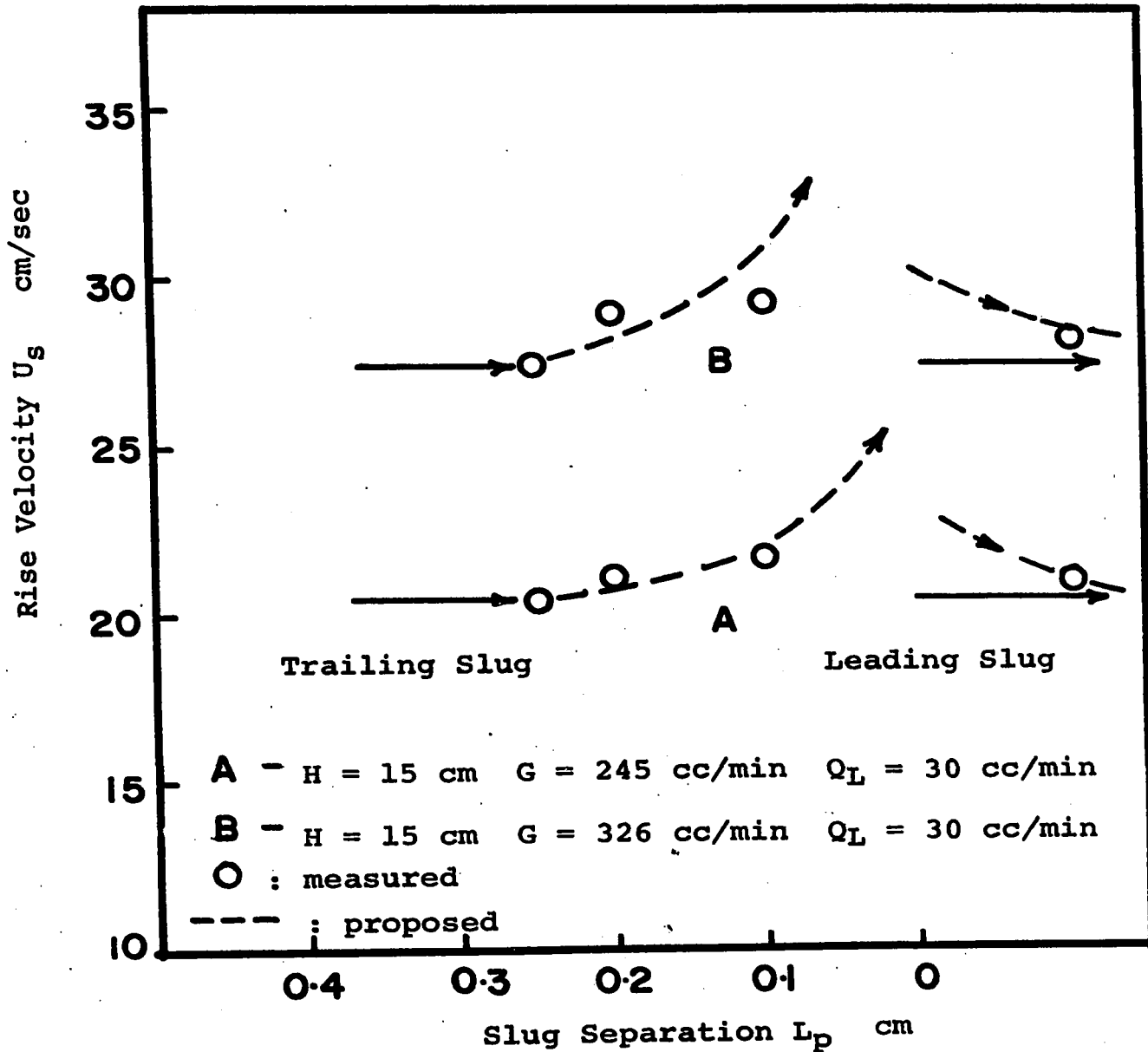
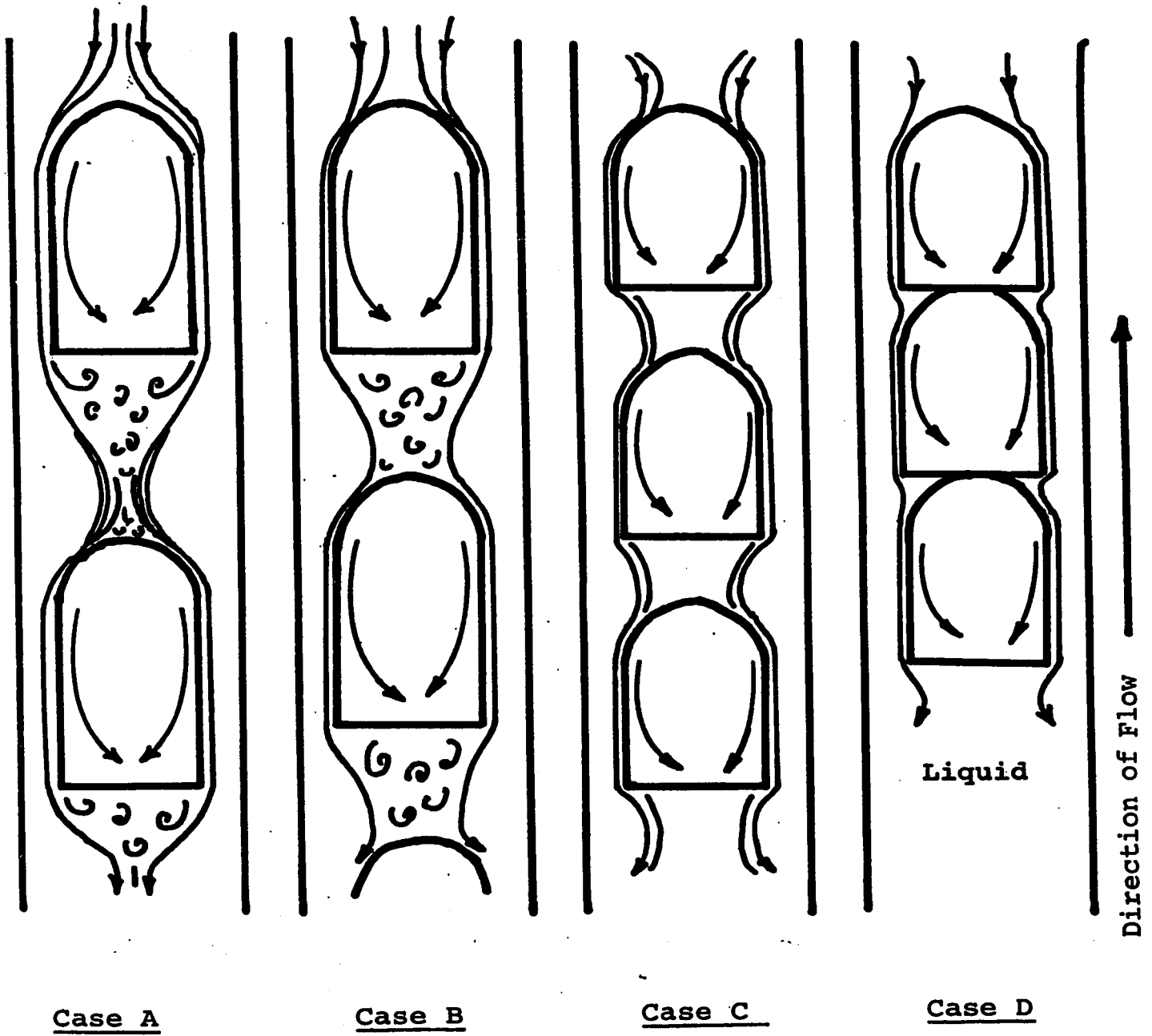


Figure 40



MIXING OF LIQUID IN VERTICAL TWO PHASE FLOW

Figure 41

was not complete. On merging, the stream lines flowed together before separating again as shown in case 41-A.

As the separation distances became smaller, the degree of mixing was reduced until finally for very short separation distances there was virtually no liquid mixing behind the slugs.

Back mixing of the liquid phase due to the relative motion of the slugs and liquid plugs was also observed by the introduction of a small piece of cork into the entrance region. The movement of the cork showed that in the entrance region the liquid phase could be considered well mixed for both heavy and light paraffin oil. The time t_f taken by the cork to travel through the absorber length was measured and compared with those with no back flow, t_L or H/U_L . The results of (t_f/t_L) were plotted against liquid rate Q_L in figure 42. (t_f/t_L) would be 1.0 if no back-flow occurred. Similar observations have also reported by Beek (11). However, the values of (t_f/t_L) in figure 42 can only be considered qualitatively as at times the cork did tend to adhere on the wall.

EFFECT OF LIQUID BACK FLOW ON LIQUID RESIDENCE TIME

System : n-Hexane-Nitrogen-Paraffin Oil

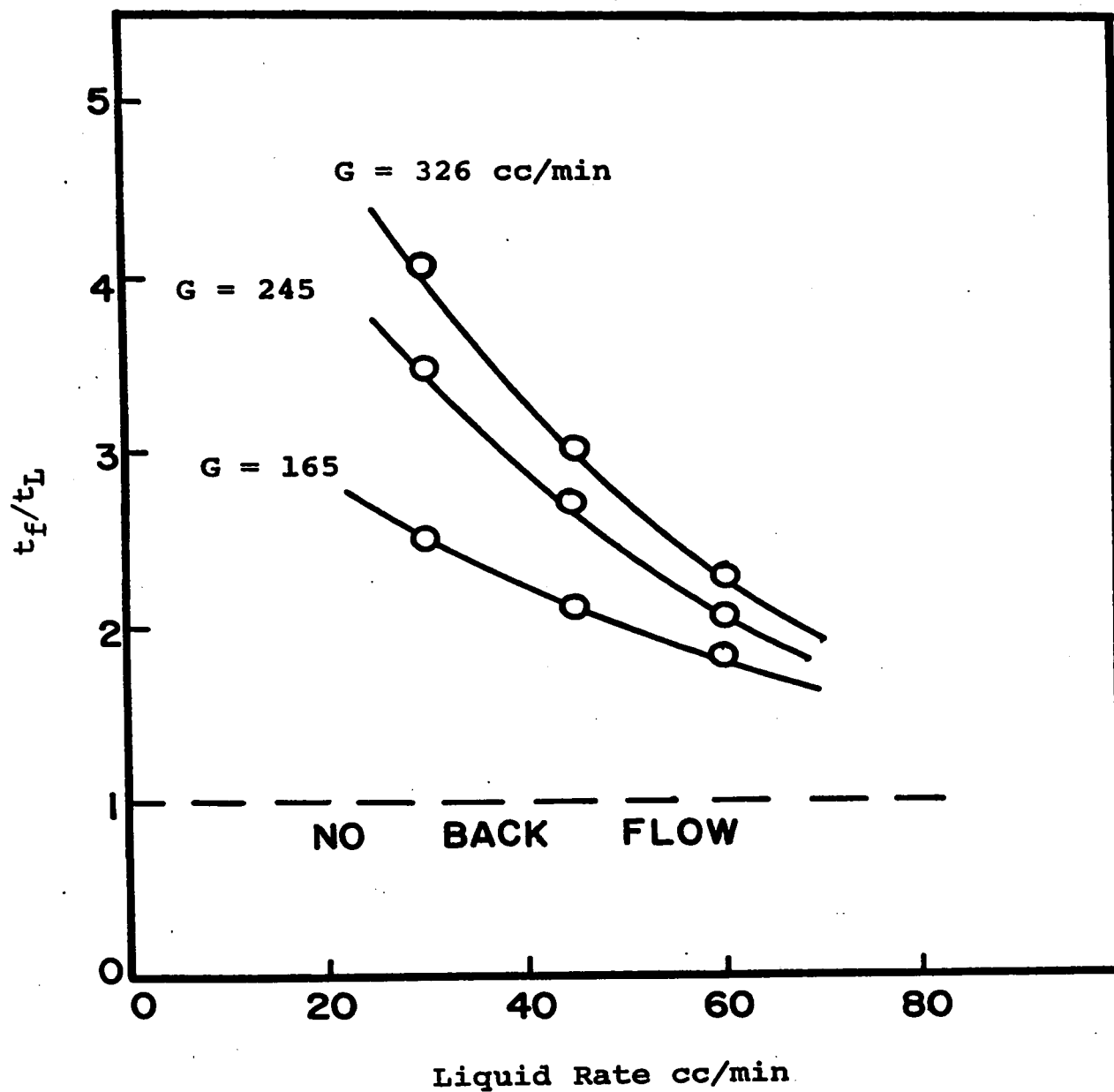


Figure 42

V-B. Mass Transfer Characteristics

B-1. Overall Mass Transfer Efficiencies

Overall efficiency E_{OT} data were obtained for the absorption of hexane from inert carrier gases into paraffin oils and the effect of varying gas and liquid flow rates, system properties, absorber length and diameter studied. The majority of the runs were carried out with nitrogen carrier gas, a complete range of variables being studied, with helium and Freon-14 more limited range of variables was investigated. Typical results are shown in figure 43 for the absorption of hexane from nitrogen into light and heavy paraffin oils and figure 44 for the absorption of hexane from helium and Freon-14.

The efficiency values obtained were high ranging in value from 0.85 to 0.99 for the light paraffin oil and from 0.79 to 0.96 for the heavy paraffin oil. The efficiencies increased with increase in contact time and absorber length as would be expected, but with the heavy paraffin oil distinct discontinuities in the E_{OT} curves were observed. The break in the curve corresponded quite closely to the minimum found in the $\bar{F}$ versus H curves as discussed previously. Thus, apparently the variation in slug surface area affected the absorp-

VARIATION OF E_{OT} WITH CONTACT TIME θ_z AND ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Paraffin Oil

--- Light Paraffin Oil

— Heavy Paraffin Oil

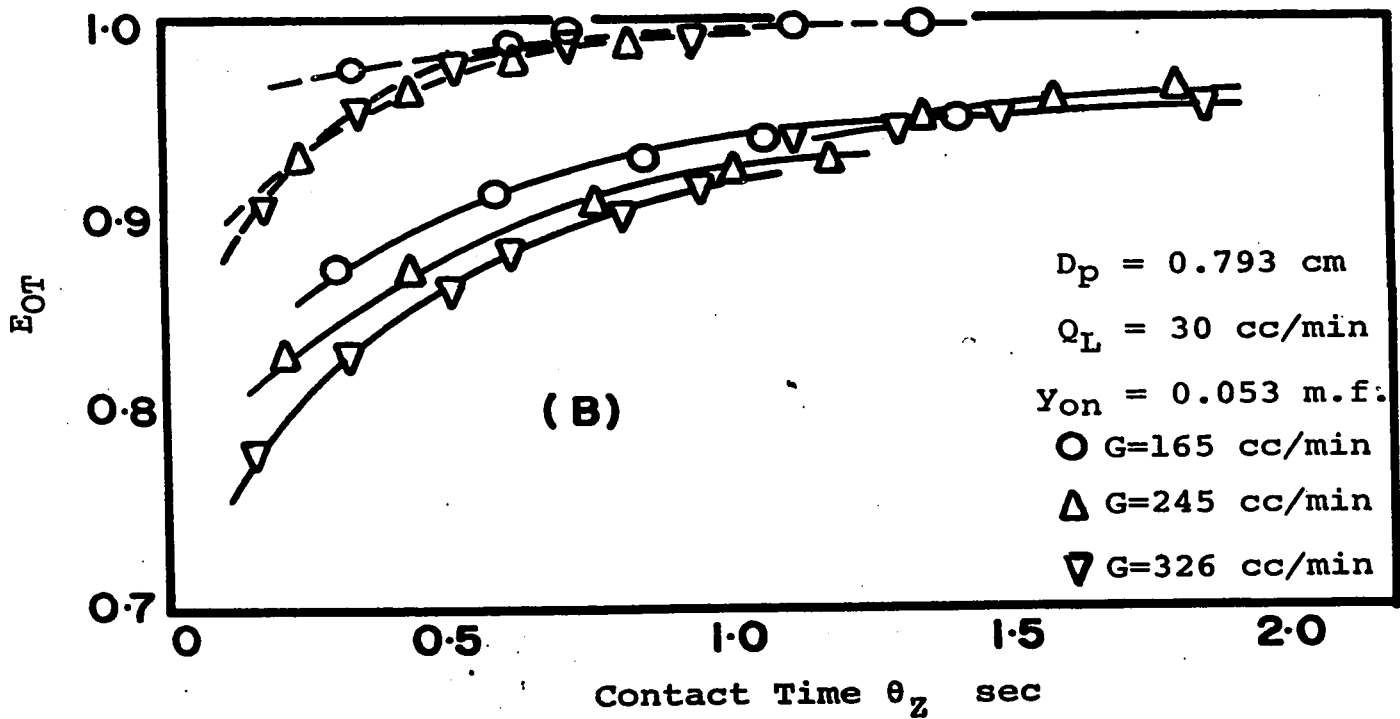
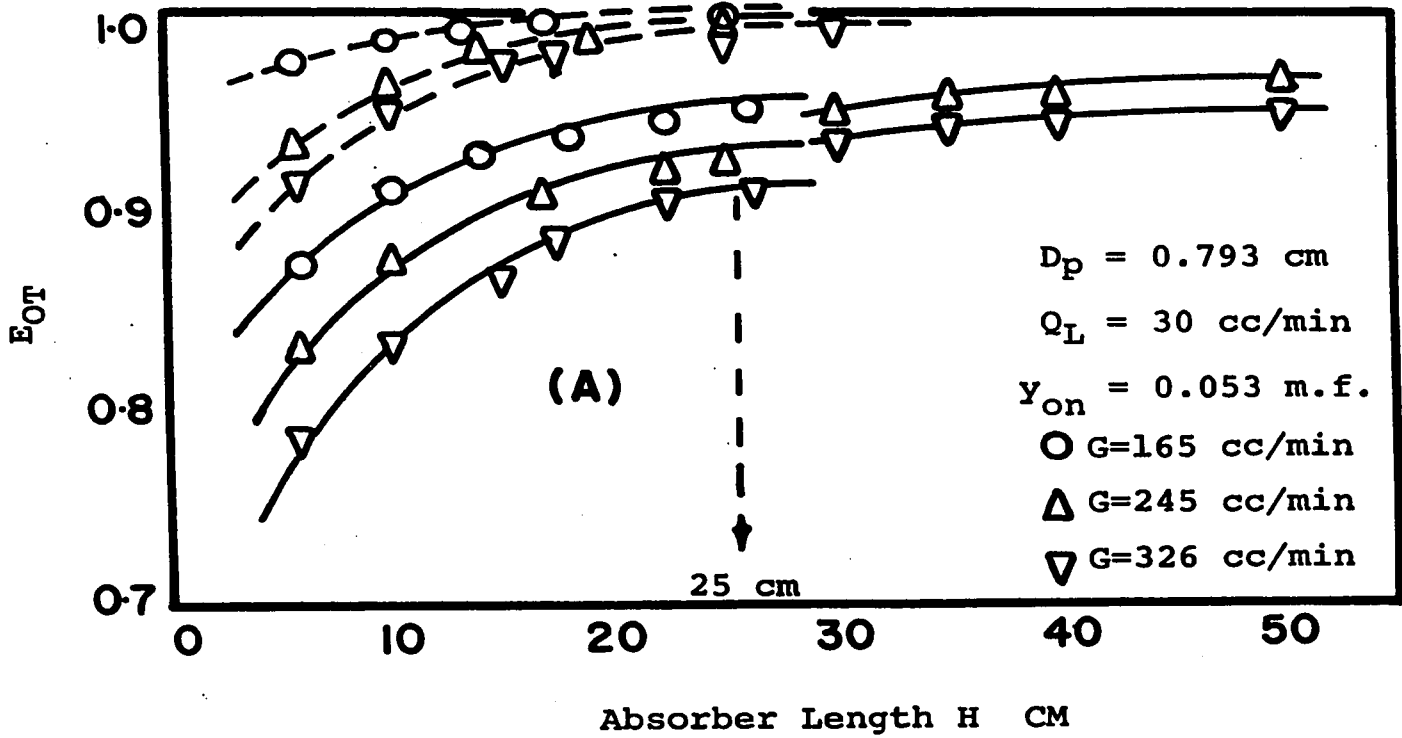


Figure 43

VARIATION OF E_{OT} WITH CONTACT TIME θ_z AND ABSORBER
LENGTH H FOR DIFFERENT CARRIER GASES

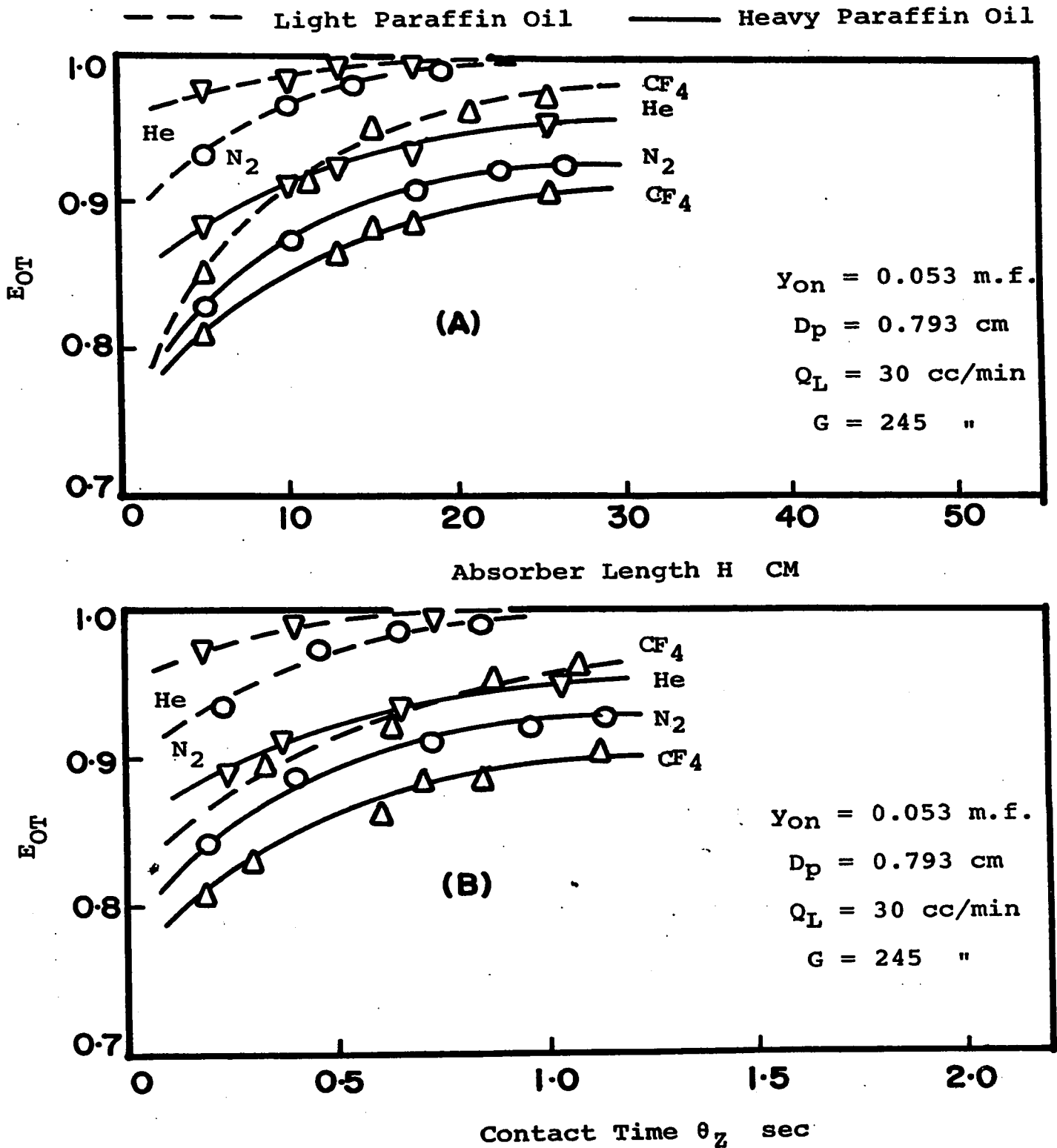


Figure 44

tion efficiencies such that the efficiencies were no longer a continuous function of absorber length H . This break was however not really apparent when light paraffin oil was used for two reasons, the changes in slug surface area with H were not as pronounced and the high absorption efficiencies for the light oil tended to reduce the magnitude of any discontinuity.

Mass transfer efficiencies were also found to be affected by changes in liquid and gas phase physical properties. E_{OT} values are reduced with increase in liquid phase viscosity, figures 43, 44 but increased with increase in gas phase diffusivity. Also observed was a definite effect of inlet gas phase composition on E_{OT} , the values increasing as the inlet gas phase hexane composition was raised from 0.023 to 0.0793 m.f., figure 45B.

Flow rates also influenced absorption efficiencies, with increase in gas rate E_{OT} values falling, this was particularly noticeable with the heavy paraffin oil. With change in liquid flow rate flow patterns were affected and the true influence of liquid rate on mass transfer rates was not readily discernible, especially with the light paraffin oil. In general the trend with increase in liquid rate was for E_{OT} to increase, see figure 45A. This effect however decreased with increase in absorber length H .

The E_{OT} values indicated that end-effect mass-transfer was high though less than had been observed in previous studies (12). End-effect mass-transfer was influenced by absorber diameter D_p and as a result the effect of D_p on overall

EFFECT OF LIQUID RATE Q_L AND INLET HEXANE

CONCENTRATION y_{on} ON E_{OT}

System : n-Hexane-Nitrogen-Paraffin Oil

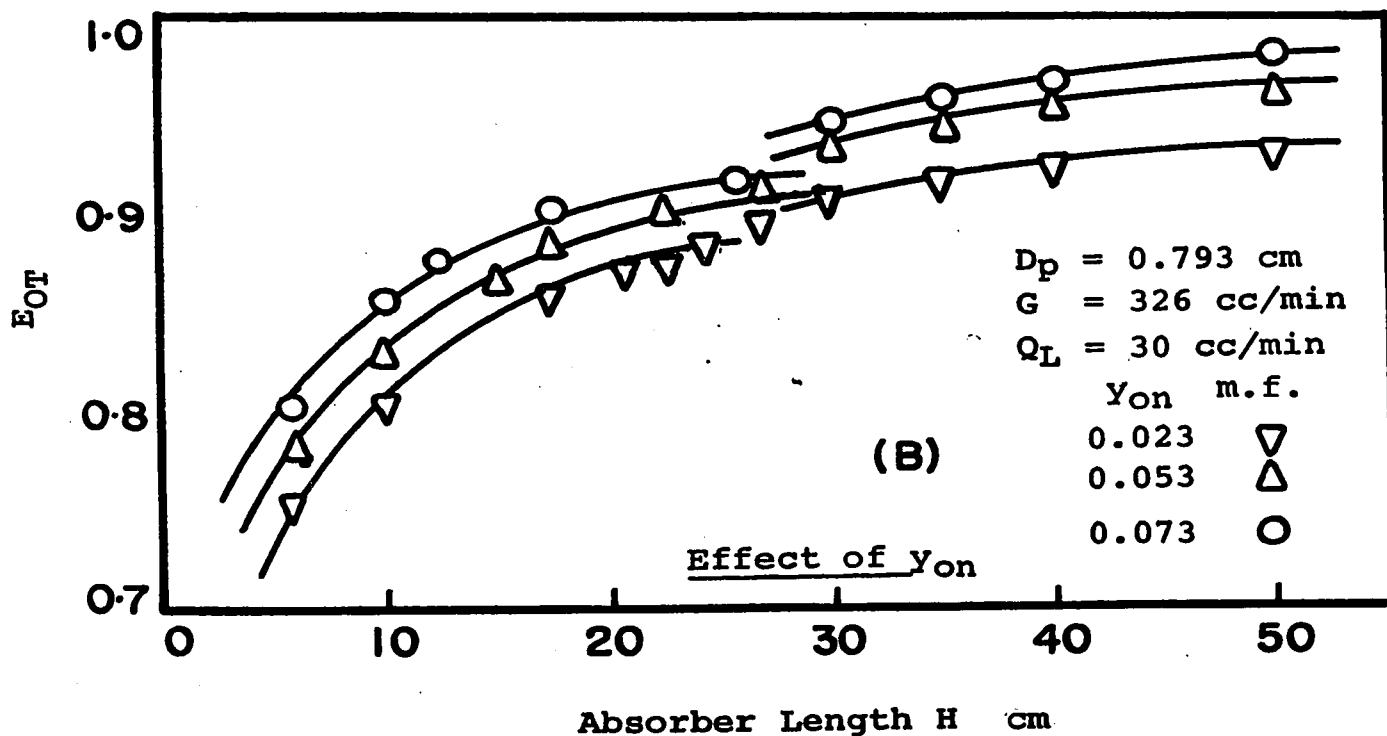
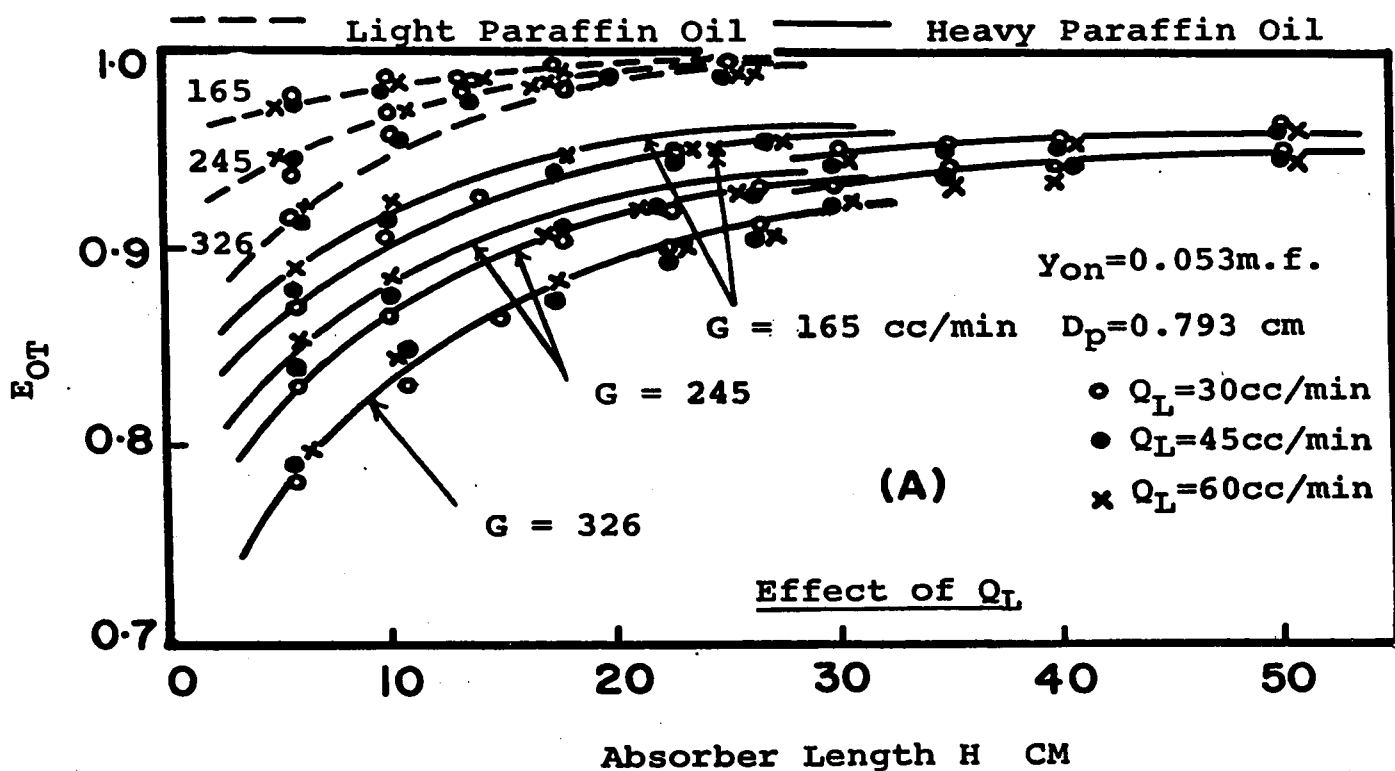


Figure 45

mass transfer efficiencies was not clear, the trend was for E_{OT} value to increase with increase in D_p but intersection of the curves took place, figure 46.

B-2. Rise Period Mass Transfer

2-a. End Effect Mass Transfer

It was necessary to estimate end effect mass transfer before overall mass transfer coefficients in the rise period could be evaluated. Plots were made of $-\ln(1-E_{OT})$ versus θ_z . Theoretically for constant K_{OG} and A_e these plots would yield straight lines but as K_{OG} and A_e were functions of H , straight lines plots did not result, figure 47. The curvature was more pronounced for the heavy paraffin oil as would be expected from the frequency measurements and the discontinuity found in the E_{OT} curves was also observed. It was found that the lower portions of the curves for H less than about 25 cm could be fitted with an equation having the form as

$$-\ln(1 - E_{OT}) = d_0 + d_1\theta_z/(1 + d_2\theta_z) \quad (V-51)$$

while the upper portion for H greater than about 25 cm by

$$-\ln(1 - E_{OT}) = b_0 + b_1\theta_z \quad (V-52)$$

where d_0 , d_1 , d_2 , b_0 and b_1 are constants.

In the latter case b_0 did not signify the end effect mass transfer but correspond to the mass transfer taking place in the zone represented by equation (V-51). End effect mass transfer efficiencies were estimated from the intercept at $\theta_z = 0.0$ from equation (V-52) and are shown in figures 48,

EFFECT OF ABSORBER DIAMETER D_p ON E_{OT}

System : n-Hexane-Nitrogen-Paraffin Oil

--- Light Paraffin Oil — Heavy Paraffin Oil

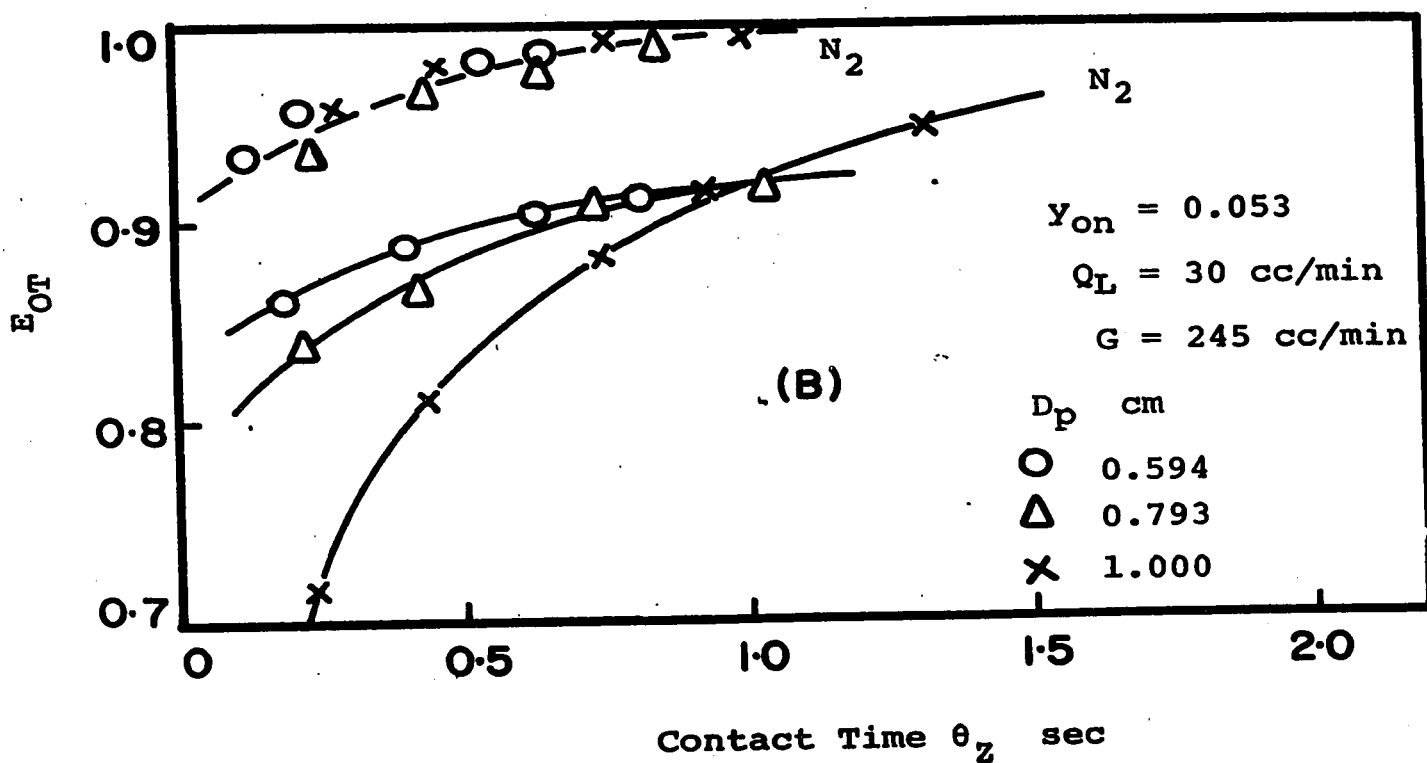
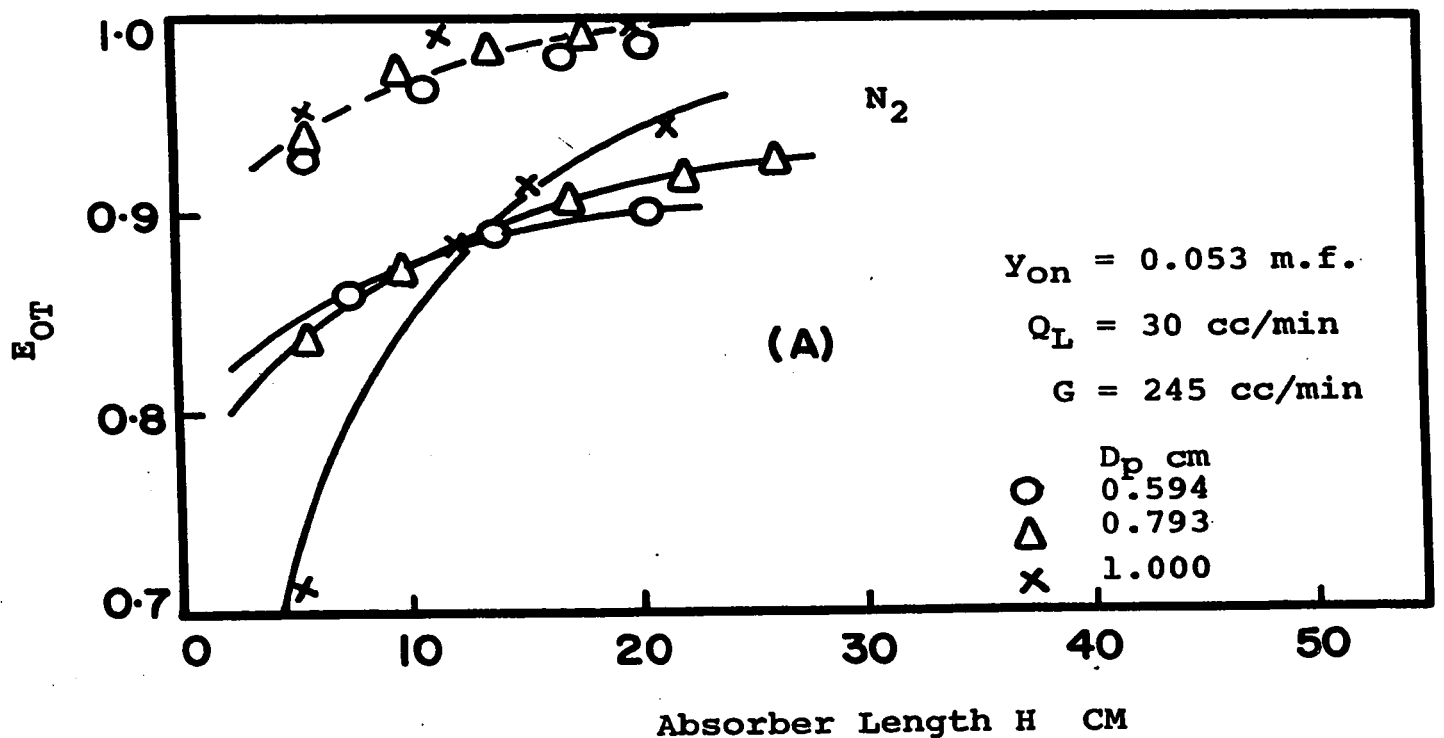


Figure 46

VARIATION OF $-\ln(1-E_{OT})$ WITH CONTACT TIME θ_z

System : n-Hexane-Nitrogen-Paraffin Oil

----- Light Paraffin Oil
 _____ Heavy Paraffin Oil

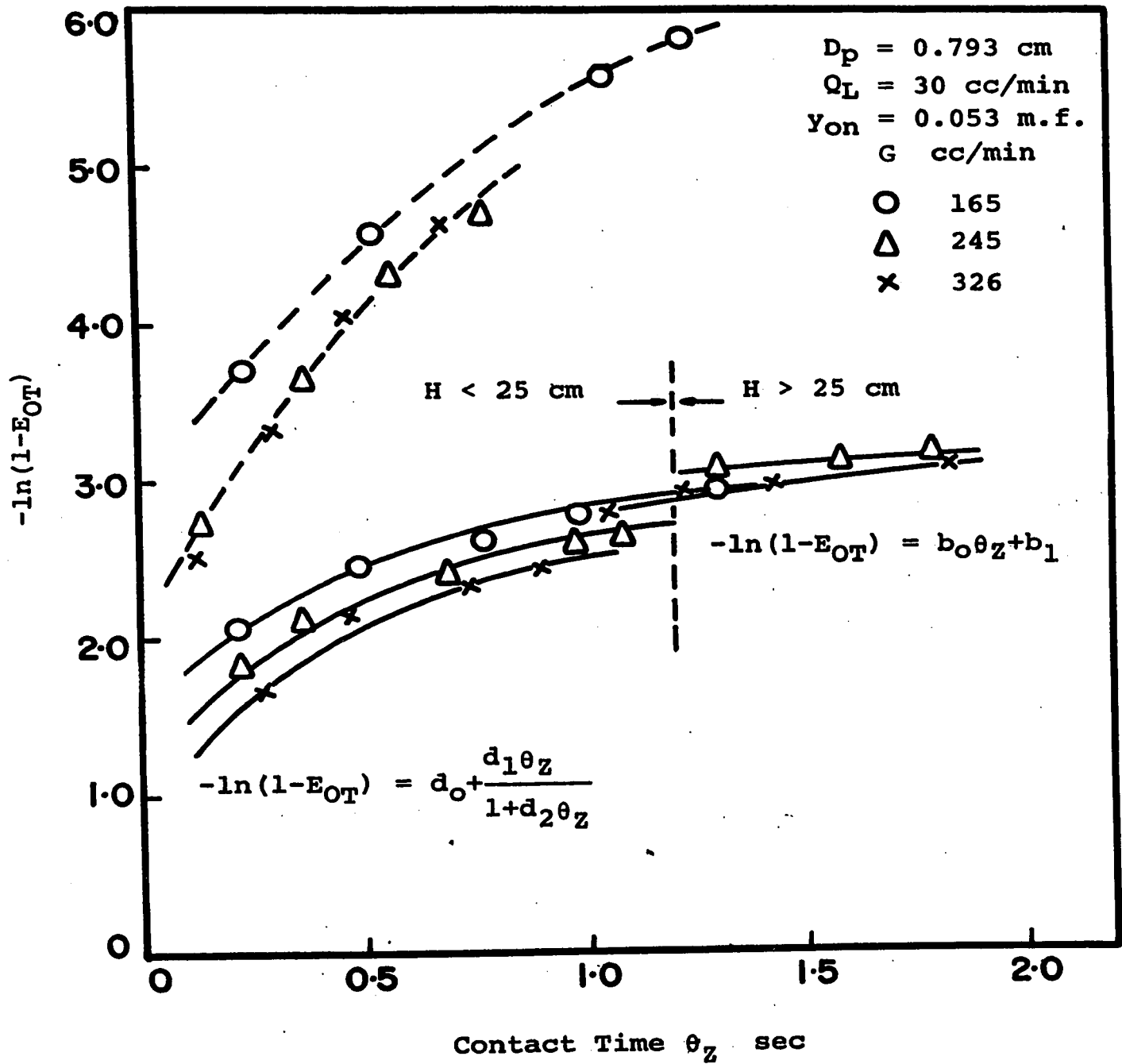


Figure 47

49 and 50. E_E values ranged from 0.57 to 0.95 being lower than had been observed in the initial studies (12).

End effect mass transfer with light paraffin oil was higher than with the heavy paraffin oil, figure 48⁵ and can be attributed to either greater liquid turbulence at formation or as a result of the smaller slug sizes in the formation zone. E_E values decreased with increase in gas rate but increased as the liquid rate was raised, the magnitude of this effect being however dependent on the gas flow rate. End effect mass transfer did not apparently appear to be as dependent on inlet gas phase concentration as rise period mass transfer. Only at the highest gas rate with the light paraffin oil and the lowest gas flow rate with the heavy paraffin oil was a distinct effect of gas phase concentration observed. E_E values also increased with increase in gas phase diffusivity the result being similar to those observed for the overall efficiency data, figure 49.

In addition, although the data were scattered, end effect mass transfer was reduced as the absorber diameter was increased, figure 50, probably due to increase in slug size and longer contact time. These results were consistent with the data reported by Porter (18) who found that the formation end effect mass transfer decreased with increase in slot free area of the sieve plate.

2-b. Overall Mass Transfer Coefficients, $K_{OG}A_e$ and $\overline{K_{OG}A_e}$

$K_{OG}A_e$ values were calculated using equation (III-17)

EFFECT OF FLUID FLOW RATES AND INLET GAS PHASE

CONCENTRATION ON END EFFECT MASS TRANSFER

System : n-Hexane-Nitrogen-Paraffin Oil

———— Heavy Paraffin Oil - - - - - Light Paraffin Oil

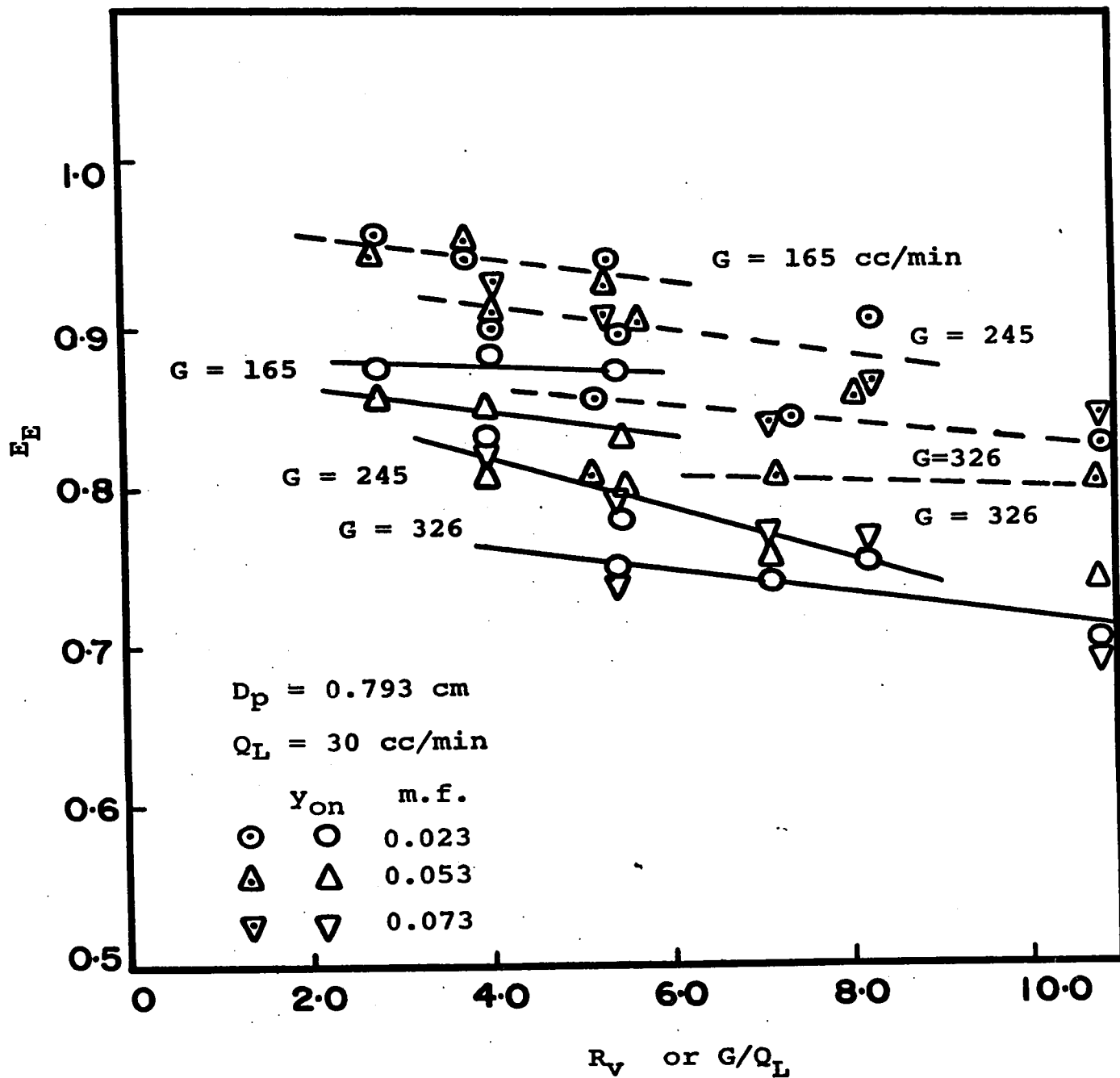


Figure 48

END EFFECT MASS TRANSFER EFFICIENCY FOR DIFFERENT
CARRIER GASES

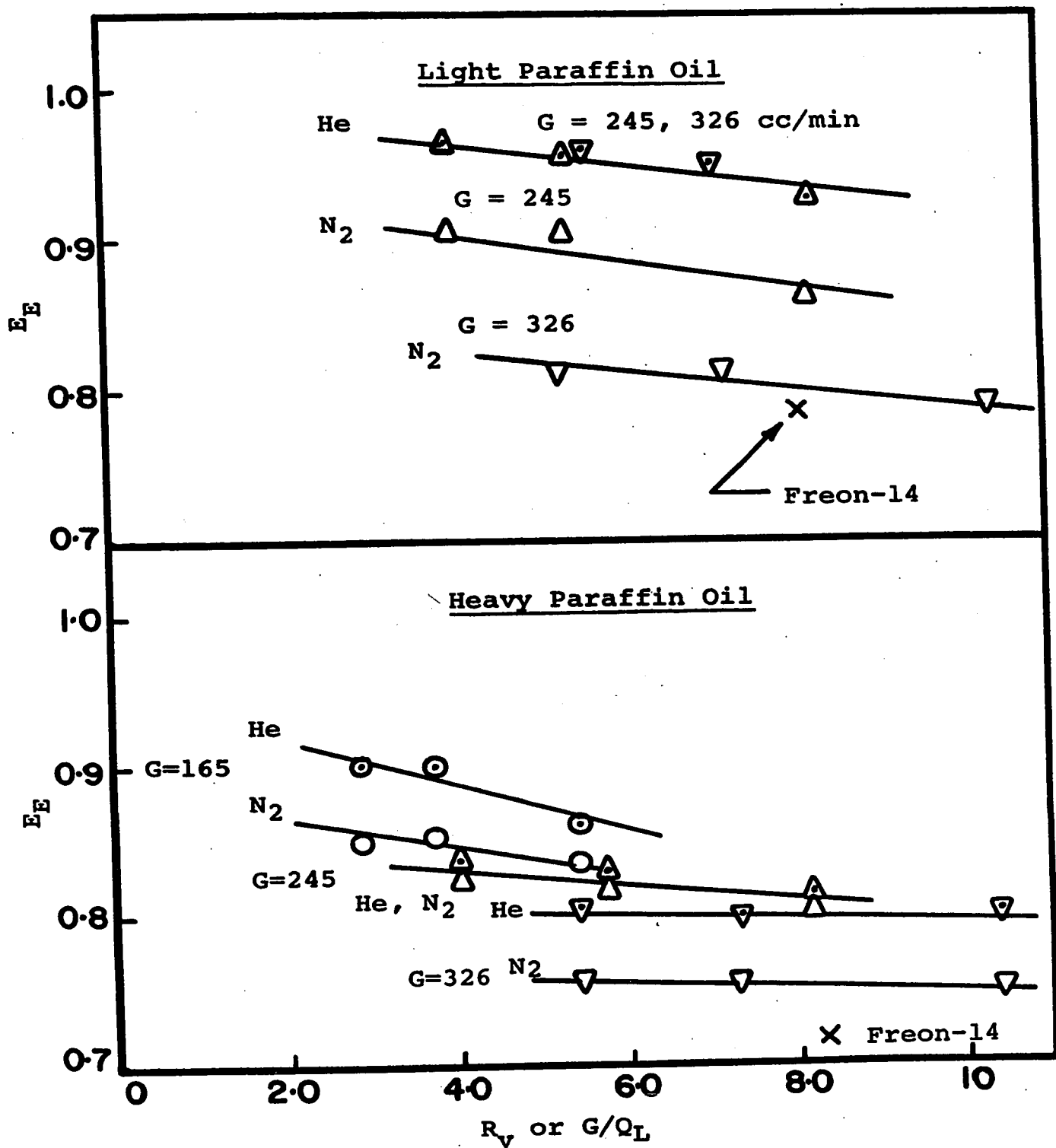


Figure 49

VARIATION OF END EFFECT MASS TRANSFER

EFFICIENCY WITH ABSORBER DIAMETER

System : n-Hexane-Nitrogen-Paraffin Oil

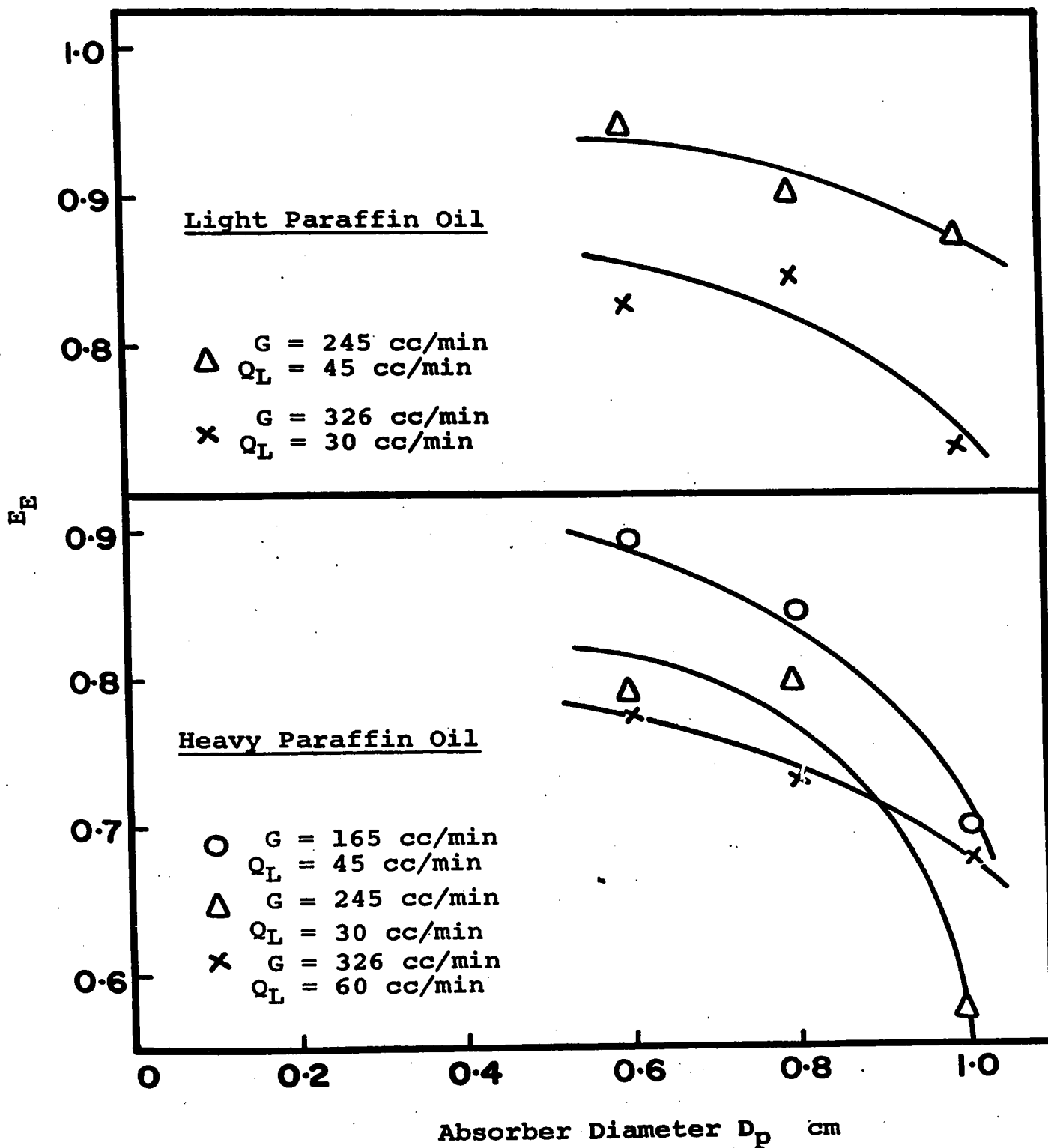


Figure 50

i.e. :

$$-\ln(1 - E_{OT}) = \int_0^{\theta_Z} \frac{K_{OG}A_e F}{G_m} d\theta_Z - \ln(1 - E_E)$$

Average values $\overline{K_{OG}A_e}$ were evaluated directly from contact time, frequency and efficiency measurement while point values $K_{OG}A_e$ can be calculated from the slopes of $-\ln(1-E_{OT})$ against θ_Z curves as described in chapter III. The effect of contacting height or absorber length on $K_{OG}A_e$ at different G and Q_L values is shown in figures 51, 52, 54 and 55. The increase in $K_{OG}A_e$ and $\overline{K_{OG}A_e}$ values with H can be attributed directly to the changes in slug surface area A_s with H , $K_{OG}A_e$ values fell corresponding to the reverse effect of H on A_s for $H > 25$ cm, figures 51 and 54. Both $K_{OG}A_e$ and $\overline{K_{OG}A_e}$ values increased with G but were generally reduced with increase in Q_L . Further, they decreased with increase in liquid phase viscosity, figure 52. The curves of slug surface area A_s versus H are shown for comparison in figure 53, showing that the variation of A_s with H was similar to the variation of $K_{OG}A_e$ with H . However, although the curves were similar in shape, the magnitude differed, i.e. a 45 percent increase in A_s only resulted in a 24 percent increase in $K_{OG}A_e$. This indicated that in all likelihood the surface area of the slug was not equally effective to mass transfer and that the mass transfer coefficient itself was decreasing with it. In a few cases, opposite effect of H on $K_{OG}A_e$ values was observed, that is $K_{OG}A_e$ decreased slightly with increase in H . This can be accounted for by the fact that in these runs the increase

VARIATION OF OVERALL MASS TRANSFER COEFFICIENT

$K_{OG}A_e$ WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

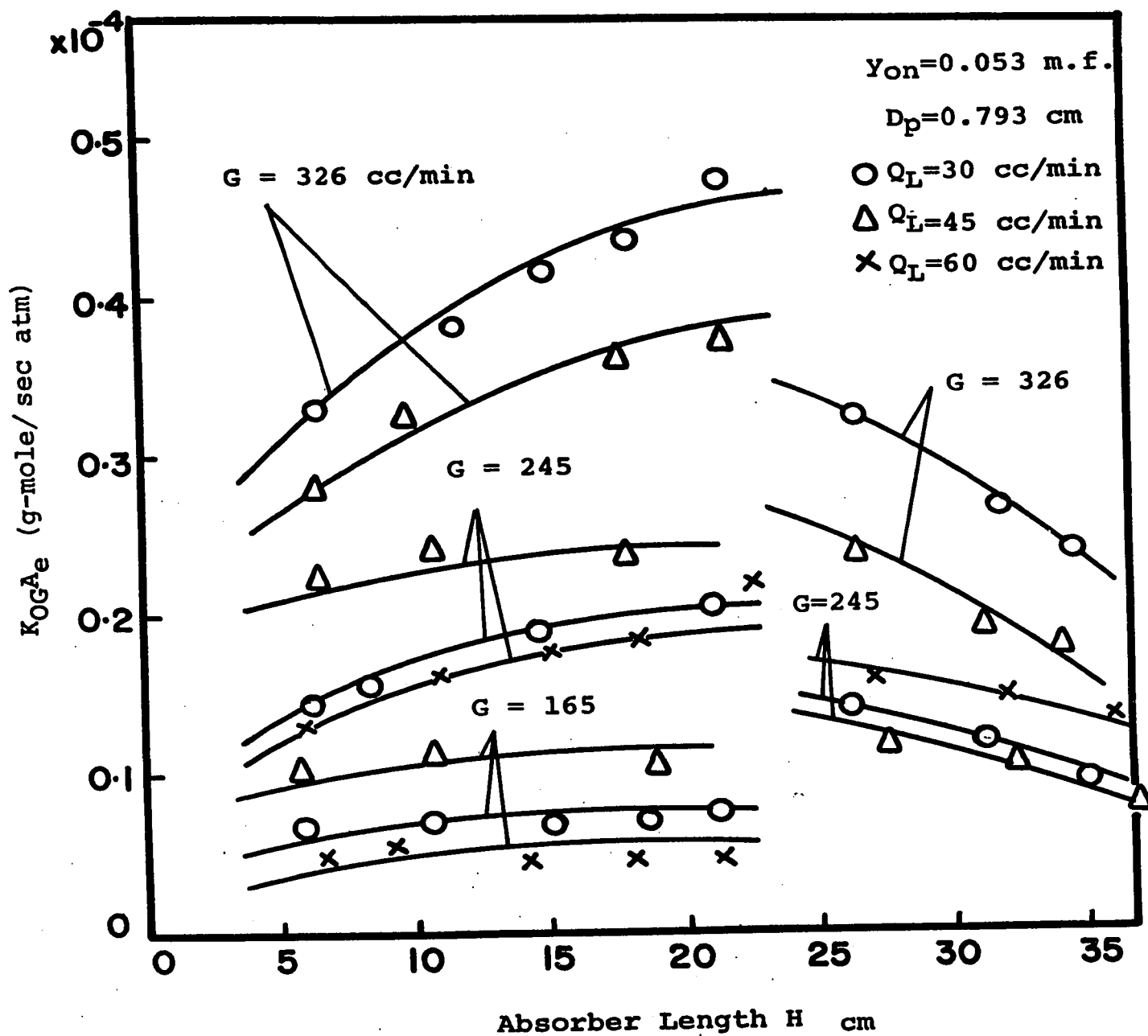


Figure 51

EFFECT OF LIQUID VISCOSITY ON OVERALL

MASS TRANSFER COEFFICIENT $\overline{K_{OG}A_e}$

System : n-Hexane-Nitrogen-Paraffin Oil

--- Light Paraffin Oil

— Heavy Paraffin Oil

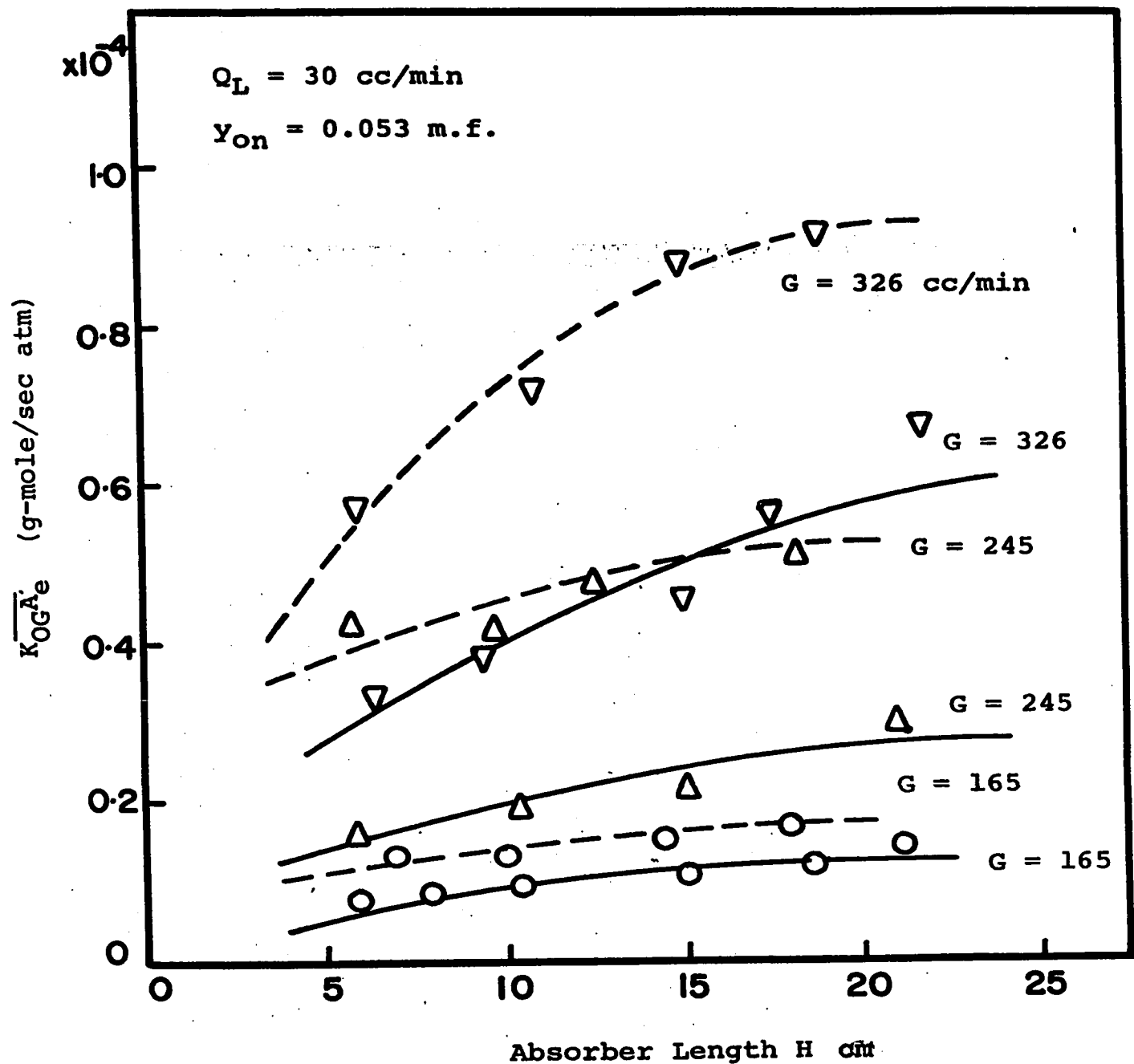


Figure 52

VARIATION OF SLUG SURFACE AREA A_s WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

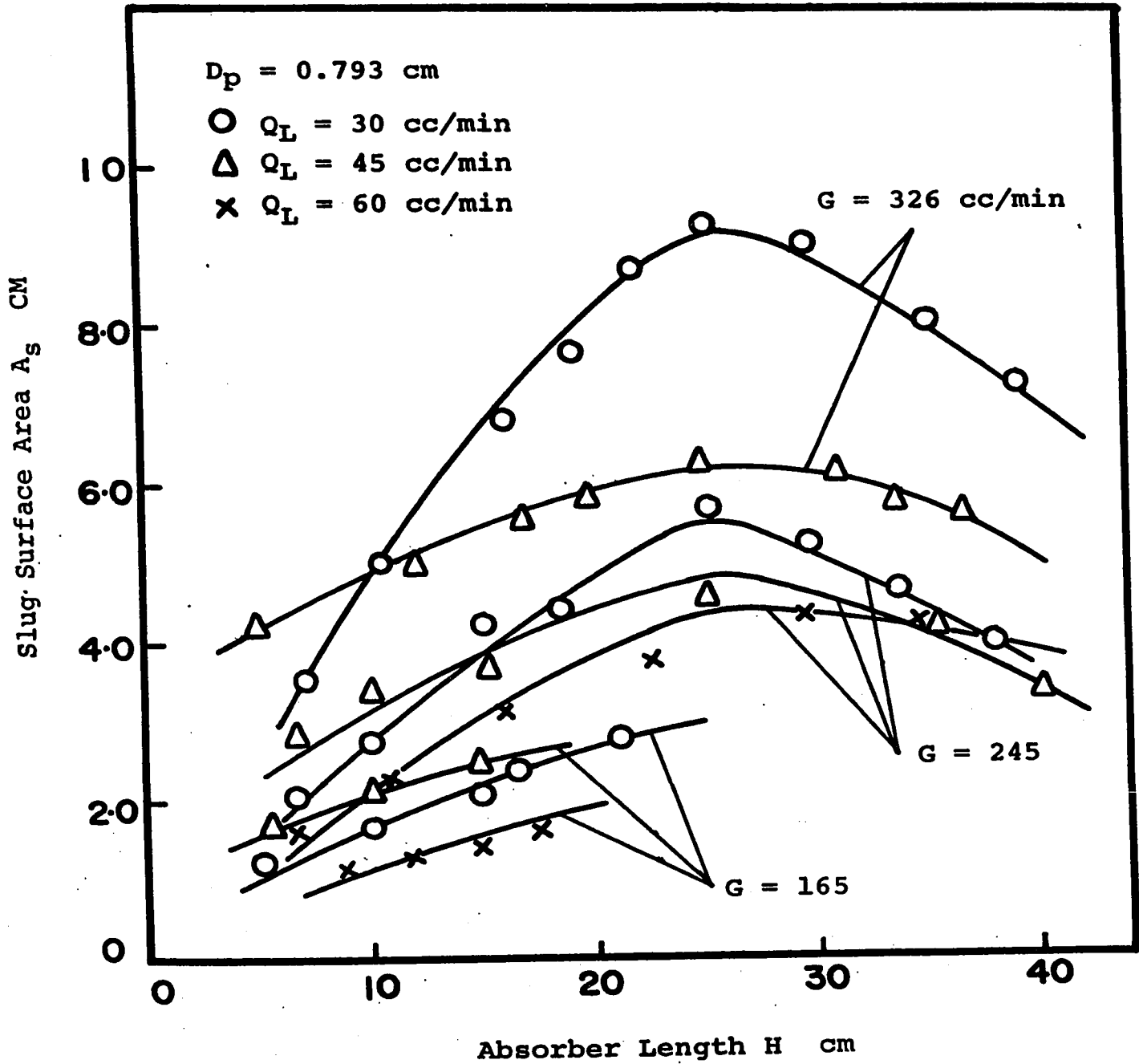


Figure 53

in A_e could not compensate for the decrease in mass transfer coefficient.

The flow pattern measurements indicated that the inlet gas phase hexane concentration y_{on} had no effect on A_s , but there was an influence of inlet hexane concentration on mass transfer rates, figures 54 and 55, $K_{OG}A_e$ increasing with increase in y_{on} . The effect of y_{on} was even more marked, figure 55, for light paraffin oil which was not expected.

2-c. Overall Mass Transfer Coefficients K_{OGa} and $\overline{K_{OGa}}$

Although previous investigations have reported mass transfer coefficient as a product of the overall mass transfer coefficient and the effective area, the results obtained in this study were rather difficult to interpret, the continually changing slug area resulting in changes in K_{OG} and $\overline{K_{OG}}$ with H . In an attempt to resolve this problem, the mean and point mass transfer coefficients $\overline{K_{OG}A_e}$ and $K_{OG}A_e$ were then divided by the corresponding total slug surface area $\overline{A_s}$ and A_s as discussed previously, Chapter III and the mass transfer coefficients reported as $\overline{K_{OGa}}$ and K_{OGa} where $\overline{a}$ and a were ratios of effective to total slug surface area.

Figure 56 show plots of mass transfer coefficient values K_{OGa} versus H corresponding to the curves previously plotted for $K_{OG}A_e$. The results were more consistent, the $\overline{K_{OGa}}$ and K_{OGa} values showed a continuous decrease with increase in H for both heavy and light paraffin oils, figures 56-58. It is interesting to note that, figure 56, the K_{OGa} data tended to fall on a single curve with K_{OGa} remaining constant or

EFFECT OF INLET HEXANE CONCENTRATION y_{on} ON
OVERALL MASS TRANSFER COEFFICIENT K_{OG}^A
 System : n-Hexane-Nitrogen-Heavy Paraffin Oil

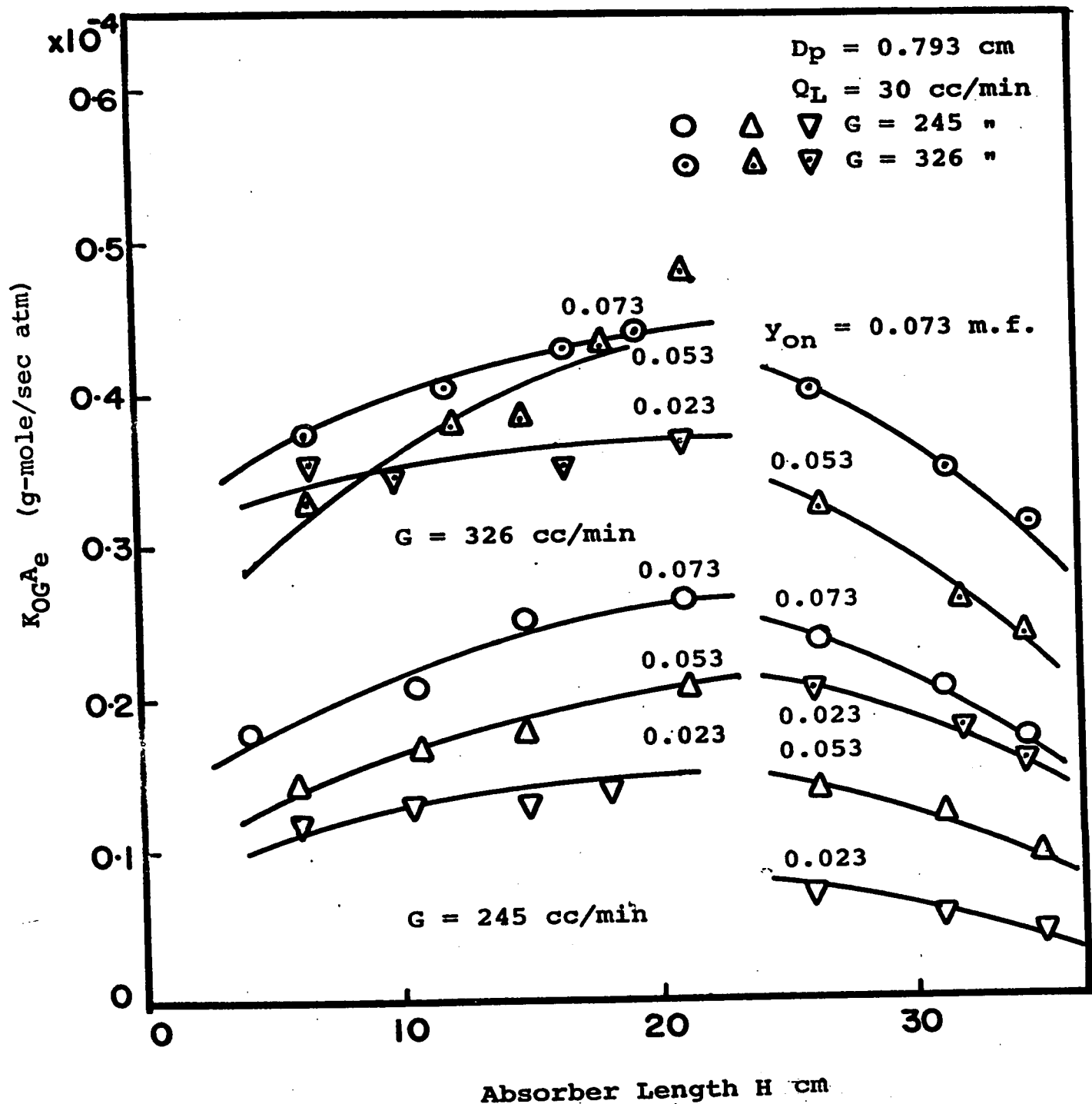


Figure 54

EFFECT OF INLET HEXANE CONCENTRATION y_{on} ON
OVERALL MASS TRANSFER COEFFICIENT $K_{OG}A_e$

System : n-Hexane-Nitrogen-Light Paraffin Oil

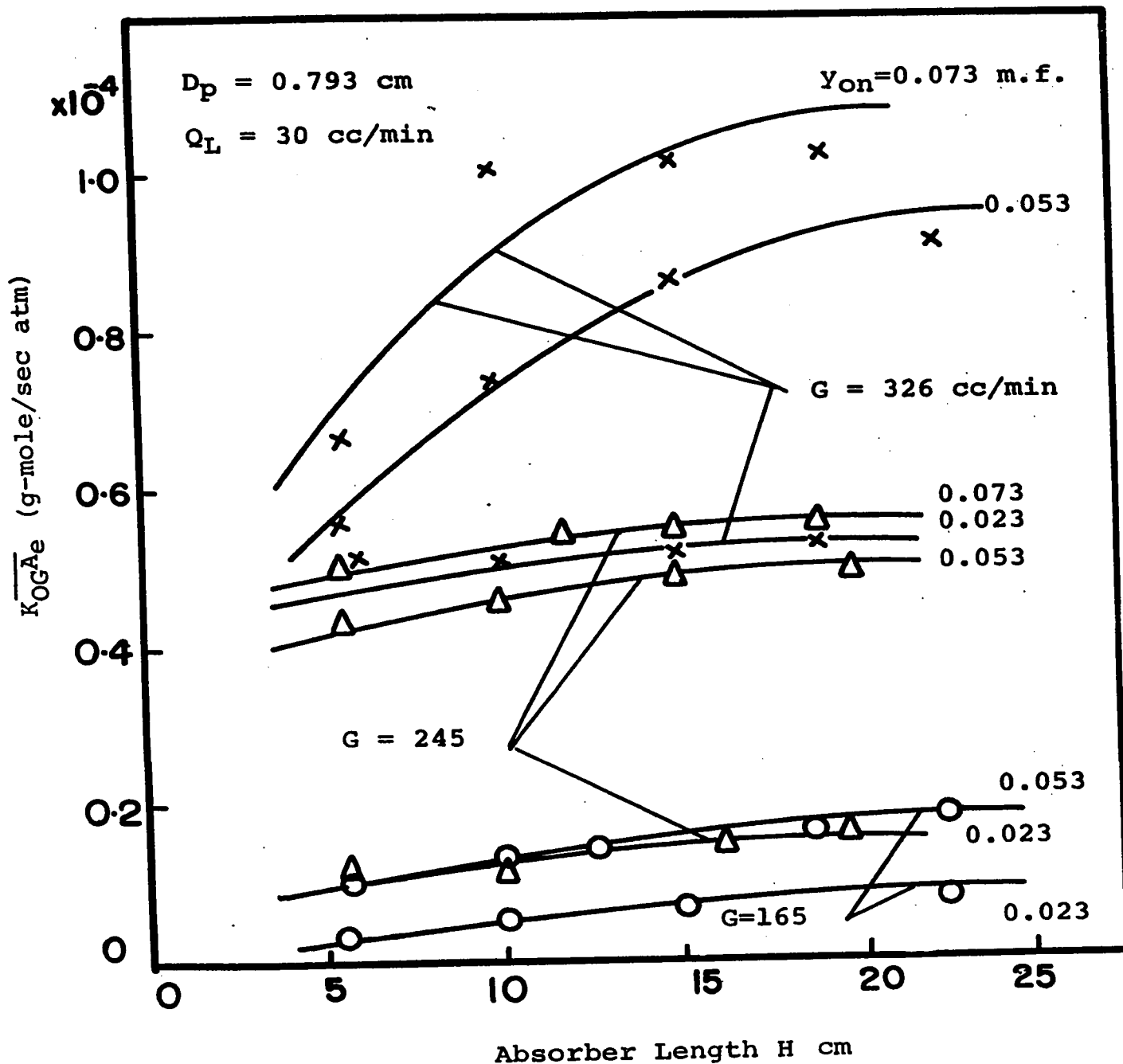


Figure 55

VARIATION OF OVERALL MASS TRANSFER COEFFICIENT

$K_{OG}a$ WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

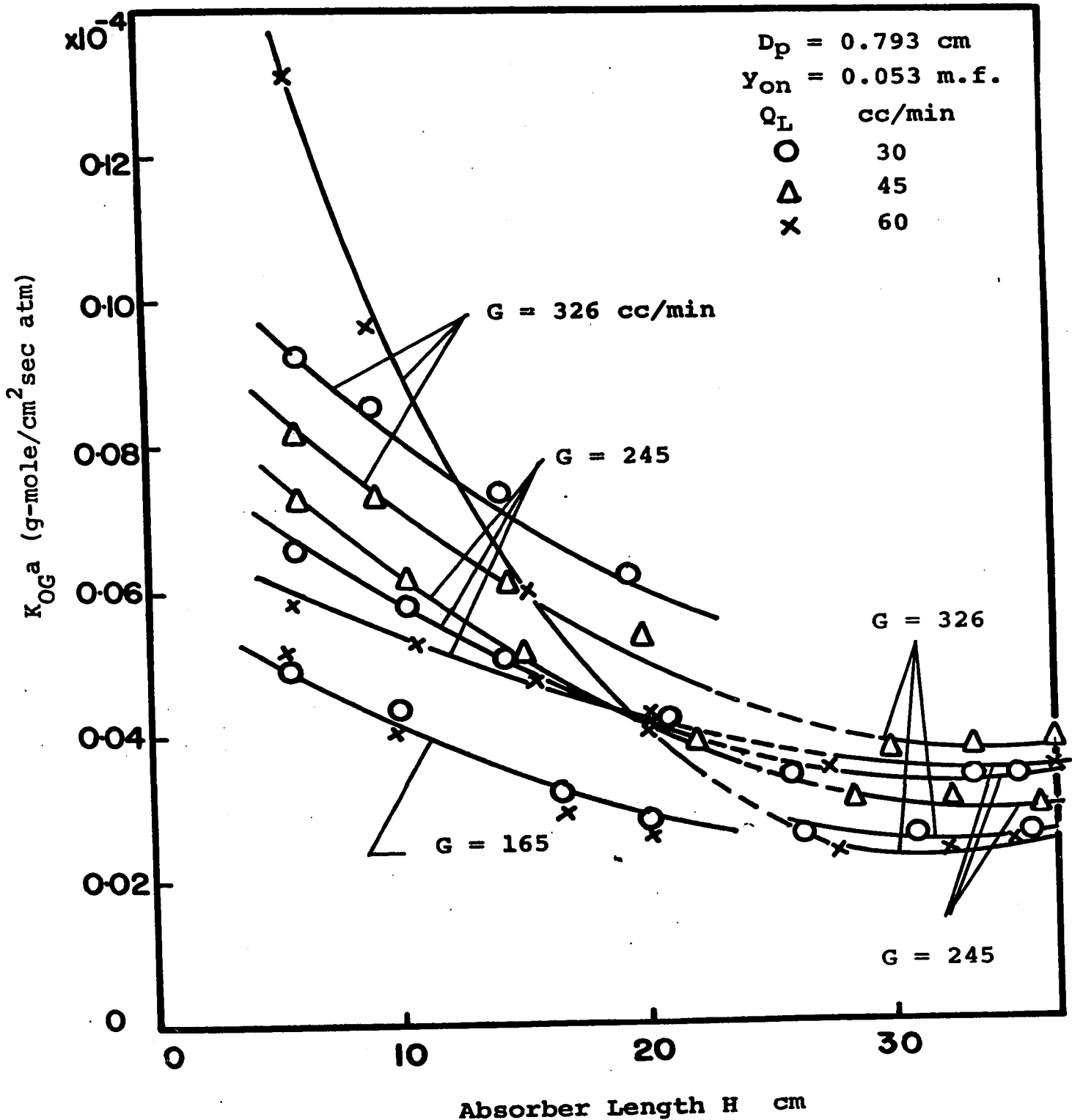


Figure 56

increasing slightly with H for H value greater than about 25 cm. This could be anticipated from the frequency measurements.

Both $\overline{K_{OGa}}$ and K_{OGa} values always increased with increase in gas flow rate G but the effect of liquid flow rates was dependent on the flow patterns, the general tendency being for increase in liquid flow rates to reduce mass transfer rates at lowest and intermediate gas flow rates and increase the mass transfer rate at highest gas rate. With the heavy paraffin oil, figure 57, no effect of Q_L was found at the lowest gas rate and a pronounced effect at the highest gas rate. With light paraffin oil, figure 58, $\overline{K_{OGa}}$ values however tended to scatter. For the smallest and intermediate gas flow rates, there were great reductions of $\overline{K_{OGa}}$ values when Q_L increased from 30 to 45 cc/min and little effect of Q_L from 45 to 60 cc/min while at the highest gas rate the effect of Q_L was again pronounced. These variation of $\overline{K_{OGa}}$ with Q_L at different gas flow rate can be attributed to the variation of slug sizes and development of chain flow pattern at the higher liquid rates.

The variation of both point K_{OGa} values and average $\overline{K_{OGa}}$ with H is shown in figure 59, average values lay well above point values illustrating in particular the reduction in mass transfer rates with H. The effect of inlet gas phase hexane composition y_{on} was again apparent, K_{OGa} values increasing with increase in y_{on} although with the light paraffin oil scatter of the data was observed, figure 60. The effect of

VARIATION OF OVERALL MASS TRANSFER COEFFICIENT

$\overline{K_{OGa}}$ WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

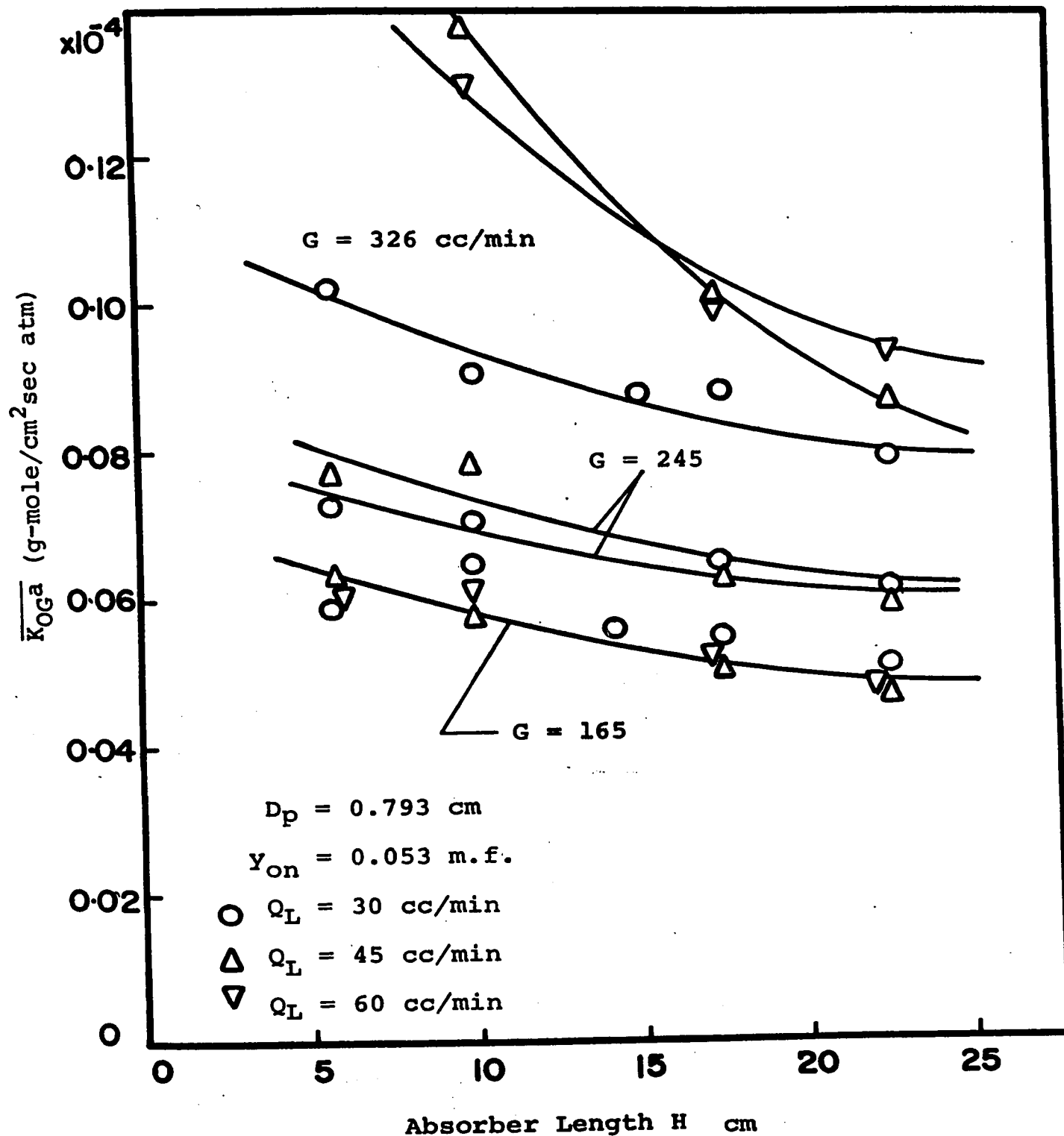


Figure 57

VARIATION OF OVERALL MASS TRANSFER COEFFICIENTS

$\overline{K}_{OG}a$ WITH ABSORBER LENGTH H

System : n-Hexane-Nitrogen-Light Paraffin Oil

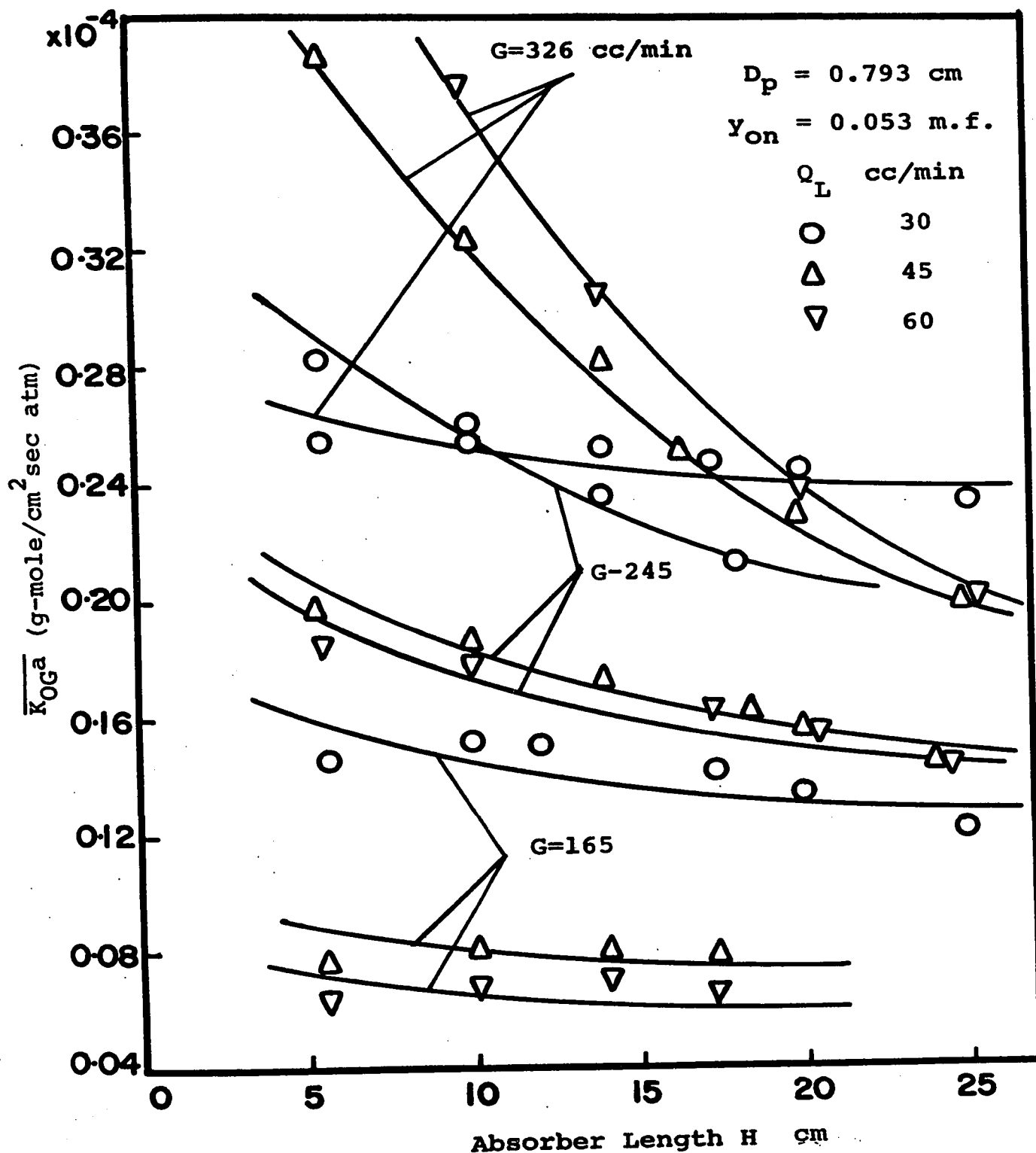


Figure 58

COMPARISON OF MEAN AND POINT OVERALL MASS
TRANSFER COEFFICIENT $\overline{K_{OGa}}$ AND K_{OGa}

System : n-Hexane-Nitrogen-Paraffin Oil

Heavy Paraffin Oil Light Paraffin Oil

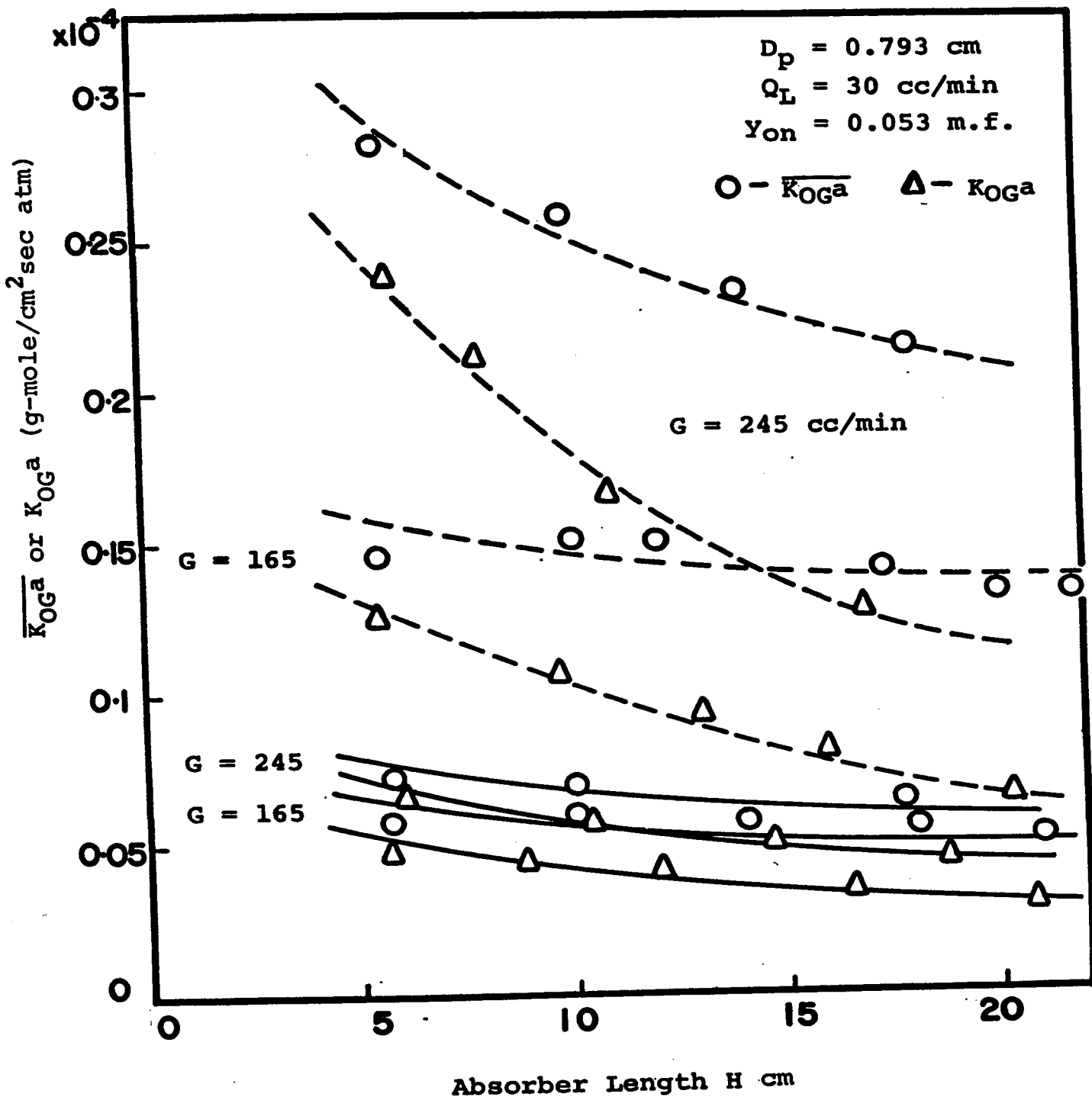


Figure 59

EFFECT OF GAS PHASE CONCENTRATION ON OVERALL

MASS TRANSFER COEFFICIENTS K_{OG}^a

System : n-Hexane-Nitrogen-Paraffin Oil

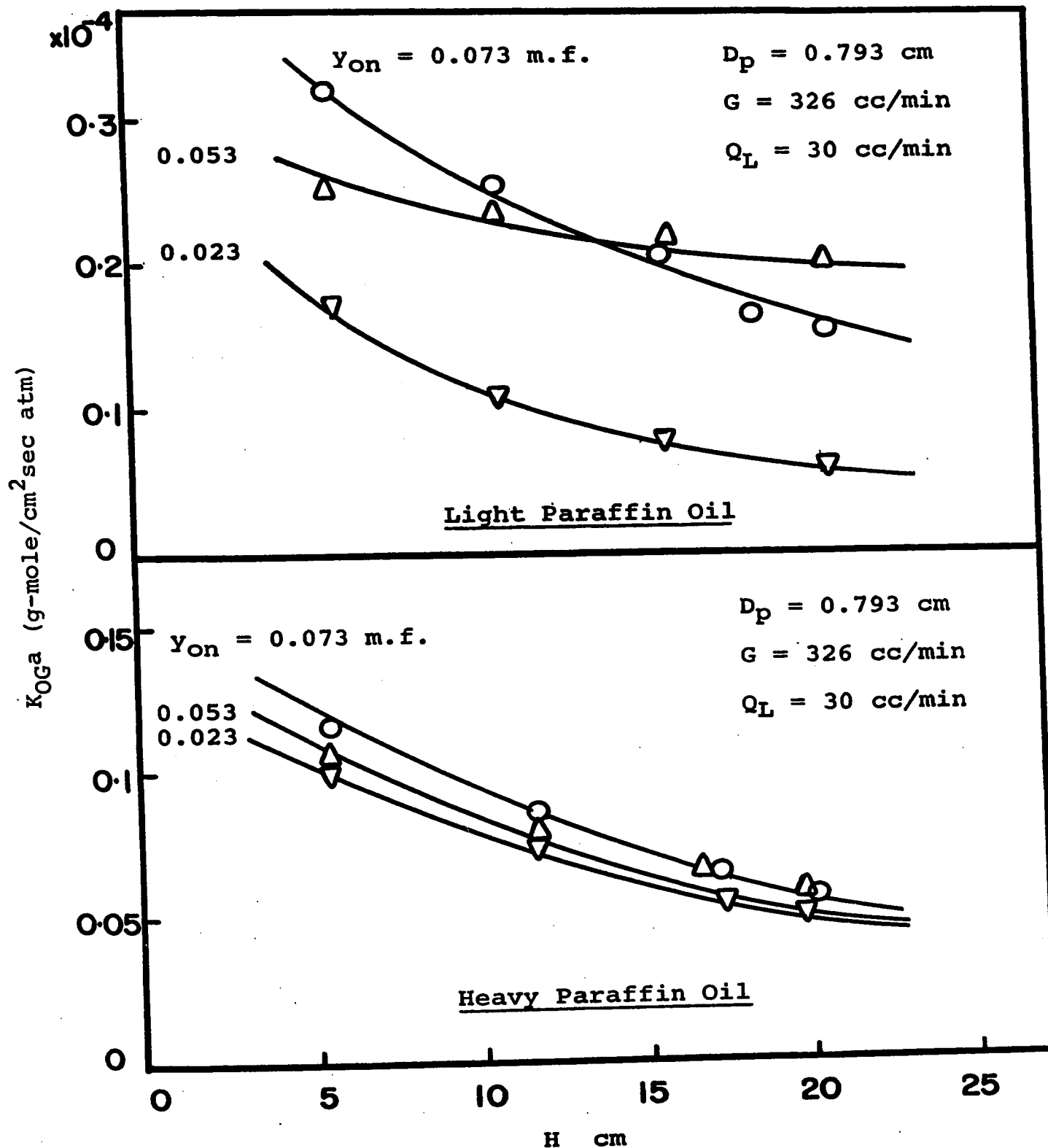


Figure 60

system properties is well shown in figure 58, for plots of $\overline{K_{OGa}}$ with H for the three different carrier gases into the two paraffin oils, the rate increased, as would be expected, with increase in gas phase diffusivity.

2-d. Effects of Flow Patterns

The effect of flow pattern on mass transfer rate can be seen from the results obtained from variation of both gas and liquid flow rates, figures 57 and 58. For any particular liquid flow rate, $\overline{K_{OGa}}$ values increased with increase in G . Several factors must be considered, the increase in slug size, increase in interfacial velocity and effect of slug separation distances. Theoretically, the effect of increases in slug size and interfacial velocity on K_{OG} oppose each other, that is increase in slug size would reduce K_{OG} and increase in interfacial velocity would increase K_{OG} . Hence the latter effect of slug separation predominated as can be seen from the results. Thus $\overline{K_{OGa}}$ and K_{OGa} values increased with G due most likely to the increase in liquid mixing between slugs when separation distances increased with increase in G as was observed in the separation distance measurements and liquid mixing studies, figures 33 and 41. Fig 4-B

An opposite effect was normally found when liquid rates were increased. Under these circumstances, for both paraffin oils, slug sizes and separation distances were observed to decrease resulting in the decrease of liquid mixing between slugs and the establishment of chain like flow pattern which resulted in a comparatively large reduction of transfer rates

COMPARISON OF OVERALL MASS TRANSFER COEFFICIENTS

$\overline{K_{OGa}}$ FOR DIFFERENT CARRIER GASES

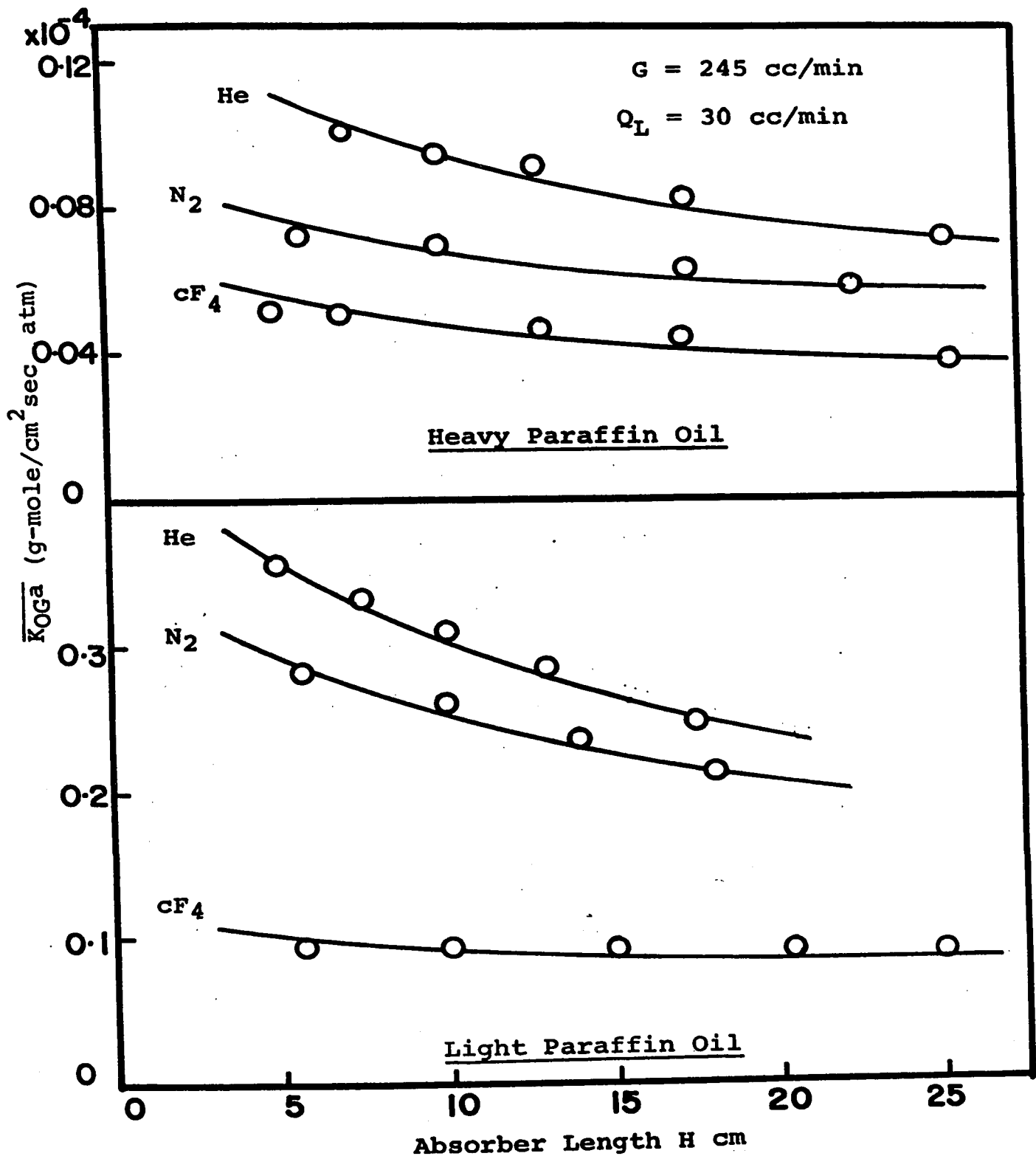


Figure 61

and effective surface areas. This is shown in figure 57 and 58 by the large reduction in $\overline{K_{OG}a}$ values with the light paraffin oil at intermediate and low gas rate when Q_L was increased from 30 to 45 cc/min. Once chain flow patterns were established, the effect of Q_L was relatively small. At the highest gas rates, when Q_L increased, slug sizes decreased but however slugs did not chain and so $\overline{K_{OG}a}$ increased with increase in Q_L .

The influence of slug separation distances on mass transfer rate is also shown by the variation of $\overline{K_{OG}a}$ values obtained for the different diameter absorbers. In figure 62, $\overline{K_{OG}a}$ values increased with increase in D_p where as theoretically very little effect of D_p should have been observed from the effect of D_p on both interfacial velocity and slug size, Table 9.

Table 9

Theoretical Effect of D_p on Overall Mass Transfer Coefficient

$H = 15 \text{ cm}$

$Q_L = 30 \text{ cc/min}$

System : n-Hexane-Nitrogen-Paraffin Oil

Paraffin Oil	$D_p \text{ cm}$	$G \text{ cc/min}$	$K_{OG} \text{ g-mole/sec cm}^2\text{atm}$
Heavy	0.594	326	0.391×10^{-4}
	0.793	326	0.393×10^{-4}
	1.000	326	0.400×10^{-4}
Light	0.594	326	0.500×10^{-4}
	0.793	326	0.671×10^{-4}
	1.000	326	0.620×10^{-4}

VARIATION OF OVERALL MASS TRANSFER COEFFICIENTS

$\overline{K}_{OG}a$ WITH ABSORBER DIAMETER D_p

System : n-Hexane-Nitrogen-Paraffin Oil

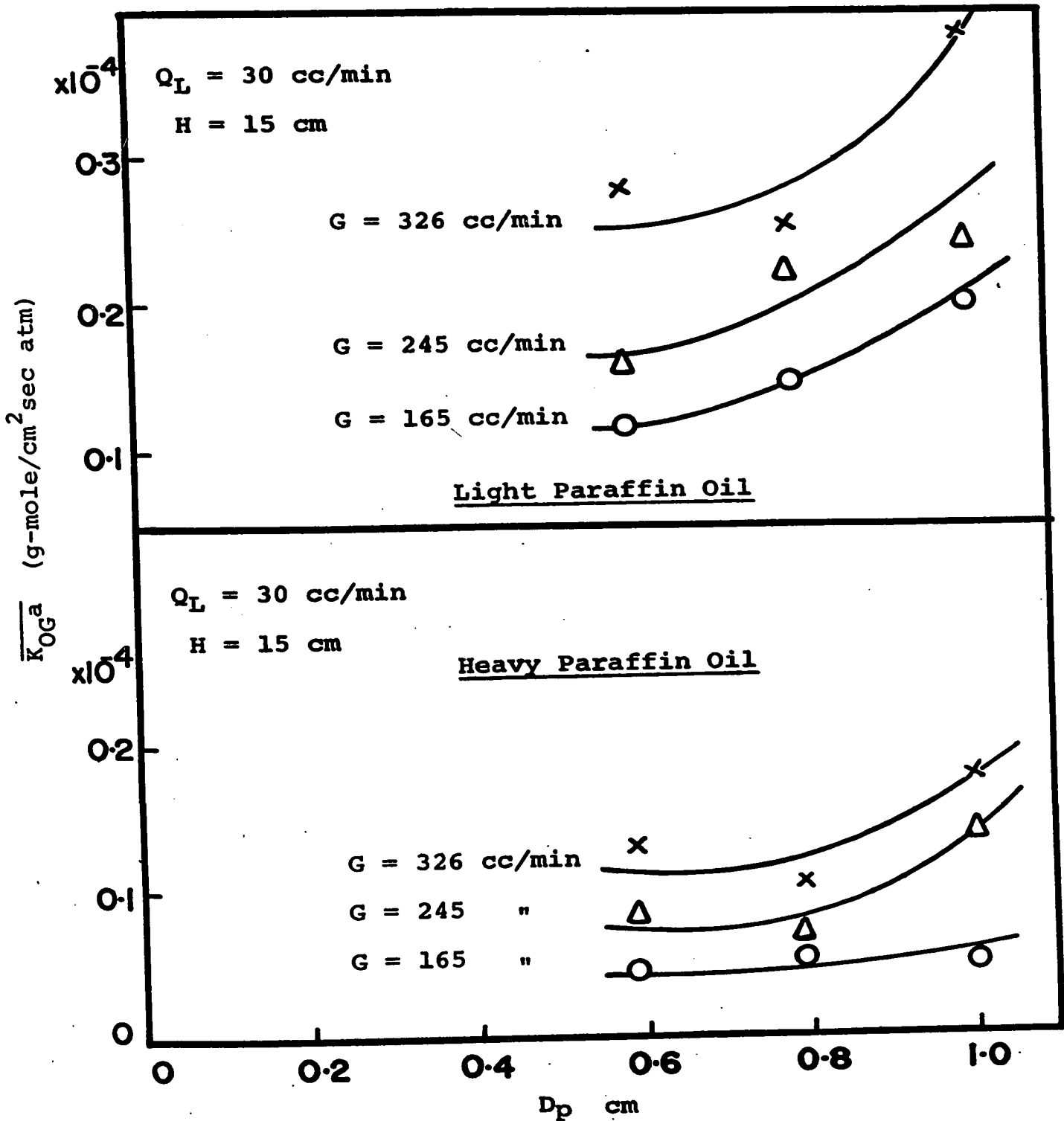


Figure 62

This appreciable increase in experimental $\overline{K_{OG}a}$ values with increase in D_p can then be attributed to the effect of D_p on flow pattern as evidenced by the increased separation distances, figure 31.

It is possible to qualitatively consider the effect of slug coalescence on mass transfer rates. From figures 56-58, $\overline{K_{OG}a}$ and $K_{OG}a$ values for the lower portion of the absorber were always appreciably larger than the values found for upper portion of the absorber and for $H > 25$ cm. This could be attributed to two effects the smaller slug sizes in shorter absorbers and the effect of slug coalescence which took place generally in the lower portion of the absorber, see figure 17. From the studies of Rennie and Smith (71) and Shah and Sharma (72), coalescence of bubbles increased mass transfer rate due to the violent oscillation of the unstable bubbles. But, in this study, oscillation in the bubble surface would be restricted due to the viscous liquid media. As shown schematically in previous figure 13, the process of slug coalescence consisted of three stages, slug pairing, slug breakage and formation of new slug. The second stage would enhance mass transfer whereas the first and third would reduce mass transfer. Consequently it can be considered that under the present contacting conditions, slug coalescence probably did not increase mass transfer rate to any great extent. No effect of bubble coalescence on mass transfer rate has also been reported by Calderbank (73). In fact, it was found, in the later section, that the variations of theoretical K_{OG} values for fully developed

flow with H closely resembled those of experimental K_{OG}^a with H.

2-e. Influence of Gas Phase Concentration on K_{OG}^a

As noted previously the inlet gas phase concentration influenced rise period mass transfer rates, figure 60. This would have arisen due to either an increase in $\overline{K_{OG}}$ or an increase in $\bar{a}$. A significant increase in $\bar{a}$ with concentration was however unlikely as flow characteristics were not influenced by the inlet gas phase concentration and viscous liquid media used, while lean gas mixture were employed so that in the rise period any reduction in slug size due to mass transfer was negligible. It would seem then that the actual $\overline{K_{OG}}$ values were affected by the change in gas phase concentration. The individual gas phase coefficient k_G would hardly be expected to be affected by concentration both from theoretical point of view and data reported in the literature (74,75). Consequently it was likely that the liquid phase coefficient k_L was affected. This influence of concentration was probably due to concentration effects on interfacial physical properties. Calculations show that based on cup-mixing concentration bulk changes in the liquid phase concentration would result in negligible concentration effects. Interfacial concentrations were calculated based on the two resistance theory, figure 63 and could result in changes in liquid phase physical properties, Table 10.

VARIATION OF INTERFACIAL LIQUID HEXANE

CONCENTRATION X_i WITH ABSORBER LENGTH H

System : n-Hexane -Nitrogen-Paraffin Oil

----- Light Paraffin Oil

———— Heavy Paraffin Oil

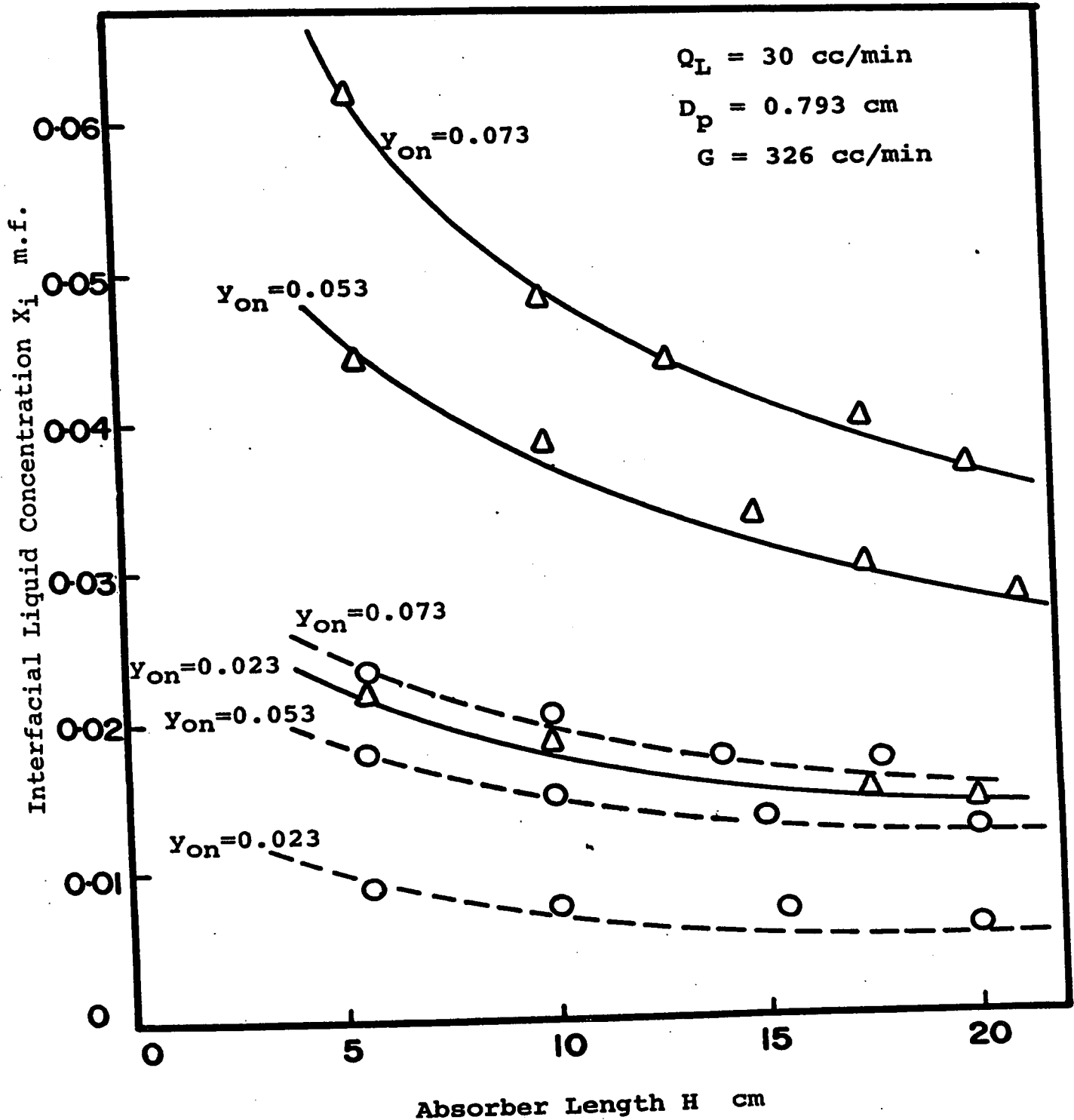


Figure 63

Table 10

Effect of Hexane Concentration on Liquid Phase Physical

Properties

Hexane Concentration m.f.	ρ_L g/cc	μ_L cp	σ dynes/cm	D_L cm/sec
<u>Heavy Paraffin Oil</u>				
0.00	0.8806	142.0	37.0	0.115×10^{-5}
0.02	0.8787	135.1	37.0	
0.05	0.8768	125.5	36.7	0.143×10^{-5}
0.10	0.8720	89.4	36.3	0.179×10^{-5}
<u>Light Paraffin Oil</u>				
0.00	0.8587	40.2	35.0	0.364×10^{-5}
0.02	0.8570	39.5	35.0	
0.05	0.8549	38.9	33.7	0.429×10^{-5}
0.10	0.8520	37.6	33.5	0.507×10^{-5}

ρ_L , μ_L and σ values were measured experimentally while D_L values calculated from equations as proposed by Wilke and Lee (76) Caldwell and Babb (77) and Dullien (78).

K_{OG} values calculated using interfacial properties i.e. D_L show that a variation of transfer rate due to the large differences between interfacial and bulk phase physical properties was possible, figure (64), but cannot account fully for the effects of y_{on} observed. Further, as can be seen from Table 10, the biggest change took place in the liquid phase viscosity of the heavy paraffin oil and therefore if the viscosity of the liquid at the interface was reduced the laminar sublayer would be effected and liquid phase mass transfer co-

EFFECTS OF INTERFACIAL LIQUID HEXANE CONCENTRATION x_i
ON THEORETICAL OVERALL MASS TRANSFER COEFFICIENTS K_{OG}

System : n-Hexane-Nitrogen Paraffin Oil

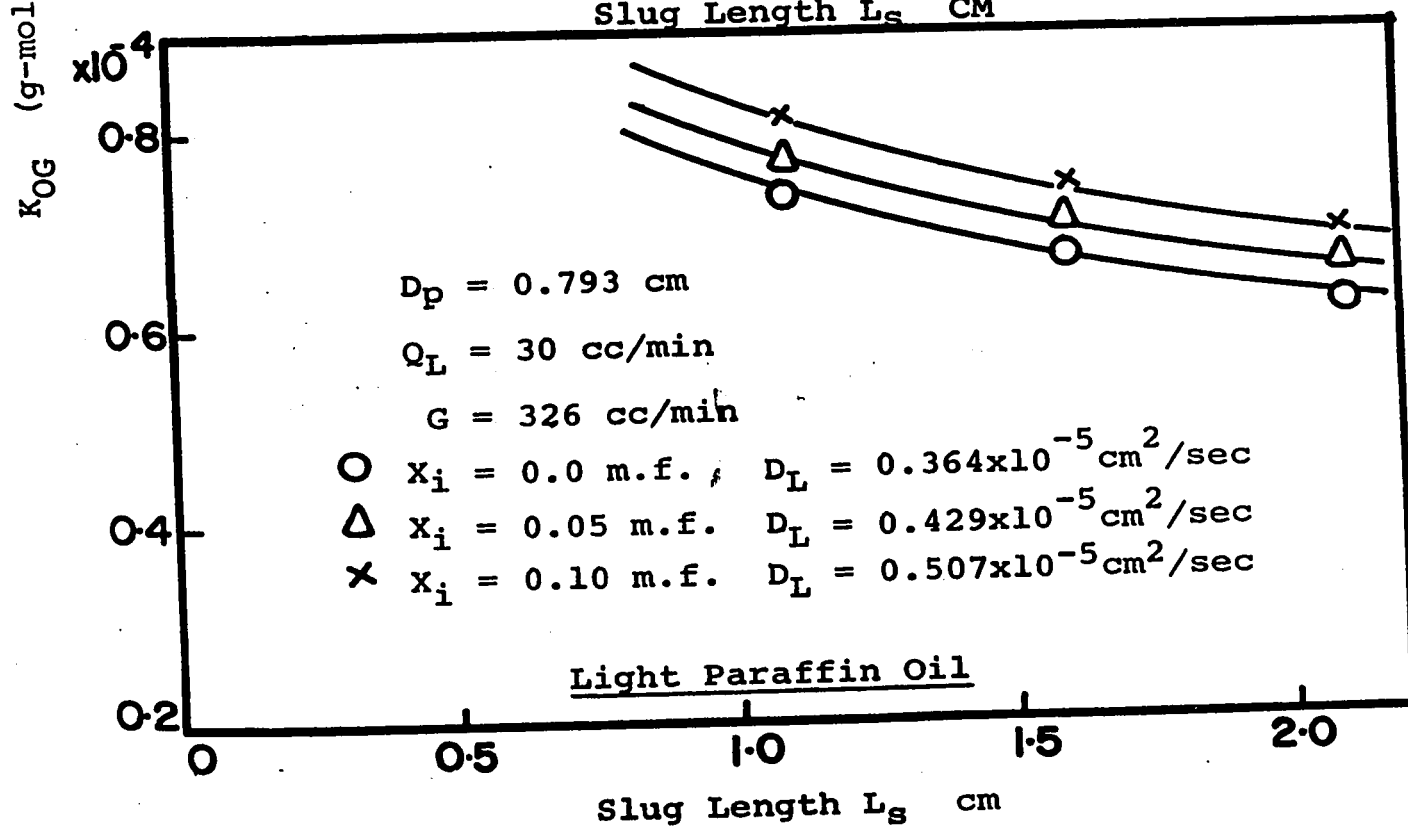
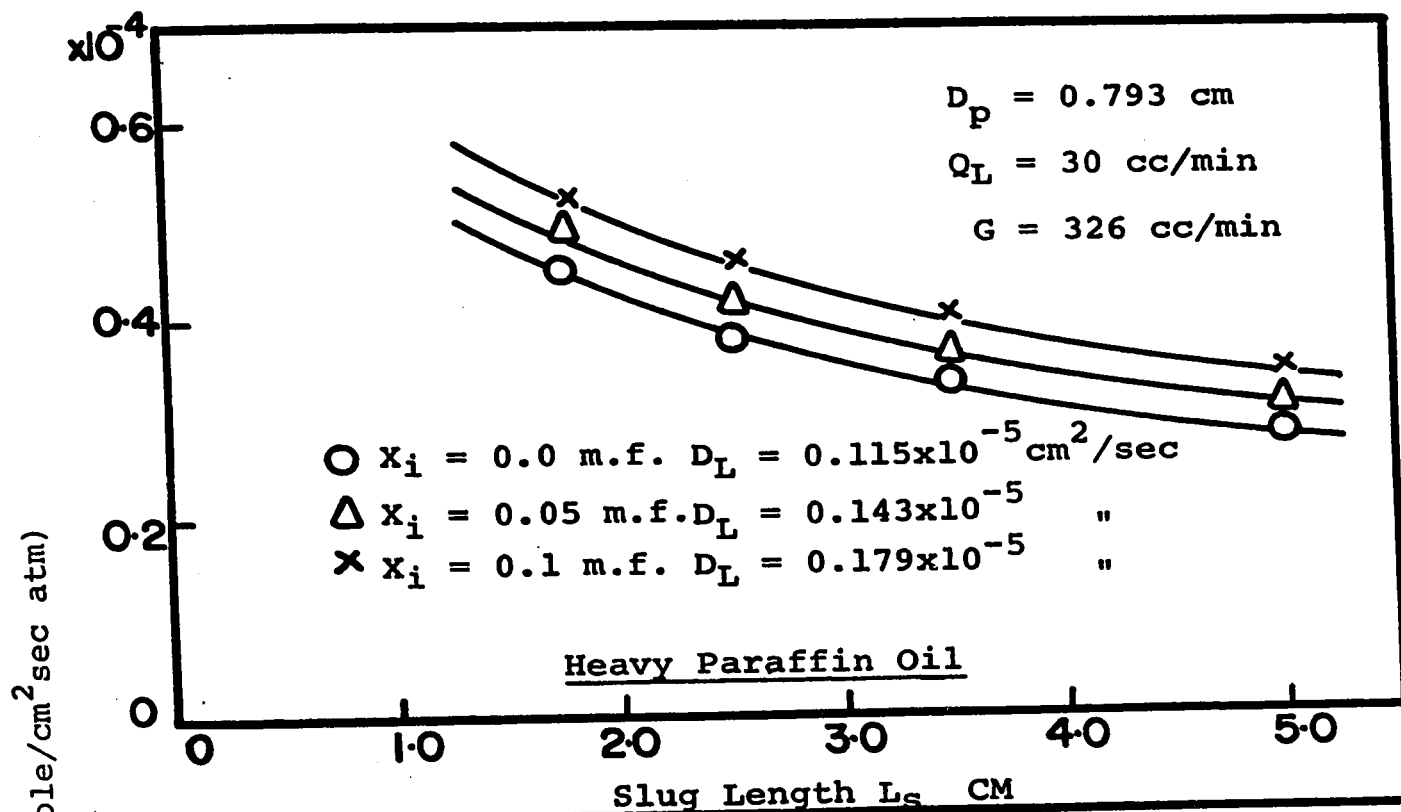


Figure 64

efficients would increase due to an increase in interfacial mobility (63,64). The surface tension gradients at the interface as the results of mass transfer would be expected to be small from the variation of surface tension with liquid composition and no surface unstabilities were observed. The work of Zuiderweg and Harmens (24) showed that when the surface tension at the interface decreased with mass transfer, bubble coalescence normally took place and in some circumstances has been considered to increase mass transfer though no change in mass transfer rate with coalescence in bubble clouds due to the variations of bubble sizes was reported by Calderbank (73).

2-f. Comparison of Theoretical and Experimental K_{OG} Values

Individual gas and liquid phase resistance were calculated on the basis of the penetration theory in both the liquid and gas phases. The slug overall mass transfer coefficients were as noted previously evaluated using the two resistance theory and the results obtained compared with experimental $\overline{K_{OG}a}$ values, figures 65 and 66.

The comparison showed that although the theoretical values followed the same trends as the experimental $\overline{K_{OG}a}$ values the theoretical values were generally 2 to 3 times greater than the experimental values for the intermediate and high gas rate while for the lowest gas rate, predicted K_{OG} values for the smallest slug were about 10 times greater than the experimental $\overline{K_{OG}a}$ values. This can be attributed in part to the total surface area not being effective to mass transfer as discussed later and development of chain like flow patterns, but could

COMPARISON OF EXPERIMENTAL AND THEORETICAL

OVERALL MASS TRANSFER COEFFICIENTS

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

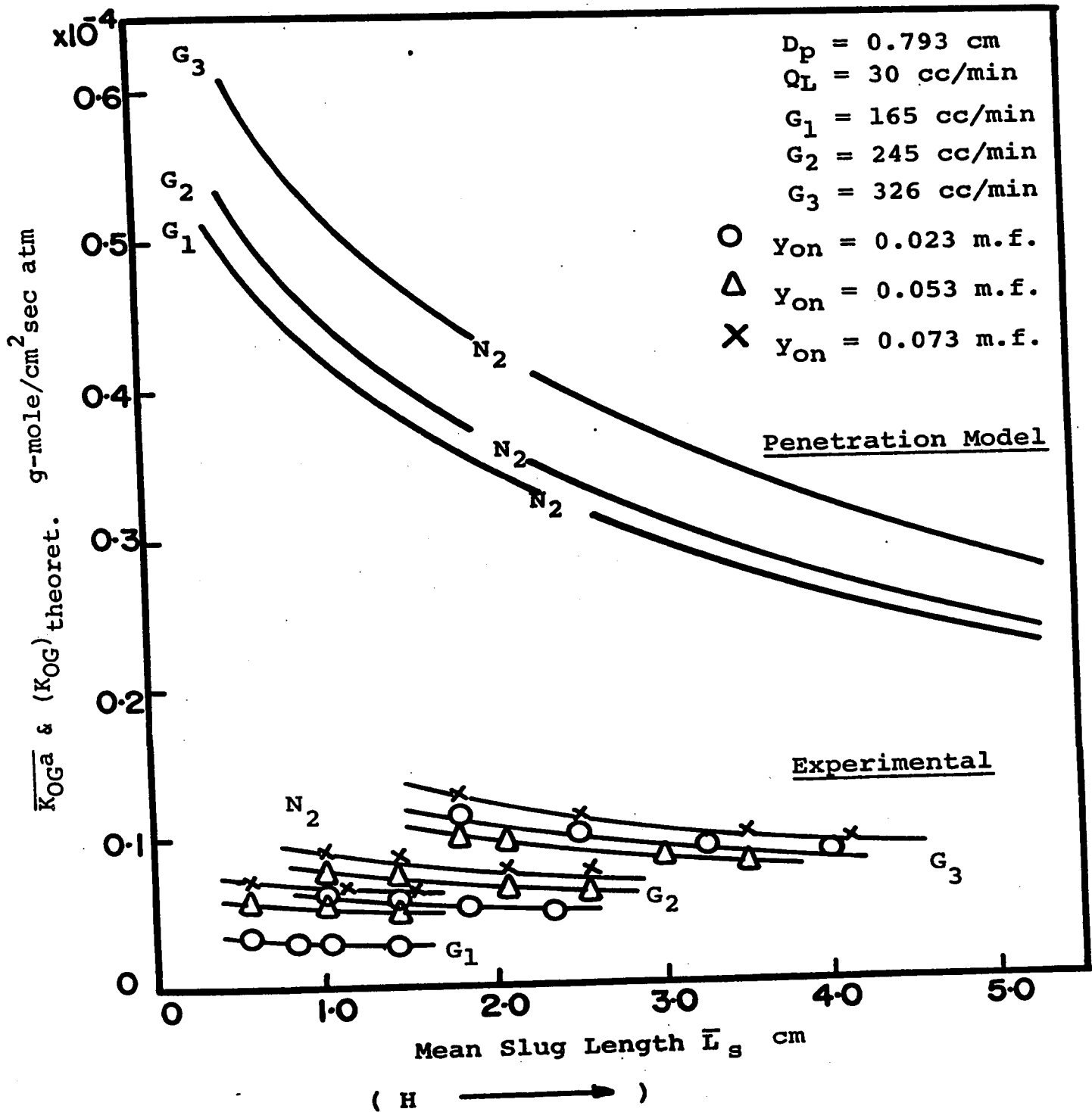


Figure 65

COMPARISON OF EXPERIMENTAL AND THEORETICAL OVERALL

MASS TRANSFER COEFFICIENTS

System : n-Hexane-Nitrogen-Light Paraffin Oil

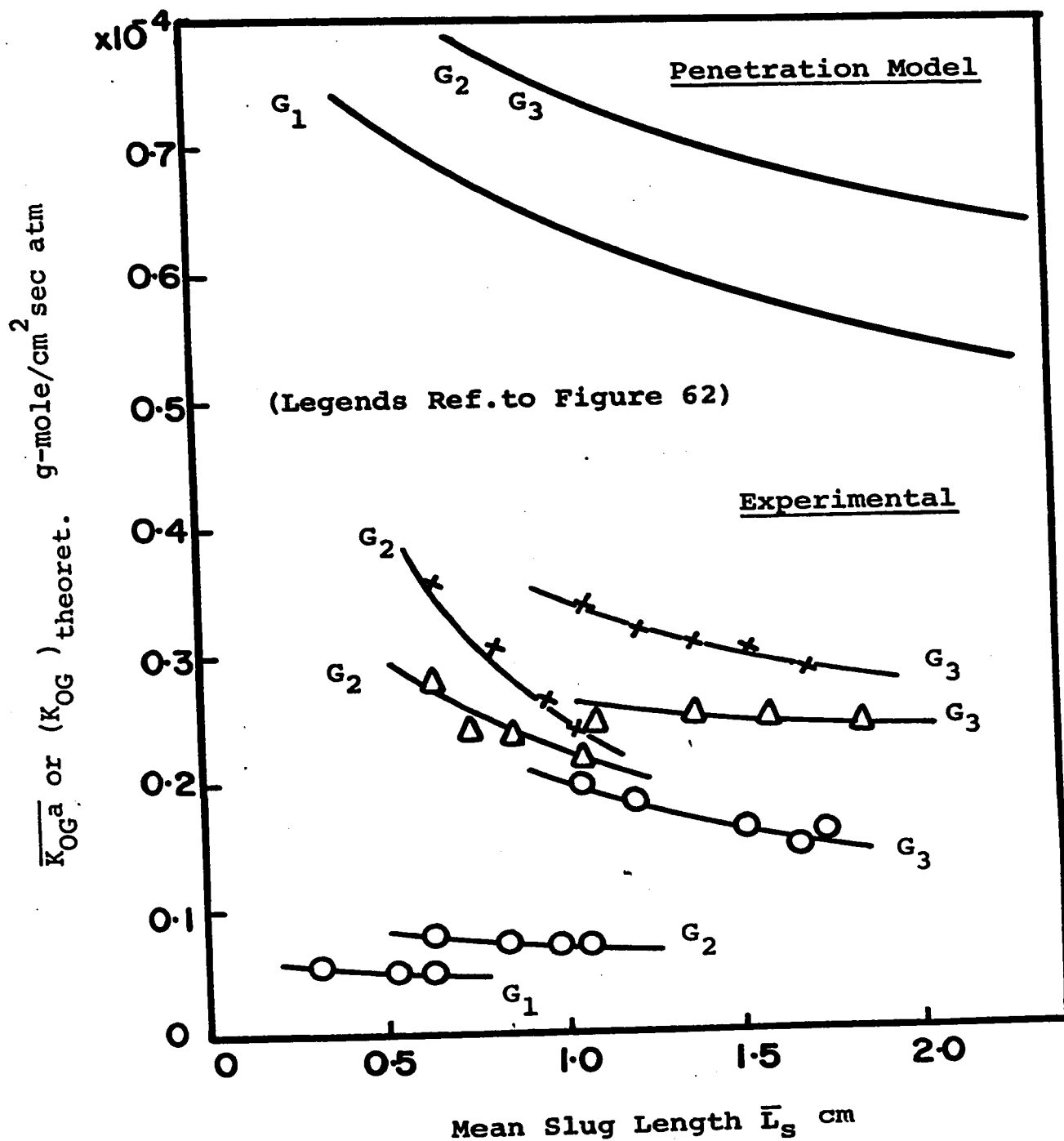


Figure 66

also be due to concentration gradient being established at the interface which would result in an interfacial resistance. Further work should be carried out in this connection. The particularly high discrepancy at low flow rates can be primarily explained in terms of the effects of chain flow patterns established, which as noted previously would result in both drastic reduction of $\overline{K_{OG}}$ and $\bar{a}$.

Theoretical and experimental values were also compared over the absorber length H, figure 67. Theoretical and experimental values again exhibiting the same trends but the theoretical values showed a reverse effect of gas flow rate, that was theoretically K_{OG} decreased with increase in G, indicating primarily the decreasing effect of slug size on mass transfer rate.

Calculations were also made of theoretical K_{OG} values with k_G values calculated on the basis of diffusion in a spherical cap and cylinder and k_L values again on the basis of penetration theory, see section III-B-4. Theoretical results in this case were 10 times lower than the experimental $\overline{K_{OGa}}$ values, Table 11, indicating that mass transfer within the slug could not adequately described by the diffusion model.

Table 11

Comparison of Experimental and Calculated Overall Mass Transfer Coefficients- Diffusion Model in Gas Phase

$D_p = 0.793 \text{ cm}$	$Y_{on} = 0.023 \text{ m.f.}$
$G = 326 \text{ cc/min}$	$Q_L = 30 \text{ cc/min}$

COMPARISON OF EXPERIMENTAL AND THEORETICAL
OVERALL MASS TRANSFER COEFFICIENTS

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

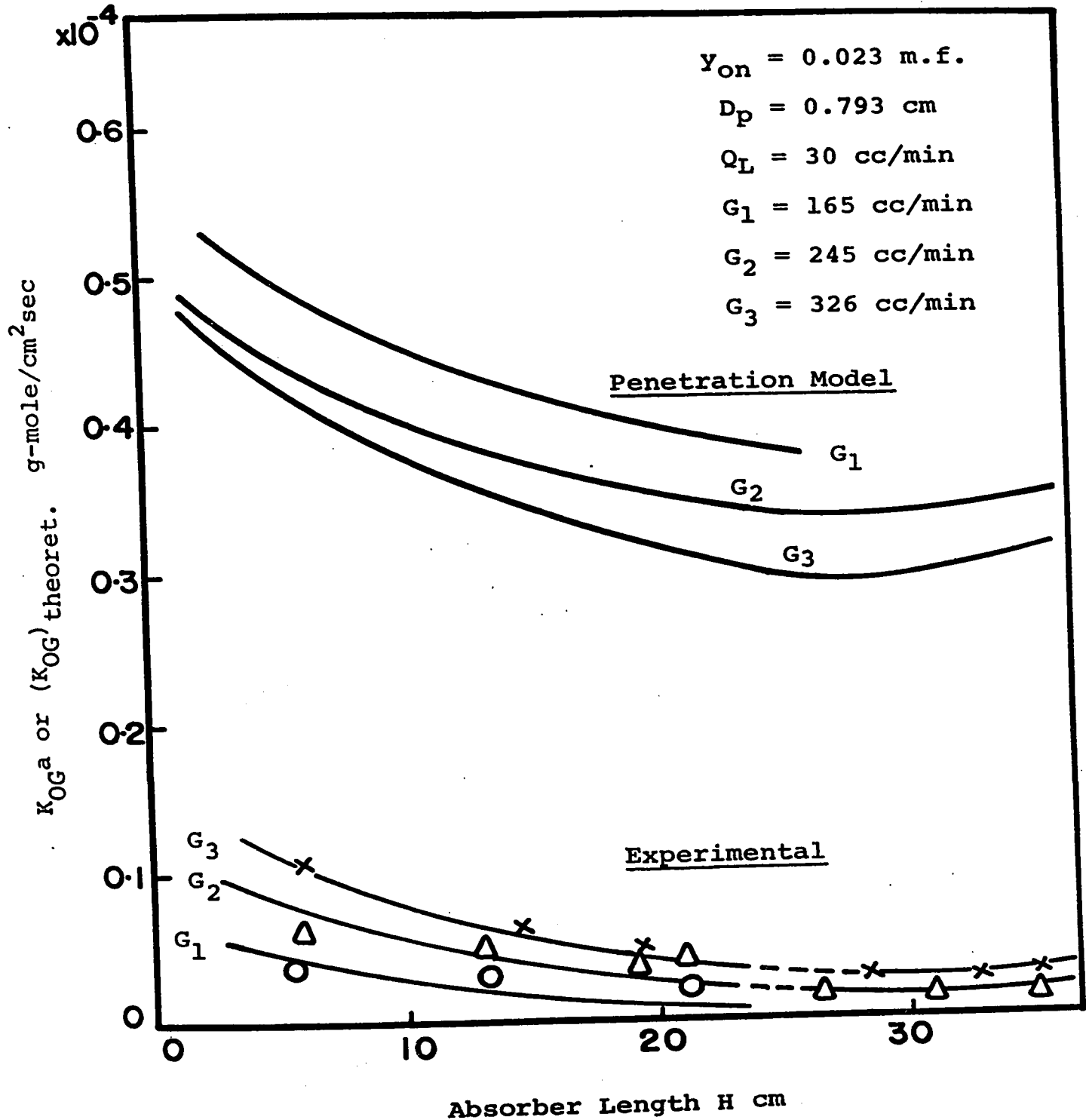


Figure 67

System : n-Hexane-Nitrogen-Paraffin Oil

$\bar{L}_s$ (cm)	$\overline{K_{OGa}}$ (expt.) (g-mole/sec cm ² atm)	K_{OG} (calc.) (g-mole/sec cm ² atm)		
		$\bar{w} = 2.5$	$\bar{w} = 10$	$\bar{w} = 25$
<u>Heavy Paraffin Oil</u>				
1.72	1.20×10^{-5}	0.30×10^{-6}	0.31×10^{-6}	0.33×10^{-6}
2.20	0.99×10^{-5}	0.21×10^{-6}	0.27×10^{-6}	0.23×10^{-6}
3.60	0.86×10^{-5}	0.15×10^{-6}	0.16×10^{-6}	0.17×10^{-6}
4.60	0.75×10^{-5}	0.12×10^{-6}	0.13×10^{-6}	0.14×10^{-6}
<u>Light Paraffin Oil</u>				
1.35	0.21×10^{-4}	0.65×10^{-6}	0.68×10^{-6}	0.85×10^{-6}
1.66	0.18×10^{-4}	0.56×10^{-6}	0.58×10^{-6}	0.72×10^{-6}
1.77	0.15×10^{-4}	0.49×10^{-6}	0.52×10^{-6}	0.65×10^{-6}
2.00	0.12×10^{-4}	0.44×10^{-6}	0.46×10^{-6}	0.60×10^{-6}

$\bar{w}$ is the ~~Correction~~ factor for D_g and would be expected to be less than 10.0 from previous study in literature (18,41).

2-g. Mass Transfer Areas

An estimate of the effective mass transfer area can be made assuming that the theoretical K_{OG} values are correct, i.e. no interfacial effect. In making this assumption, the effect of gas phase concentration observed experimentally appeared as an effect on $\bar{a}$ values. As stated previously, $\bar{a}$ was not expected to be appreciably affected by gas phase concentration and the results of $\bar{a}$ can only be considered approximate. However, for a fixed gas phase concentration, the effects of slug size and gas rate on $\bar{a}$ can be readily observed, figures 68, and 69.

VARIATION OF SLUG EFFECTIVE SURFACE AREA

$\bar{a}$ WITH SLUG LENGTH $\bar{L}_s$

System : n-Hexane-Nitrogen-Heavy Paraffin Oil

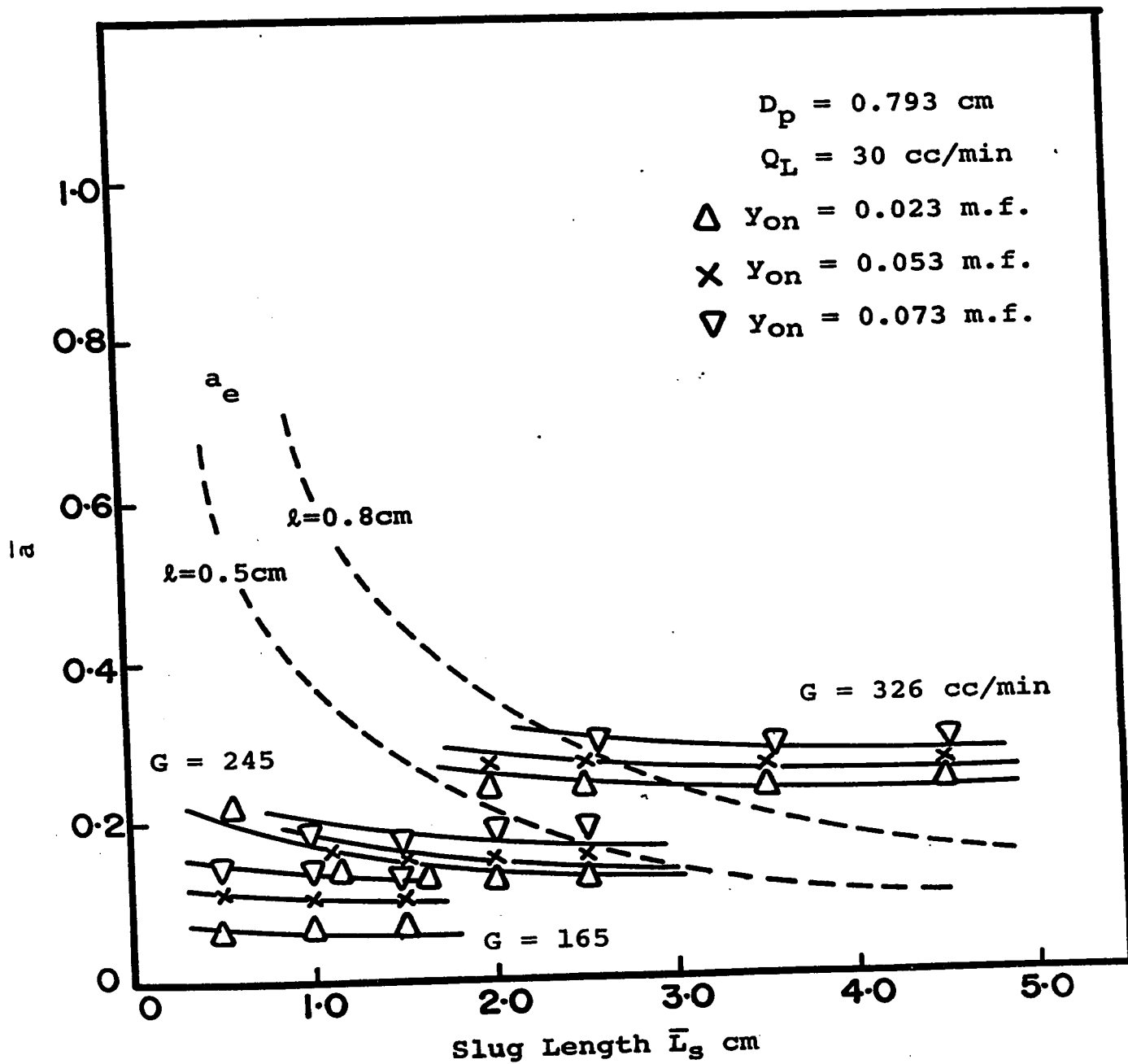


Figure 68

VARIATION OF SLUG EFFECTIVE SURFACE AREA

$\bar{a}$ WITH SLUG LENGTH $\bar{L}_s$

System : n-Hexane-Nitrogen-Light Paraffin Oil

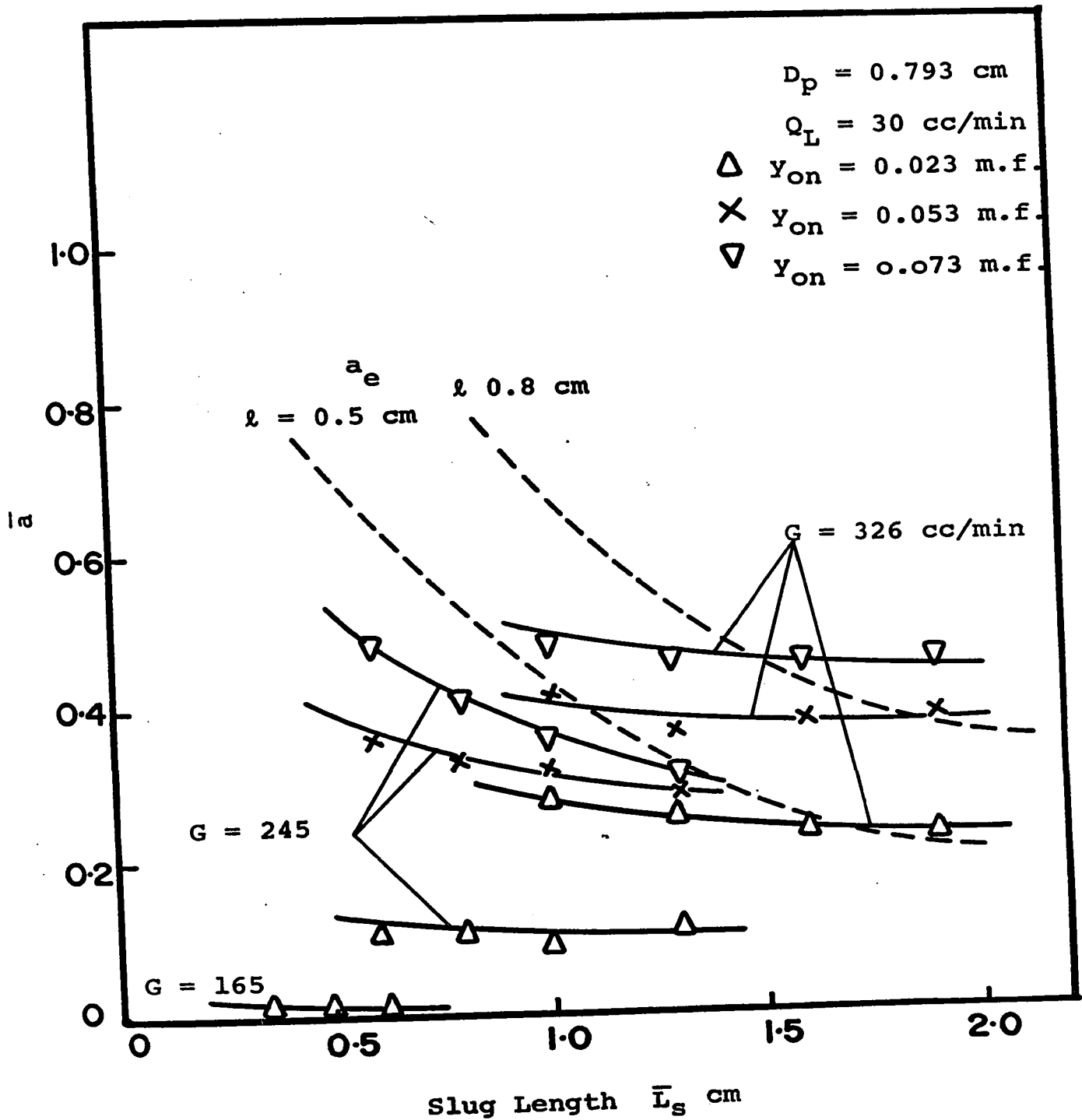


Figure 69

At low gas rate when chain flow characterization were obtained, apparent effective areas were very low and in the order of 0.1 and less of the total surface area, emphasizing the differences between the predicted K_{OG} and measured $\overline{K_{OGa}}$ values. For the light paraffin oil, the apparent effective areas normally varied from 0.05 to 0.3 of the total surface area while the corresponding calculated values for the heavy paraffin oil were from 0.075 to 0.3. Also plotted in the graphs were the frontal surface area ratios a_e where $a_e = A_a/A_s$ with A_a being the slug frontal surface area of height ℓ . In a 0.793 cm I.D. absorber, ℓ is about 0.5 cm when the curvature of the slug shape is small, see previous figure (27). Comparison of the curves showed that at low gas rate when chains of slugs occur, $\bar{a}$ values were much smaller than the a_e values particularly for those with the light paraffin oil while at high gas rate, $\bar{a}$ and a_e values in some cases closely coincide, figures 68 and 69. These indicate that the frontal area might be the most effective mass transfer area of the slug so that when slugs are in close proximity to each other mass transfer through the frontal area would be inhibited and therefore the values of $\bar{a}$ and $\overline{K_{OG}}$ reduced greatly. It was also found that for relatively short slugs at intermediate gas and liquid rate, the $(\overline{K_{OG}A_e}/A_a, \ell=0.5\text{cm})$ values also closely compared with the theoretical K_{OG} values based on penetration theory for prolate spheroids (79) with eccentricities $(r_i/0.5)$ of about 0.6. However, normally the $\bar{a}$ curves at $G = 326 \text{ cc/min}$ lay well above the a_e curve for $\ell = 0.5\text{cm}$

but intersected a_e curve for $\ell = 0.8$ cm indicating that mass transfer was taking place not only through the frontal surface area but through the cylindrical portion of the slug as well. It would be of great interest to undertake further study in an attempt to evaluate the effective surface areas.

2-h. Effect of System Variables

h-i. Introduction

From the results obtained, mass transfer rates were found to increase with decrease in liquid phase viscosity and increase with increase in gas phase diffusivity. In analysing the effects of system properties, it was necessary to take into account any change in transfer rate that arose either due to change in interfacial velocity or in slug size resulting from changes in mean slug frequencies. Interfacial velocities and slug sizes were functions of both liquid and gas phase physical properties. For example, increase in both gas phase density and liquid phase viscosity normally resulted in the reduction of interfacial velocities but an increase in slug sizes, Table 12.

Table 12

Variations of Interfacial Velocities, Slug Sizes and Mass Transfer Diffusivities With System Properties.

$$H = 15 \text{ cm}$$

$$D_p = 0.793 \text{ cm}$$

$$G = 245 \text{ cc/min}$$

$$Q_L = 30 \text{ cc/min}$$

Carrier Gas	ρ_g g/cc	μ_L cp	D_g cm ² /sec	D_L cm ² /sec	U_i cm/sec	$\bar{L}_s$ cm
<u>Heavy Paraffin Oil</u>						
He	0.21×10^{-3}	142.0	0.2744	1.15×10^{-6}	-27.2	1.50
N ₂	1.26×10^{-3}	"	0.0813	"	-27.8	1.64
Freon-14	3.88×10^{-3}	"	0.0477	"	-21.1	1.95
<u>Light Paraffin Oil</u>						
He	0.21×10^{-3}	40.2	0.2744	3.66×10^{-6}	-38.2	1.50
N ₂	1.26×10^{-3}	"	0.0813	"	-36.0	1.81
Freon-14	3.88×10^{-3}	"	0.0477	"	-21.0	0.46

where U_i is the final interfacial velocity at the slug surface.

h-ii. Gas Phase Density and Gas Phase Diffusivity

Variation of $\overline{K_{OG}}$ values with different carrier gases have been shown in figure 61. $\overline{K_{OG}}$ values were lowest for Freon-14 and highest for helium gas. These increases in mass transfer rates were apparently due to the increases in gas phase diffusivities D_g and decreases in gas phase densities ρ_g when nitrogen and helium gases were used. The effect of increase in ρ_g was to increase U_i and decrease $\bar{L}_s$ which would theoretically increase $\overline{K_{OG}}$ values. Hence, in order to study the effect of diffusivity on the experimental $\overline{K_{OG}}$, the influence of changes in U_i and $\bar{L}_s$ with gas phase densities on $\overline{K_{OG}}$ values had to be determined. Calculations were made to determine approximately how theoretical K_{OG} values were influenced by changes in U_i and $\bar{L}_s$ and the experimental $\overline{K_{OG}}$ values corrected proportionally.

Theoretical K_{OG} values were first calculated for the

three carrier gases using experimental U_i and $\bar{L}_s$ data. A common slug length of 1.56 cm was chosen and the effect of U_i determined for three carrier gases. U_i was then fixed and the effect of varying slug length calculated. Overall calculations showed that for the heavy paraffin oil, about 68 and 45 percent of the increases in K_{OG} values of nitrogen and helium gases respectively over those of Freon-14 were resulted from the increase in U_i and decrease in $\bar{L}_s$ while, for the light paraffin oil, the fractions of increases in K_{OG} due to changes in U_i and $\bar{L}_s$ were in the order of about 26 percent respectively. Hence, if the effective area $\bar{a}$ was assumed to be the same for all gases, the $\overline{K_{OGa}}$ values for nitrogen and helium gases could be corrected for the effects of changes in U_i and $\bar{L}_s$ on the basis of the common conditions as for Freon-14. The assumption of constant $\bar{a}$ might be valid with the heavy paraffin oil but drastic changes in slug size between systems took place with light paraffin oil and the $\bar{a}$ values would vary. The corrected $\overline{K_{OGa}}$ values, $\widetilde{K_{OGa}}$, were shown in Table 13 and these values were then used to illustrate the dependence of mass transfer rates on $\sqrt{D_g}$.

Table 13

$\overline{K_{OGa}}$ Values Corrected For The Effects of Changes in U_i and $\bar{L}_s$

$$D_p = 0.793 \text{ cm}$$

$$Q_L = 30 \text{ cc/min}$$

$$G = 245 \text{ cc/min}$$

Heavy Paraffin Oil

H cm		$\overline{K_{OGa}}$ (g-mole/cm ² sec atm) x 10 ⁻⁴	$\widetilde{K_{OGa}}$
15.0	Freon-14	0.046	0.046
	N ₂	0.066	0.056
	He	0.094	0.080
17.5	Freon-14	0.044	0.044
	N ₂	0.063	0.053
	He	0.083	0.071
25.0	Freon-14	0.038	0.038
	N ₂	0.059	0.050
	He	0.071	0.060

From the two resistance theory

$$\frac{1}{\widetilde{K_{OGa}}} = \frac{1}{\widetilde{k_{Ga}}} + \frac{m}{\widetilde{k_{La}}}$$

$$\text{or } \widetilde{K_{OGa}} = \frac{(\widetilde{k_{Ga}})(\widetilde{k_{La}})}{m(\widetilde{k_{Ga}}) + (\widetilde{k_{La}})} \quad (V-53)$$

where $\widetilde{k_G}$ and $\widetilde{k_L}$ are the individual mass transfer coefficients.

If penetration theory is applicable to the mass transfer mechanism in both the gas and liquid phases,

then

$$\widetilde{k_{Ga}} = \frac{1}{\sqrt{\pi D_g t_c}} \left\{ 2 \widetilde{a} \left(\frac{D_g}{t_c} \right)^{\frac{1}{2}} \right\}$$

$$\widetilde{k_{La}} = \frac{\rho_L}{MW} \left\{ 2 \widetilde{a} \left(\frac{D_L}{t_c} \right)^{\frac{1}{2}} \right\}$$

$$\tilde{K}_{OGa} = \frac{2.0 \rho_L \tilde{a} D_L^{\frac{1}{2}}}{MW \cdot m \pi t_c} \times \frac{1.0}{\{1.0 + (\rho_L^0 RT D_L^{\frac{1}{2}} / (MW \cdot m) (1 / D_g^{\frac{1}{2}}))\}} \quad (V-54)$$

$$\text{or } \tilde{K}_{OGa} = \frac{0.00001276 \tilde{a}}{(t_c)^{\frac{1}{2}}} \times \frac{1}{\{1.0 + (0.2766) / (D_g)^{\frac{1}{2}}\}}$$

$$\ln(\tilde{K}_{OGa}) = \ln \frac{0.00001276 \tilde{a}}{(L_s)^{\frac{1}{2}} / U_i} - \ln(1.0 + \frac{0.2766}{D_g^{\frac{1}{2}}}) \quad (V-55)$$

If penetration theory described the mass transfer within the slug, the plots of $\ln(\tilde{K}_{OGa})$ against $\ln(1.0 + 0.2766/D_g^{\frac{1}{2}})$ for the three gases would then yield straight lines with slopes equal to -1.0. Results of the slopes calculated by linear curve fit ranged from -1.3 to -1.1 and closely compared to -1.0. Calculations were also made to evaluate the ratios of the diffusion thickness δ_d in slugs for different carrier gases if $\tilde{K}_{OGa}$ was dependent on D_g to the power of 1.0. The results showed that δ_d for different carrier gases, though under similar hydrodynamic conditions, differed widely indicating that diffusion model did not describe the mass transfer within the slug.

h-iii. Liquid Viscosities and Liquid Phase Diffusivity

The effect of liquid viscosity μ_L on overall mass transfer coefficients is shown in figure 70A. $\tilde{K}_{OGa}$ values fell with increase in μ_L as a result of decrease in liquid phase diffusivity and increase in slug length inspite of a tendency for the interfacial velocity to increase, Table 11. The typical effect of μ_L on D_L and therefore theoretical K_{OG} is shown in Table 14.

EFFECT OF LIQUID VISCOSITY ON SLUG
CHARACTERISTICS AND OVERALL MASS TRANSFER COEFFICIENTS

System : n-Hexane-Nitrogen-Paraffin Oil

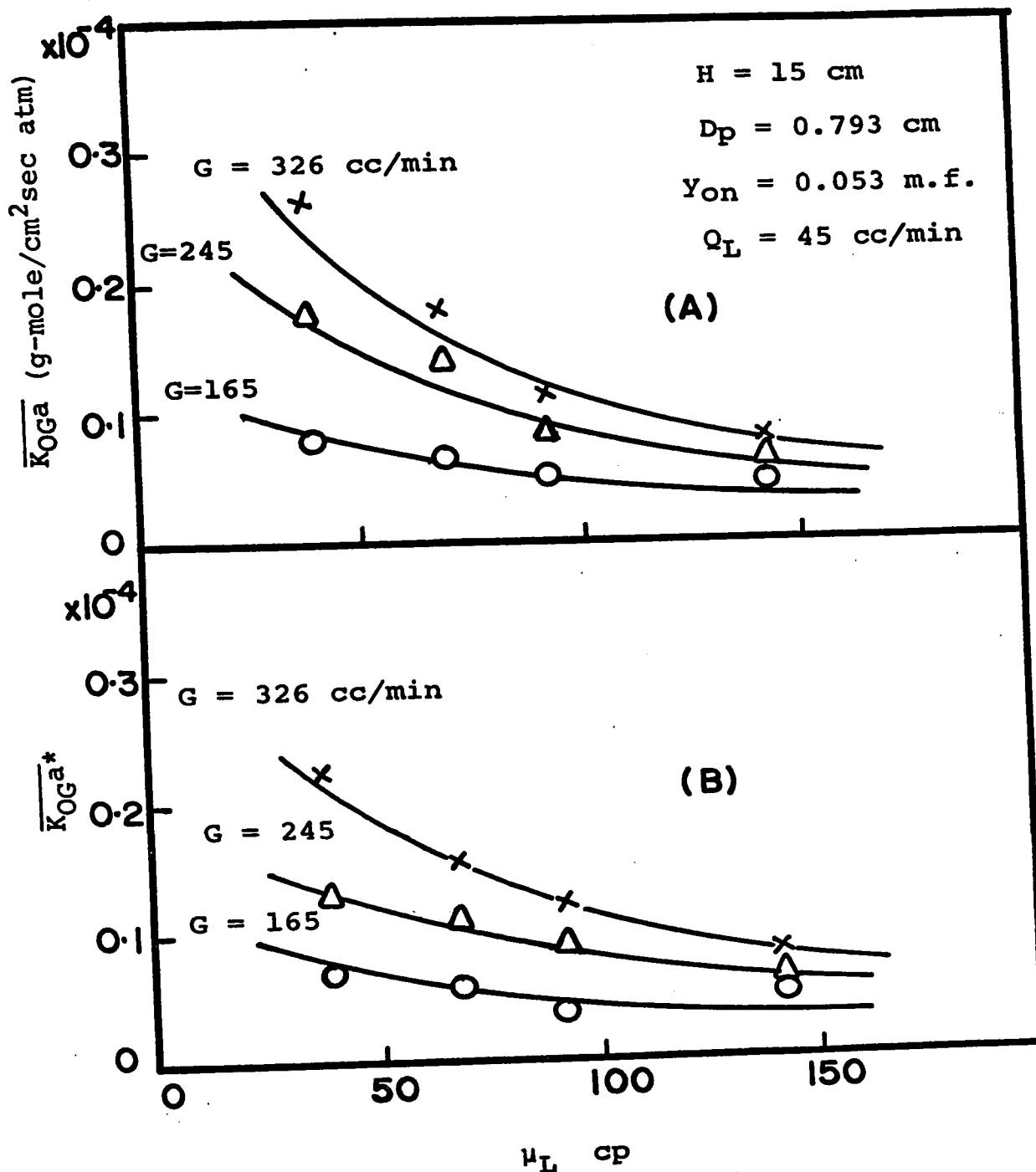


Figure 70

Table 14

Theoretical Effect of D_L on Overall Mass Transfer Coefficient K_{OG}

$Q_L = 30$ cc/min

$H = 15$ cm

System : n-Hexane-Nitrogen-Paraffin Oil

μ_L cp	G cc/min	$\bar{L}_S$ cm	D_L cm ² /sec	K_{OG} g-mole/cm ² sec atm
40	245	2.1	3.64×10^{-6}	0.592×10^{-4}
142	245	2.1	1.15×10^{-6}	0.352×10^{-4}
40	326	3.6	3.64×10^{-6}	0.480×10^{-4}
142	326	3.6	1.15×10^{-6}	0.313×10^{-4}

Using the two resistance and penetration theories, it was possible to rearrange equation (V-54) such that the overall coefficients became independent of liquid phase diffusivity. From equation (V-54) :

$$\left\{ m \left(\frac{D_g}{D_L} \right)^{\frac{1}{2}} + \frac{\rho_L^0 RT}{MW} \right\} \overline{K_{OG} a} = \frac{2 \bar{a} \rho_L}{MW} \left(\frac{D_g}{\pi t_c} \right)^{\frac{1}{2}} \quad (V-56)$$

For nitrogen carrier gas, $D_g = 0.0813$ cm²/sec and equation (V-56) becomes :

$$\overline{K_{OG} a}^* = 0.322 \frac{\bar{a} \rho_L}{MW} \left(\frac{U_i}{\bar{L}_S} \right)^{\frac{1}{2}} \quad (V-57)$$

$$\text{Where } \overline{K_{OG} a}^* = \left(0.57 D_L^{-\frac{1}{2}} + \frac{\rho_L^0 RT}{MW} \right) \overline{K_{OG} a}$$

When $\overline{K_{OG} a}^*$ values were plotted against μ_L , the effects of changes in slug characteristics with μ_L on overall coefficients

and effective areas were well illustrated, figure 70B.

V-C. Comparison of Mass Transfer Rates in Slug Flow and in Plate and Sieve Tray Columns

A major reason for undertaking this study was to determine whether, in slug flow, contacting conditions were more representative of conditions existing in a froth and foam. Analysis of this study was dependent on knowledge of flow patterns and mass transfer coefficients $\overline{K_{OG}}$ could not be unambiguously evaluated. It is of great interest to compare $\overline{K_{OG}^a}$ values obtained in this study with the k_G , K_{OG} and k_L values reported in the literature for mass transfer studies in plate and sieve tray columns and from single bubble studies. In plate or sieve tray columns, mass transfer coefficients are generally reported as $K_{OG}a'$, k_Ga' or k_La' where a' is the interfacial area per unit volume. Hence, in order to compare mass transfer coefficients so that the effect of the surface area under different contacting conditions could be excluded, a' values had to be evaluated. This was carried out according to the method suggested by Calderbank (80), Golderen (81) and Crozier (82),

$$a' = \frac{6H_g}{D_b}$$

Where ; H_g = volume fraction of gas in dispersion

D_b = mean average bubble diameter cm

Summary of methods for the evaluations of H_g and a' are given in appendix 3-B. A value of $D_b = 0.45$ cm for froths was taken as reported by Calderbank (80) and Dillon and Harris (83) and

k_G and k_L values are compared with $\overline{K_{OG}a}$ values obtained in this study, figure 71.

The comparison shows that the present data were below the values reported in the literature but are of the same order of magnitude. In addition, the data points lie well above the single bubble studies reported by Poutanen (21) for the absorption of hexane from single bubbles into paraffin oil. These latter results can be attributed to the concentration streamlines being established in the liquid medium (21). The data for air humidification (14), air distillation (23), absorption of SO_2 into water (18) lie above the present $\overline{K_{OG}a}$ data as would be expected due to the influence of liquid phase viscosity. The values obtained also lie above the data reported for the absorption of CO_2 into glycerol.

It is of interest to compare the effect of flow rate or rise velocity on mass transfer rates for the different contacting conditions. The data show that in slug absorption, increase in flow rate or rise velocity is not accompanied by drastic change in $\overline{K_{OG}a}$ values and therefore is more representative of behaviours in a froth and foam. Hay (19) and Thorogood (23) have also noted that an increase in foam height also resulted in a decrease of mass transfer rates presumably due to change in contacting characteristics within foams.

COMPARISON OF MASS TRANSFER COEFFICIENTS UNDER
DIFFERENT CONTACTING CONDITIONS

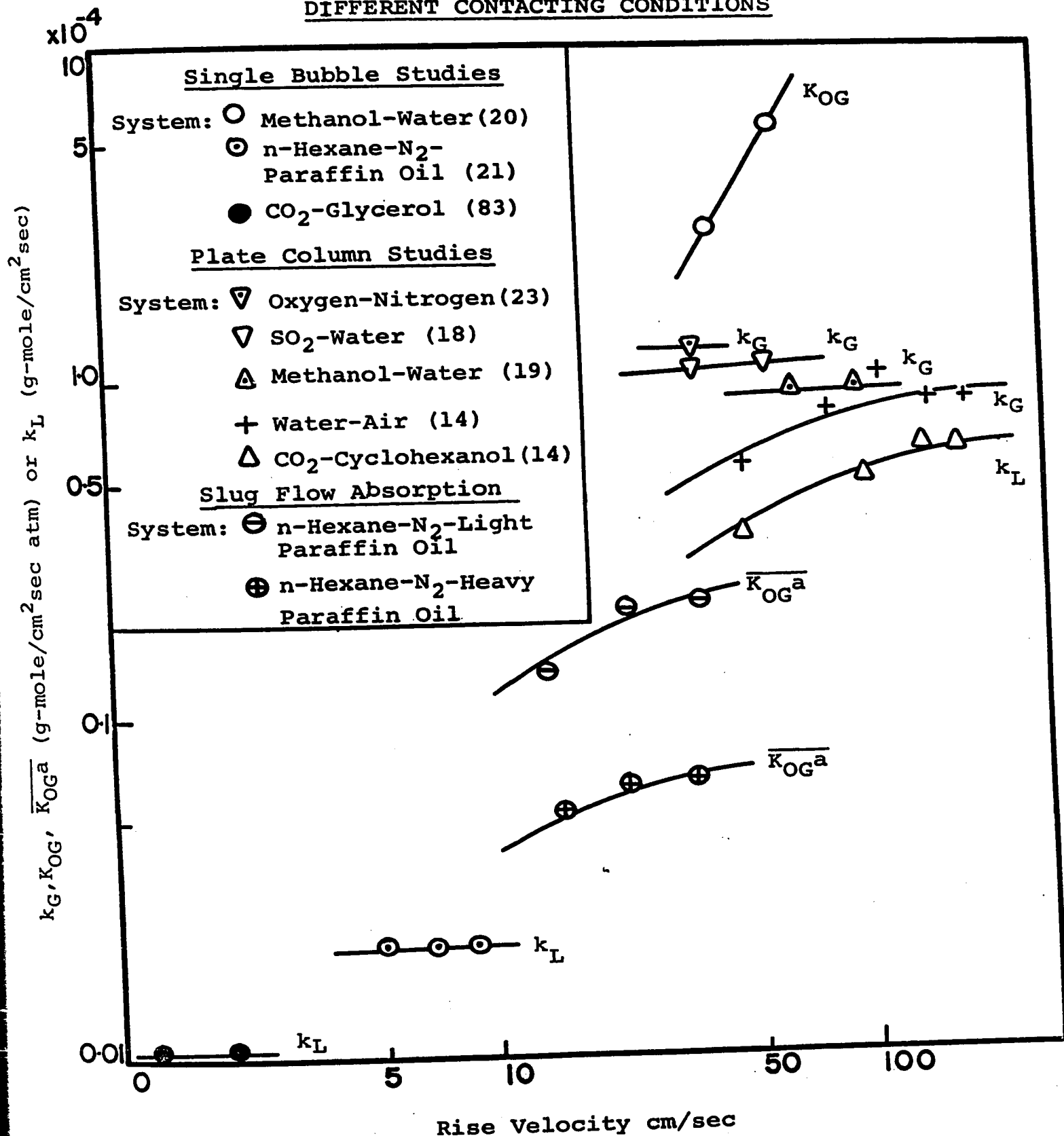


Figure 71

VI. SUMMARY AND CONCLUSION

VI-A. Introduction

Flow characteristics and mass transfer have been investigated in vertical two phase slug flow. Flow characteristics were determined using photographic techniques and the effects of flow rates, absorber geometry and mass transfer measured. Overall absorption efficiencies were obtained for the absorption of hexane into light and heavy paraffin oils. Overall mass transfer coefficients were evaluated and the effect of flow rates, system properties and absorber geometry determined.

VI-B. Flow Characteristics

Flow patterns were found to be unstable, the patterns depending on fluid flow rates, system properties, tube geometry and mass transfer. In the absence of mass transfer, the slugs tended to chain, slugs being only separated from each other by thin liquid films. When mass transfer took place from the gas phase into the liquid phase, two distinct patterns were obtained, one where flow was characterized by bullet shaped slugs which paired and tended to coalesce as they rose up the absorber and a second observed at high liquid rates where a chain flow pattern was still maintained. It should be noted that the direction of mass transfer influenced flow characteristics for when mass transfer took place from the liquid to the gas phase, flow patterns were similar to those observed in the absence of mass transfer. It was however observed that the effect of mass transfer on flow pattern was

not affected by variations of inlet gas phase concentration.

Slug frequencies and slug length were measured. Due to coalescence, they were functions not only of fluid flow rates, system properties, absorber diameter and length but also of position in the tube. Frequencies showed a definite variation with absorber length H , at first decreasing until a minimum was reached at H of about 25 cm at which time frequencies started to increase with H . Similar behaviour was also exhibited by the variation of gas phase void fraction with H which showed a maximum at H of about 25 cm. A range of slug sizes was observed. The mean slug length increased with increase in gas flow rates and liquid phase viscosity but were reduced with increase in liquid flow rate.

The nose radii of bullet shaped slugs was found to be affected by surface tension and liquid viscosity and a function of δ_o , the equilibrium liquid film thickness. In general, r_o was equal to $0.855(R - \delta_o)$. Due to the scatter of frequency data, individual surface area A_s and volume V_s data could not be correlated but the ratio, $(\bar{A}_s/\bar{V}_s)$ showed a much more regular behaviour.

Slug separation distances between slugs were also measured. They were found to influence mixing characteristics in the liquid plugs as studied by the injection of red merian oil into the liquid. It was found that when slugs separated by each other by a distance more than 0.25 absorber diameter, no pairing and coalescence of slugs took place.

Rise velocities of the non coalescing slugs were mea-

sured. A correlation was attempted using an equation similar to the equation employed for fully developed flow, namely $U_s = C_1 U_L + C_0 (g D_p)^{\frac{1}{2}}$. For constant C_1 and C_0 the data of this study were not well represented but if C_1 was equal to 1.2 and C_0 was made a function of fluid flow rates, liquid and gas phase physical properties and absorber geometry, good agreement between experimental and calculated velocities was obtained.

VI-C. Mass Transfer Characteristics

E_{OT} values were observed to be generally high ranging between 0.79 to 0.99. Efficiencies were not only found to be a function of fluid flow rates, liquid and gas phase properties but in addition were affected by gas phase concentration. With the heavy paraffin oil a distinct discontinuity was observed when E_{OT} was plotted against absorber length. This discontinuity could be related to the minimum found in the slug frequency curves. No real discernible discontinuity was observed with the light paraffin oil which could be a result of the high absorption efficiencies masking the effect of changes in slug frequencies. End effect mass transfer was observed to take place and end effect efficiencies ranged from 0.57 to 0.95 which were appreciably lower than those found for earlier studies (12).

Overall mass transfer coefficients were calculated by two methods, an average value $\overline{K_{OG} A_e}$ and the point value $K_{OG} A_e$ where A_e is the effective contact area. $\overline{K_{OG} A_e}$ and $K_{OG} A_e$ values were found to first increase with increase in H for H less than 25 cm after which $K_{OG} A_e$ decreased. This was attributed largely to the variation of effective area with H .

To overcome the variation in slug surface area along the absorber, mass transfer rates were compared in terms of the point K_{OGa} and $\overline{K_{OGa}}$ values where a and $\bar{a}$ were the fraction of slug surface area effective to mass transfer. K_{OGa} and $\overline{K_{OGa}}$ values were found to continually decrease with H for H less than about 25 cm while K_{OGa} values for H greater than 25 cm remained constant or tended to slightly increase with H . Further, they both increased with increase in gas flow rate and absorber diameter, decreased with increase in liquid viscosity and were also affected by liquid flow rate Q_L and inlet gas phase concentration, y_{on} . Mass transfer rates normally decreased with increase in Q_L due to the effect of Q_L in reducing slug separation distance and so liquid mixing between slugs but increase with increase in gas phase composition. The increase can be attributed to interfacial concentration differing significantly from bulk concentrations, which tended to decrease the interfacial viscosity and increase the interfacial liquid phase diffusivity.

Experimental $\overline{K_{OGa}}$ values were compared to K_{OG} value calculated using the penetration and two resistance theory. Predicted values were always well above the experimental values which could be attributed firstly to the fact that $\bar{a}$ was less than 1.0 as could be seen from the variations of mass transfer coefficients $K_{OG}\bar{a}_e$ and slug surface area with absorber length H and secondly might have been a result of concentration gradients being established in the paraffin oils. Although there was a wide discrepancy between the

theoretical K_{OG} and experimental $\overline{K_{OG}a}$ values both showed the same trends in their dependences on slug sizes. When the effects of variations in interfacial velocity and slug size were accounted for, calculation also showed the changes in $\overline{K_{OG}a}$ due to variation of gas phase diffusivity were well predicted by the penetration theory. Approximate values of $\bar{a}$ were also calculated with the assumption of equality between the theoretical K_{OG} and experimental $\overline{K_{OG}}$. The results indicated that the frontal area was the most effective mass transfer area of the slug. This was well illustrated by a drastic reduction in mass transfer rates when chaining of slugs took place. The effect of slug coalescence was probably to increase mass transfer rate but the magnitude of this effect was counteracted by the chaining of slugs which reduced mass transfer rates.

The mass transfer coefficients $\overline{K_{OG}a}$ were compared with k_G and k_L values reported for mass transfer in single bubbles, foams and froths in pilot plant and laboratory sized plate columns. The comparison indicated that the contacting behaviour in vertical slug flow did in fact resemble that taking place in a froth or foam. The results of this type of study therefore could be of some help in determining the effect of system and operating variables on mass transfer operation in froths and foams as long that appreciable liquid phase concentrations gradients were not anticipated in the column. In addition the results of this study would provide useful information for the designs of vertical gas-liquid pipeline contactors, particularly when short pipe lines are used.

VII. RECOMMENDATION

The effect of mass transfer on flow characteristics as observed in this study indicated that flow characteristics measured in the absence of mass transfer were not necessary similar to those obtained when mass transfer took place. Further studies are therefore required to examine the actual influence of mass transfer on flow behaviour not only in slug flows but other flow regions as well. More flow characteristic studies using systems with a wide range of physical properties are also required to substantiate the proposed correlations for slug rise velocities and the ratios, $(\bar{A}_S/\bar{V}_S)$.

In this study, end effect mass transfer though much lower than those obtained in earlier studies was still high and therefore consideration should be given to additional methods of reducing these end effects.

It would be of interest to undertake further studies on the effect of gas phase concentration on mass transfer rates as found in this study and to evaluate the slug effective mass transfer area so that the actual mass transfer coefficient could be evaluated and mass transfer mechanisms studied.

Contacting conditions in slug flow are considered to be more representative to those taking place in froths and foams than single bubble studies. Future investigations on the factors influencing mass transfer in froths or foams could well be directed toward studying mass transfer in slug flow rather than in single bubbles.

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APPENDIX 1

EXPERIMENTAL DATA

- 1-A. General Flow Characteristics
- 1-B. Consistency of Experimental Data
- 1-C. Mass Transfer Efficiencies

1-A/ General Flow Characteristics

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Table 1-1

Slug Shapes and Sizes

NO.	D _p	ℓ	r _i	A _f	A _s	V _s	δ _o
HEAVY PARAFFIN OIL							
1	0.594	0.0151	0.0667	0.0143	0.0283	0.0001	0.085
2	0.594	0.0606	0.1364	0.0685	0.1269	0.0017	0.085
3	0.594	0.1061	0.1667	0.1208	0.2081	0.0051	0.085
4	0.594	0.1667	0.1864	0.1921	0.3012	0.0111	0.085
5	0.594	0.2424	0.1994	0.2854	0.4103	0.0199	0.085
6	0.594	0.3485	0.2061	0.4207	0.5541	0.0336	0.085
7	0.594	0.5000	0.2121	0.6203	0.7617	0.0545	0.085
8	0.594	1.0000	0.2121	1.2867	1.4281	0.1252	0.085
9	0.594	2.0000	0.2121	2.6195	2.7609	0.2665	0.085
10	0.594	3.0000	0.2121	3.9523	4.0937	0.4079	0.085
11	0.594	4.0000	0.2121	5.2851	5.4265	0.5492	0.085
12	0.793	0.0156	0.0625	0.0126	0.0249	0.0001	0.101
13	0.793	0.0625	0.1563	0.0854	0.1621	0.0021	0.101
14	0.793	0.1094	0.2031	0.1609	0.2905	0.0070	0.101
15	0.793	0.1563	0.2344	0.2388	0.4113	0.0141	0.101
16	0.793	0.2031	0.2531	0.3161	0.5174	0.0228	0.101
17	0.793	0.2813	0.2734	0.4499	0.6848	0.0399	0.101
18	0.793	0.3594	0.2850	0.5887	0.8439	0.0591	0.101
19	0.793	0.5000	0.2942	0.8472	1.1192	0.0965	0.101
20	0.793	0.5625	0.2953	0.9630	1.2370	0.1137	0.101
21	0.793	1.0000	0.2953	1.7748	2.0488	0.2335	0.101
22	0.793	1.5000	0.2953	2.7025	2.9765	0.3705	0.101
23	0.793	2.0000	0.2953	3.6303	3.9043	0.5075	0.101
24	0.793	3.0000	0.2953	5.4858	5.7598	0.7815	0.101
25	1.000	0.0151	0.1000	0.0318	0.0632	0.0002	0.112
26	1.000	0.0606	0.2000	0.1360	0.2617	0.0034	0.112
27	1.000	0.1061	0.2500	0.2320	0.4284	0.0108	0.112
28	1.000	0.1515	0.2818	0.3250	0.5745	0.0209	0.112
29	1.000	0.2576	0.3303	0.5532	0.8959	0.0530	0.112
30	1.000	0.3485	0.3545	0.7567	1.1516	0.0865	0.112
31	1.000	0.4545	0.3727	1.0035	1.4399	0.1309	0.112
32	1.000	0.6061	0.3879	1.3695	1.8422	0.2003	0.112
33	1.000	1.2000	0.3879	2.8170	3.2897	0.4810	0.112
34	1.000	2.0000	0.3879	4.7667	5.2394	0.8592	0.112
35	1.000	3.0000	0.3879	7.2038	7.6765	1.3318	0.112
LIGHT PARAFFIN OIL							
36	0.594	0.0151	0.0636	0.0131	0.0258	0.0001	0.067
37	0.594	0.0606	0.1394	0.0705	0.1316	0.0017	0.067
38	0.594	0.1515	0.1909	0.1821	0.2966	0.0100	0.067
39	0.594	0.2576	0.2136	0.3216	0.4650	0.0239	0.067
40	0.594	0.3485	0.2236	0.4478	0.6050	0.0377	0.067
41	0.594	0.5000	0.2303	0.6646	0.8313	0.0623	0.067
42	0.594	1.0000	0.2303	1.3882	1.5548	0.1456	0.067
43	0.594	2.5000	0.2303	3.5587	3.7253	0.3955	0.067
44	0.594	3.5000	0.2303	5.0058	5.1724	0.5622	0.067
45	0.793	0.0222	0.0755	0.0187	0.0366	0.0001	0.091
A 46	0.793	0.0889	0.2000	0.1429	0.2686	0.0048	0.091
E 47	0.793	0.1556	0.2529	0.2677	0.4687	0.0161	0.091

48	0.793	0.2444	0.2835	0.4295	0.6821	0.0367	0.091
49	0.793	0.3333	0.2978	0.5940	0.8725	0.0603	0.091
50	0.793	0.4889	0.3067	0.8901	1.1856	0.1049	0.091
51	0.793	1.2000	0.3067	2.2604	2.5558	0.3150	0.091
52	0.793	2.0000	0.3067	3.8018	4.0973	0.5514	0.091
53	0.793	2.5000	0.3067	4.7652	5.0607	0.6991	0.091
54	1.000	0.0151	0.0970	0.0299	0.0594	0.0001	0.107
55	1.000	0.0606	0.2061	0.1444	0.2778	0.0040	0.107
56	1.000	0.1515	0.2879	0.3391	0.5994	0.0225	0.107
57	1.000	0.2576	0.3394	0.5735	0.9354	0.0558	0.107
58	1.000	0.3333	0.3621	0.7482	1.1602	0.0852	0.107
59	1.000	0.5000	0.3885	1.1497	1.6238	0.1599	0.107
60	1.000	1.0000	0.3939	2.3866	2.8741	0.4032	0.107
61	1.000	2.0000	0.3939	4.8618	5.3493	0.8907	0.107
62	1.000	3.5000	0.3939	8.5745	9.0621	1.6220	0.107

Table 1-2
Slug Frequencies and Mean Slug Lengths
(Photographic Techniques)

Run NO.	D _p	H	G	Q _L	F ₁	F ₂	F	F̄	L _s	A _s /V _s
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL										
1	0.594	15.1	165.0	30.0	12.37	11.34	11.34	11.68	1.78	10.48
2	0.594	15.1	245.0	30.0	10.31	8.25	8.25	8.93	3.35	9.97
3	0.594	15.1	326.0	30.0	10.31	10.31	10.31	10.31	3.84	9.90
4	0.594	15.1	245.0	45.0	19.59	16.49	16.49	17.53	1.76	10.49
5	0.594	15.1	326.0	60.0	18.56	12.37	9.28	13.40	2.98	10.04
6	0.594	40.0	245.0	30.0	10.31	10.31	10.31	10.31	2.92	10.06
7	0.793	15.1	165.0	30.0	12.37	12.37	12.37	12.37	0.96	8.87
8	0.793	15.0	165.0	30.0	14.43	12.37	12.37	13.06	0.92	8.99
9	0.793	25.0	165.0	30.0	8.25	7.22	7.22	7.55	1.48	8.05
10	0.793	15.0	245.0	30.0	9.28	9.28	9.28	9.28	1.75	7.83
11	0.793	15.0	245.0	30.0	11.34	9.28	9.28	9.97	1.64	7.91
12	0.793	25.0	245.0	30.0	5.15	5.15	5.15	5.15	3.04	7.36
13	0.793	40.0	245.0	30.0	13.40	11.34	9.28	11.34	1.46	8.07
14	0.793	40.0	245.0	30.0	13.40	12.37	10.31	12.03	1.39	8.15
15	0.793	15.0	326.0	30.0	10.31	7.22	7.22	8.25	2.55	7.48
16	0.793	15.0	326.0	30.0	7.22	7.22	7.22	7.22	2.90	7.39
17	0.793	25.0	326.0	30.0	5.15	4.12	4.12	4.47	4.59	7.16
18	0.793	25.0	326.0	30.0	9.28	4.12	4.12	5.84	3.54	7.27
19	0.793	40.0	326.0	30.0	7.22	7.22	6.19	6.87	3.03	7.36
20	0.793	15.0	165.0	45.0	10.31	8.25	6.19	8.25	1.36	8.17
21	0.793	15.0	165.0	45.0	11.34	9.28	8.25	9.62	1.19	8.41
22	0.793	25.0	165.0	45.0	9.28	9.28	8.25	8.93	1.27	8.29
23	0.793	15.0	245.0	45.0	8.25	6.19	6.19	6.87	2.32	7.56
24	0.793	15.0	245.0	45.0	13.40	6.19	6.19	8.59	1.88	7.76
25	0.793	25.0	245.0	45.0	9.28	9.28	6.19	8.25	1.95	7.72
26	0.793	40.0	245.0	45.0	11.34	11.34	11.34	11.34	1.46	8.07
27	0.793	15.0	326.0	45.0	8.25	8.25	8.25	8.25	2.55	7.48
28	0.793	25.0	326.0	45.0	8.25	8.25	8.25	8.25	2.55	7.48
29	0.793	40.0	326.0	45.0	8.25	6.19	6.19	6.87	3.03	7.36
30	0.793	40.0	326.0	45.0	10.31	6.19	6.19	7.56	2.77	7.42
31	0.793	15.0	165.0	60.0	25.77	20.62	20.62	22.34	0.60	10.57
32	0.793	25.0	165.0	60.0	12.37	12.37	12.37	12.37	0.96	8.87
33	0.793	15.0	245.0	60.0	11.34	9.28	9.28	9.97	1.64	7.91

34	0.793	15.0	245.0	60.0	11.34	9.28	9.28	9.97	1.64	7.91
35	0.793	15.0	245.0	60.0	15.46	9.28	9.28	11.34	1.46	8.07
36	0.793	25.0	245.0	60.0	8.25	7.22	7.22	7.56	2.12	7.64
37	0.793	25.0	245.0	60.0	13.40	8.25	7.22	9.62	1.70	7.87
38	0.793	40.0	245.0	60.0	15.46	13.40	7.22	12.03	1.39	8.15
39	0.793	15.0	326.0	60.0	15.46	8.25	8.25	10.65	2.01	7.69
40	0.793	15.0	326.0	60.0	20.62	8.25	8.25	12.37	1.75	7.84
41	0.793	25.0	326.0	60.0	10.31	8.25	5.15	7.90	2.66	7.45
42	0.793	25.0	326.0	60.0	12.37	8.25	5.15	8.59	2.46	7.51
43	0.793	40.0	326.0	60.0	11.34	10.31	7.22	9.62	2.21	7.60
44	0.793	40.0	326.0	60.0	11.34	10.31	8.25	9.97	2.14	7.63
45	1.000	15.1	165.0	30.0	10.31	8.25	6.19	8.25	0.89	7.58
46	1.000	15.1	245.0	30.0	7.22	6.19	6.19	6.53	1.51	6.45
47	1.000	15.1	326.0	30.0	8.25	6.19	5.15	6.53	1.94	5.13
48	1.000	15.1	245.0	45.0	9.28	9.28	9.28	9.28	1.11	7.00
49	1.000	15.1	326.0	60.0	7.22	7.22	7.22	7.22	1.78	6.23
50	1.000	40.0	245.0	30.0	7.22	7.22	7.22	7.22	1.38	6.59

SYSTEM: NITROGEN-HEAVY PARAFFIN OIL

51	0.793	15.0	245.0	30.0	13.50	12.10	12.10	12.55	1.34	8.21
52	0.793	25.0	245.0	30.0	11.30	10.60	10.60	10.80	1.53	8.01
53	0.793	35.0	245.0	30.0	12.40	12.40	11.40	12.10	1.38	8.16

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN OIL MIXTURE (RATIO 2 : 1)

54	0.793	15.1	245.0	30.0	10.31	10.31	10.31	10.31	1.51	7.84
55	0.793	40.0	245.0	30.0	12.37	12.37	12.37	12.37	1.28	8.08

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN OIL MIXTURE (RATIO 1 : 1)

56	0.793	15.1	245.0	30.0	10.31	10.31	10.31	10.31	1.51	7.84
57	0.793	40.0	326.0	30.0	11.34	11.34	11.34	11.34	1.80	7.63

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN OIL MIXTURE (RATIO 1 : 2)

58	0.793	15.1	245.0	30.0	13.40	12.37	10.31	12.03	1.31	8.04
59	0.793	40.0	326.0	30.0	10.31	10.31	10.31	10.31	1.96	7.54

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

60	0.594	15.1	165.0	30.0	24.74	24.74	24.74	24.74	0.79	11.30
61	0.594	15.1	245.0	30.0	16.49	16.49	16.49	16.49	1.61	9.86
62	0.594	15.1	326.0	30.0	12.37	12.37	12.37	12.37	2.76	9.35
63	0.594	15.1	245.0	45.0	11.34	11.34	11.34	11.34	2.29	9.49
64	0.594	15.1	326.0	45.0	12.37	12.37	12.37	12.37	2.76	9.35
65	0.594	40.0	245.0	30.0	11.34	9.28	9.28	9.97	2.59	9.39
66	0.594	40.0	326.0	60.0	10.31	8.25	8.25	8.93	3.78	9.16
67	0.793	15.0	165.0	30.0	27.84	24.74	21.65	24.74	0.51	11.02
68	0.793	25.0	165.0	30.0	18.56	16.49	10.31	15.12	0.75	9.27
69	0.793	15.0	245.0	30.0	8.25	8.25	8.25	8.25	1.81	7.54
70	0.793	25.0	245.0	30.0	16.23	14.41	11.22	13.99	1.12	8.24
71	0.793	40.0	245.0	30.0	13.41	12.83	11.12	12.45	1.24	8.05
72	0.793	15.0	326.0	30.0	12.37	11.34	11.34	11.68	1.71	7.61
73	0.793	15.0	326.0	30.0	12.37	11.34	11.34	11.68	1.71	7.61
74	0.793	15.0	326.0	30.0	12.37	12.37	11.34	12.03	1.67	7.64
75	0.793	25.0	326.0	30.0	11.34	11.34	9.28	10.65	1.86	7.51
76	0.793	40.0	326.0	30.0	12.37	9.28	9.28	10.31	1.92	7.48
77	0.793	15.0	165.0	45.0	18.56	18.56	15.46	17.53	0.66	9.71

78	0.793	25.0	165.0	45.0	13.40	13.40	11.34	12.71	0.86	8.84
79	0.793	15.0	245.0	45.0	11.34	11.34	11.34	11.34	1.35	7.92
80	0.793	25.0	245.0	45.0	16.49	15.46	11.34	14.43	1.09	8.30
81	0.793	25.0	245.0	45.0	17.53	15.46	11.34	14.78	1.07	8.34
82	0.793	40.0	245.0	45.0	10.31	10.31	10.31	10.31	1.48	7.79
83	0.793	15.0	326.0	45.0	13.40	13.40	13.40	13.40	1.51	7.76
84	0.793	25.0	326.0	45.0	12.37	12.37	12.37	12.37	1.62	7.67
85	0.793	40.0	326.0	45.0	13.40	13.40	11.34	12.71	1.58	7.70
86	0.793	15.0	165.0	60.0	36.08	36.08	36.08	36.08	0.39	12.95
87	0.793	25.0	165.0	60.0	16.49	11.34	10.31	12.71	0.86	8.84
88	0.793	25.0	165.0	60.0	16.49	11.34	11.34	13.06	0.85	8.90
89	0.793	15.0	245.0	60.0	18.56	17.53	16.49	17.53	0.92	8.67
90	0.793	25.0	245.0	60.0	15.07	14.27	12.69	14.01	1.12	8.24
91	0.793	40.0	245.0	60.0	40.21	37.11	28.87	35.40	0.52	10.85
92	0.793	15.0	326.0	60.0	11.34	11.34	11.34	11.34	1.76	7.58
93	0.793	25.0	326.0	60.0	10.31	10.31	10.31	10.31	1.92	7.48
94	0.793	25.0	326.0	60.0	11.34	10.31	10.31	10.65	1.86	7.51
95	0.793	40.0	326.0	60.0	22.68	11.34	10.31	14.78	1.38	7.89
96	1.000	15.1	165.0	30.0	30.93	26.80	22.68	26.80	0.38	12.83
97	1.000	15.1	245.0	30.0	8.25	8.25	8.25	8.25	1.19	6.75
98	1.000	15.1	326.0	30.0	9.28	9.28	5.15	7.90	1.59	6.28
99	1.000	15.1	245.0	45.0	10.31	9.28	8.25	9.28	1.08	6.96
100	1.000	15.1	326.0	60.0	8.25	8.25	7.22	7.90	1.59	6.28
101	1.000	40.0	245.0	30.0	8.25	7.22	5.15	6.87	1.39	6.47

SYSTEM: N-HEXANE-HELIUM-HEAVY PARAFFIN OIL.

102	0.793	40.0	245.0	30.0	8.25	8.25	8.25	8.25	1.95	7.72
103	0.793	40.0	326.0	60.0	7.22	7.22	7.22	7.22	2.90	7.39
104	0.793	15.1	245.0	30.0	12.37	10.31	10.31	11.00	1.50	8.03
105	0.793	15.1	326.0	30.0	7.22	7.22	7.22	7.22	2.90	7.39
106	0.793	15.1	165.0	45.0	18.56	12.37	11.34	14.09	0.86	9.17
107	0.793	15.1	326.0	30.0	9.28	9.28	9.28	9.28	2.29	7.57

SYSTEM: N-HEXANE-HELIUM-LIGHT PARAFFIN OIL

108	0.793	40.0	245.0	30.0	8.25	7.22	7.22	7.56	1.97	7.46
109	0.793	40.0	326.0	30.0	11.34	11.34	11.34	11.34	1.76	7.58
110	0.793	15.1	165.0	30.0	35.05	34.02	34.02	34.36	0.40	12.76
111	0.793	15.1	245.0	45.0	12.37	11.34	11.34	11.68	1.32	7.96
112	0.793	15.1	326.0	60.0	11.34	11.34	11.34	11.34	1.76	7.58

SYSTEM: N-HEXANE-FREON-14-HEAVY PARAFFIN OIL

113	0.793	15.1	165.0	30.0	11.34	11.34	11.34	11.34	1.03	8.70
114	0.793	15.1	245.0	30.0	9.28	8.25	7.22	8.25	1.95	7.72
115	0.793	15.1	326.0	60.0	10.31	9.28	8.25	9.28	2.29	7.57
116	0.793	15.1	326.0	30.0	18.56	13.40	13.40	15.12	1.46	8.07
117	0.793	40.0	326.0	30.0	8.25	7.22	7.22	7.56	2.77	7.42

SYSTEM: N-HEXANE-FREON-14-LIGHT PARAFFIN OIL

118	0.793	15.1	165.0	30.0	15.46	15.46	15.46	15.46	0.73	9.34
119	0.793	15.1	245.0	30.0	48.60	42.71	35.35	42.22	0.46	11.69
120	0.793	15.1	326.0	30.0	11.34	11.34	9.28	10.65	1.86	7.51
121	0.793	15.1	245.0	30.0	28.87	28.87	28.87	28.87	0.61	10.06
122	0.793	40.0	326.0	30.0	12.37	12.37	12.37	12.37	1.62	7.67

Table 1-3
Slug Frequencies and Mean Slug Lengths
(Stroboscope)

Run NO.	D _p	H	G	Q _L	F	L _s	A _s /V _s
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL							
123	0.793	10.0	165.0	30.0	16.60	0.75	9.59
124	0.793	20.0	165.0	30.0	8.30	1.36	8.18
125	0.793	10.0	245.0	30.0	12.00	1.39	8.15
126	0.793	20.0	245.0	30.0	6.10	2.59	7.47
127	0.793	30.0	245.0	30.0	5.80	2.72	7.44
128	0.793	10.0	326.0	30.0	9.60	2.21	7.60
129	0.793	20.0	326.0	30.0	4.90	4.20	7.19
130	0.793	30.0	326.0	30.0	4.10	4.98	7.13
131	0.793	10.0	165.0	45.0	11.30	1.04	8.69
132	0.793	20.0	165.0	45.0	9.30	1.23	8.35
133	0.793	10.0	245.0	45.0	9.30	1.75	7.84
134	0.793	20.0	245.0	45.0	8.10	1.99	7.70
135	0.793	30.0	245.0	45.0	9.00	1.80	7.80
136	0.793	10.0	326.0	45.0	7.40	2.83	7.41
137	0.793	20.0	326.0	45.0	7.40	2.83	7.41
138	0.793	30.0	326.0	45.0	6.70	3.11	7.35
139	0.793	10.0	165.0	60.0	26.00	0.53	11.19
140	0.793	20.0	165.0	60.0	13.00	0.92	8.98
141	0.793	10.0	245.0	60.0	16.20	1.07	8.63
142	0.793	20.0	245.0	60.0	8.60	1.88	7.76
143	0.793	30.0	245.0	60.0	9.10	1.79	7.81
144	0.793	10.0	326.0	60.0	14.00	1.56	7.98
145	0.793	20.0	326.0	60.0	8.00	2.63	7.46
146	0.793	30.0	326.0	60.0	9.00	2.35	7.55

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

147	0.793	10.0	165.0	30.0	33.00	0.41	12.51
148	0.793	20.0	165.0	30.0	18.20	0.64	9.83
149	0.793	10.0	245.0	30.0	20.00	0.82	8.98
150	0.793	20.0	245.0	30.0	11.40	1.35	7.93
151	0.793	30.0	245.0	30.0	10.80	1.41	7.85
152	0.793	10.0	326.0	30.0	15.00	1.36	7.91
153	0.793	20.0	326.0	30.0	9.70	2.03	7.43
154	0.793	30.0	326.0	30.0	9.90	2.00	7.44
155	0.793	10.0	165.0	45.0	22.40	0.55	10.59
156	0.793	20.0	165.0	45.0	14.00	0.80	9.07
157	0.793	10.0	245.0	45.0	20.00	0.82	8.98
158	0.793	20.0	245.0	45.0	11.00	1.39	7.88
159	0.793	30.0	245.0	45.0	10.40	1.46	7.80
160	0.793	10.0	326.0	45.0	13.20	1.53	7.75
161	0.793	20.0	326.0	45.0	11.90	1.68	7.63
162	0.793	30.0	326.0	45.0	11.60	1.72	7.60
163	0.793	10.0	165.0	60.0	36.00	0.39	12.93
164	0.793	20.0	165.0	60.0	20.00	0.60	10.16
165	0.793	10.0	245.0	60.0	21.60	0.77	9.17
166	0.793	20.0	245.0	60.0	15.50	1.03	8.43
167	0.793	30.0	245.0	60.0	18.40	0.88	8.78
168	0.793	10.0	326.0	60.0	13.00	1.55	7.73
169	0.793	20.0	326.0	60.0	10.40	1.91	7.49
170	0.793	30.0	326.0	60.0	11.50	1.74	7.59

Table 1-4

Gas Phase Void Fractions α and Hold Up Ratio γ

Run NO.	D_p	H	G	Q_L	ΔV_L	V_H	α	γ
SYSTEM: NITROGEN-HEAVY PARAFFIN OIL								
1	0.793	20.9	165.0	45.0	6.30	10.322	0.390	5.733
2	0.793	20.9	245.0	45.0	5.68	10.322	0.450	6.653
3	0.793	20.9	326.0	45.0	5.57	10.322	0.460	8.504
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL								$\gamma_{on}=0.073$
4	0.793	20.9	165.0	45.0	6.65	10.322	0.356	6.639
5	0.793	20.9	245.0	45.0	6.25	10.322	0.395	8.356
6	0.793	20.9	326.0	45.0	6.05	10.322	0.414	10.258
								$\gamma_{on}=0.053$
7	0.594	14.0	165.0	30.0	2.10	3.880	0.459	6.490
8	0.594	30.0	165.0	30.0	3.95	8.314	0.525	4.979
9	0.594	14.0	165.0	45.0	2.10	3.880	0.459	4.327
10	0.594	14.0	165.0	60.0	2.70	3.880	0.304	6.294
11	0.594	14.0	245.0	30.0	2.10	3.880	0.459	9.637
12	0.594	30.0	245.0	30.0	4.20	8.314	0.495	8.338
13	0.594	14.0	245.0	45.0	2.30	3.880	0.407	7.927
14	0.594	14.0	245.0	60.0	2.40	3.880	0.381	6.623
15	0.594	30.0	245.0	60.0	4.70	8.314	0.435	5.311
16	0.594	14.0	326.0	30.0	2.00	3.880	0.484	11.562
17	0.594	30.0	326.0	30.0	3.90	8.314	0.531	9.602
18	0.594	14.0	326.0	45.0	2.30	3.880	0.407	10.548
19	0.594	14.0	326.0	60.0	2.50	3.880	0.356	9.846
20	0.594	30.0	326.0	60.0	4.60	8.314	0.447	6.730
21	0.793	10.0	165.0	30.0	3.15	4.939	0.362	9.684
22	0.793	10.0	245.0	30.0	2.85	4.939	0.423	11.142
23	0.793	10.0	326.0	30.0	2.75	4.939	0.443	13.652
24	0.793	10.0	165.0	45.0	3.25	4.939	0.342	7.056
25	0.793	10.0	245.0	45.0	3.10	4.939	0.372	9.178
26	0.793	10.0	326.0	45.0	2.85	4.939	0.423	9.884
27	0.793	10.0	165.0	60.0	3.35	4.939	0.322	5.798
28	0.793	10.0	245.0	60.0	3.15	4.939	0.362	7.190
29	0.793	10.0	326.0	60.0	3.00	4.939	0.393	8.406
30	0.793	20.9	165.0	30.0	6.35	10.322	0.385	8.792
31	0.793	20.9	225.0	30.0	6.05	10.322	0.414	10.620
32	0.793	20.9	245.0	30.0	6.05	10.322	0.414	11.564
33	0.793	20.9	326.0	30.0	6.05	10.322	0.454	15.388
34	0.793	20.9	165.0	45.0	6.65	10.322	0.356	6.639
35	0.793	20.9	245.0	45.0	6.25	10.322	0.395	8.356
36	0.793	20.9	326.0	45.0	6.10	10.322	0.409	10.466
37	0.793	20.9	165.0	60.0	6.90	10.322	0.332	5.544
38	0.793	20.9	245.0	60.0	6.55	10.322	0.365	7.090
39	0.793	20.9	326.0	60.0	6.25	10.322	0.395	8.339
40	0.793	30.0	165.0	30.0	8.75	14.817	0.409	7.932
41	0.793	30.0	245.0	30.0	8.45	14.817	0.430	10.839
42	0.793	30.0	326.0	30.0	8.20	14.817	0.447	13.466
43	0.793	30.0	165.0	45.0	9.20	14.817	0.379	6.006
44	0.793	30.0	245.0	45.0	8.75	14.817	0.409	7.852
45	0.793	30.0	326.0	45.0	8.35	14.817	0.426	9.354
46	0.793	30.0	165.0	60.0	9.05	14.817	0.389	4.316
47	0.793	30.0	245.0	60.0	8.85	14.817	0.403	6.056

NA	48	0.793	30.0	326.0	60.0	8.55	14.817	0.423	7.413
	49	0.793	40.0	165.0	30.0	14.15	19.756	0.284	13.883
OUT	50	0.793	40.0	165.0	30.0	11.15	19.756	0.436	7.126
	51	0.793	40.0	225.0	30.0	11.55	19.756	0.415	10.556
	52	0.793	40.0	245.0	30.0	11.35	19.756	0.425	11.027
	53	0.793	40.0	326.0	30.0	10.75	19.756	0.441	12.971
	54	0.793	40.0	165.0	45.0	14.55	19.756	0.264	10.248
	55	0.793	40.0	165.0	45.0	10.95	19.756	0.446	4.559
	56	0.793	40.0	245.0	45.0	11.65	19.756	0.410	7.825
	57	0.793	40.0	270.0	45.0	11.65	19.756	0.410	8.623
	58	0.793	40.0	326.0	45.0	11.05	19.756	0.441	9.195
	59	0.793	40.0	192.0	60.0	14.05	19.756	0.289	7.880
	60	0.793	40.0	192.0	60.0	11.15	19.756	0.436	4.146
	61	0.793	40.0	245.0	60.0	12.45	19.756	0.370	6.958
	62	0.793	40.0	270.0	60.0	12.15	19.756	0.385	7.188
	63	0.793	40.0	326.0	60.0	11.95	19.756	0.395	8.318
	64	0.793	20.9	165.0	30.0	6.95	10.322	0.327	11.334
	65	0.793	20.9	220.0	30.0	6.75	10.322	0.346	13.856
	66	0.793	20.9	245.0	30.0	6.35	10.322	0.385	13.054
	67	0.793	20.9	326.0	30.0	6.15	10.322	0.404	16.017
	68	0.793	30.0	245.0	30.0	8.65	14.817	0.416	11.455
	69	0.793	30.0	270.0	30.0	8.55	14.817	0.423	12.279
	70	0.793	30.0	326.0	30.0	8.45	14.817	0.430	14.422
	71	1.000	15.5	165.0	30.0	7.90	12.174	0.351	10.167
	72	1.000	15.5	165.0	45.0	8.10	12.174	0.335	7.291
	73	1.000	15.5	165.0	60.0	8.20	12.174	0.326	5.675
	74	1.000	15.5	245.0	30.0	7.45	12.174	0.388	12.880
	75	1.000	30.0	245.0	30.0	14.50	23.562	0.385	13.067
	76	1.000	15.5	245.0	45.0	7.70	12.174	0.367	9.371
	77	1.000	15.5	245.0	60.0	7.80	12.174	0.359	7.282
	78	1.000	30.0	245.0	60.0	15.35	23.562	0.349	7.633
	79	1.000	15.5	326.0	30.0	7.10	12.174	0.417	15.207
	80	1.000	30.0	326.0	30.0	14.10	23.562	0.402	16.193
	81	1.000	15.5	326.0	45.0	7.30	12.174	0.400	10.851
	82	1.000	15.5	326.0	60.0	7.50	12.174	0.384	8.719
	83	1.000	30.0	326.0	60.0	14.50	23.562	0.385	8.694

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 2 : 1)

	84	0.793	30.0	245.0	30.0	8.65	14.817	0.416	11.455
	85	0.793	30.0	326.0	30.0	8.45	14.817	0.430	14.422
	86	0.793	30.0	270.0	30.0	8.55	14.817	0.423	12.279
	87	0.793	20.9	245.0	30.0	6.35	10.322	0.385	13.054
	88	0.793	20.9	326.0	30.0	6.15	10.322	0.404	16.017
	89	0.793	20.9	220.0	30.0	6.75	10.322	0.346	13.856

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

	90	0.594	14.0	165.0	30.0	2.00	3.880	0.484	5.852
	91	0.594	14.0	165.0	45.0	2.25	3.880	0.420	5.062
	92	0.594	14.0	165.0	60.0	2.30	3.880	0.407	4.004
	93	0.594	14.0	245.0	30.0	1.85	3.880	0.523	7.444
	94	0.594	30.0	245.0	30.0	4.05	8.314	0.513	7.758
	95	0.594	14.0	245.0	45.0	2.15	3.880	0.446	6.768
	96	0.594	14.0	245.0	60.0	2.20	3.880	0.433	5.348
	97	0.594	30.0	245.0	60.0	4.10	8.314	0.507	3.973
	98	0.594	14.0	326.0	30.0	1.95	3.880	0.497	10.981

99	0.594	30.0	326.0	30.0	3.90	8.314	0.531	9.602
100	0.594	14.0	326.0	45.0	2.05	3.880	0.472	8.117
101	0.594	30.0	326.0	45.0	4.05	8.314	0.513	6.882
102	0.594	14.0	326.0	60.0	2.10	3.880	0.459	6.411
103	0.594	30.0	326.0	60.0	4.10	8.314	0.507	5.287
104	C.793	10.0	165.0	30.0	3.35	4.939	0.322	11.596
105	C.793	10.0	195.0	30.0	3.15	4.939	0.362	11.445
106	0.793	10.0	245.0	30.0	3.00	4.939	0.393	12.636
107	C.793	10.0	326.0	30.0	2.95	4.939	0.403	16.117
108	0.793	10.0	165.0	45.0	3.45	4.939	0.301	8.495
109	0.793	10.0	245.0	45.0	3.15	4.939	0.362	9.586
110	C.793	10.0	326.0	45.0	3.00	4.939	0.393	11.209
111	0.793	10.0	165.0	60.0	3.60	4.939	0.271	7.394
112	C.793	10.0	245.0	60.0	3.15	4.939	0.362	7.190
113	C.793	10.0	326.0	60.0	3.05	4.939	0.382	8.773
114	0.793	20.9	165.0	30.0	6.05	10.322	0.414	7.788
115	C.793	20.9	165.0	30.0	7.75	10.322	0.249	16.570
116	0.793	20.9	225.0	30.0	5.95	10.322	0.424	10.206
117	0.793	20.9	225.0	30.0	7.00	10.322	0.322	15.802
118	0.793	20.9	245.0	30.0	6.35	10.322	0.385	13.054
119	0.793	20.9	326.0	30.0	6.15	10.322	0.404	16.017
120	0.793	20.9	165.0	45.0	5.95	10.322	0.424	4.990
121	0.793	20.9	165.0	45.0	8.35	10.322	0.191	15.522
122	0.793	20.9	245.0	45.0	6.50	10.322	0.370	9.258
123	0.793	20.9	326.0	45.0	6.15	10.322	0.404	10.678
124	C.793	20.9	165.0	60.0	6.20	10.322	0.399	4.136
125	0.793	20.9	165.0	60.0	8.45	10.322	0.181	12.410
126	C.793	20.9	245.0	60.0	6.55	10.322	0.365	7.090
127	0.793	20.9	326.0	60.0	6.25	10.322	0.395	8.339
128	0.793	30.0	195.0	30.0	10.55	14.817	0.288	16.071
129	0.793	30.0	195.0	30.0	7.95	14.817	0.463	7.525
130	0.793	30.0	225.0	30.0	8.98	14.817	0.394	11.539
131	C.793	30.0	245.0	30.0	8.65	14.817	0.416	11.455
132	C.793	30.0	326.0	30.0	8.30	14.817	0.440	13.840
133	0.793	30.0	202.0	45.0	10.55	14.817	0.288	11.099
134	0.793	30.0	202.0	45.0	7.95	14.817	0.463	5.197
135	0.793	30.0	245.0	45.0	8.97	14.817	0.395	8.353
136	0.793	30.0	326.0	45.0	8.50	14.817	0.426	9.748
137	0.793	30.0	245.0	60.0	9.05	14.817	0.389	6.408
138	0.793	30.0	270.0	60.0	8.85	14.817	0.403	6.674
139	0.793	30.0	326.0	60.0	8.55	14.817	0.423	7.413
140	0.793	40.0	225.0	30.0	14.25	19.756	0.279	19.411
141	0.793	40.0	225.0	30.0	10.85	19.756	0.451	9.137
142	C.793	40.0	245.0	30.0	12.15	19.756	0.385	13.046
143	C.793	40.0	326.0	30.0	11.40	19.756	0.423	14.825
144	0.793	40.0	245.0	45.0	13.95	19.756	0.294	13.081
145	C.793	40.0	245.0	45.0	11.10	19.756	0.438	6.982
146	0.793	40.0	270.0	45.0	12.15	19.756	0.385	9.585
147	0.793	40.0	326.0	45.0	11.75	19.756	0.405	10.632
148	C.793	40.0	245.0	60.0	14.60	19.756	0.261	11.563
VA 149	0.793	40.0	245.0	60.0	11.35	19.756	0.425	5.513
UE 150	0.793	40.0	270.0	60.0	12.45	19.756	0.370	7.668
151	0.793	40.0	326.0	60.0	12.05	19.756	0.390	8.495
152	1.000	15.5	165.0	30.0	9.20	12.174	0.244	17.016
153	1.000	15.5	165.0	45.0	9.40	12.174	0.228	12.425

154	1.000	15.5	165.0	60.0	9.40	12.174	0.228	9.320
155	1.000	15.5	245.0	30.0	8.30	12.174	0.318	17.498
156	1.000	30.0	245.0	30.0	16.60	23.562	0.295	19.472
157	1.000	15.5	245.0	45.0	8.70	12.174	0.285	13.636
158	1.000	15.5	245.0	60.0	8.75	12.174	0.281	10.436
159	1.000	30.0	245.0	60.0	16.90	23.562	0.283	10.358
160	1.000	15.5	326.0	30.0	7.90	12.174	0.351	20.087
161	1.000	30.0	326.0	30.0	15.50	23.562	0.342	20.892
162	1.000	15.5	326.0	45.0	8.10	12.174	0.335	14.405
163	1.000	15.5	326.0	60.0	8.15	12.174	0.331	11.005
164	1.000	30.0	326.0	60.0	15.70	23.562	0.334	10.850

SYSTEM: N-HEXANE-HELIUM-HEAVY PARAFFIN OIL

165	0.793	17.4	245.0	30.0	4.70	8.594	0.453	9.858
166	0.793	17.4	245.0	45.0	5.05	8.594	0.412	7.758
167	0.793	17.4	245.0	60.0	5.00	8.594	0.418	5.681
168	0.793	17.4	326.0	30.0	4.35	8.594	0.494	11.139
169	0.793	17.4	326.0	45.0	4.65	8.594	0.459	8.542
170	0.793	17.4	326.0	60.0	4.65	8.594	0.459	6.405

SYSTEM: N-HEXANE-FREON-14-HEAVY PARAFFIN OIL

171	0.793	35.5	245.0	30.0	10.05	17.533	0.427	10.968

SYSTEM: N-HEXANE-FREON-14-LIGHT PARAFFIN OIL

172	0.793	35.5	245.0	30.0	10.25	17.533	0.415	11.493

Table 1-5a

Slug Lengths L_s and Separation Distances L_p

Run NO.	D_p	H	G	Q_L	$\bar{n}$	L_s	L_p
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL							
1	0.594	15.0	165.0	30.0	1	2.50	0.33
2	0.594	15.0	165.0	30.0	2	1.35	0.25
3	0.594	15.0	165.0	30.0	3	1.40	0.35
4	0.594	15.0	165.0	30.0	4	0.90	0.15
5	0.594	15.0	165.0	30.0	5	2.60	0.25
6	0.594	15.0	245.0	30.0	1	2.25	0.30
7	0.594	15.0	245.0	30.0	2	4.30	0.75
8	0.594	15.0	245.0	30.0	3	6.00	1.35
9	0.594	15.0	245.0	30.0	4	3.00	0.45
10	0.594	15.0	245.0	30.0	5	3.00	0.45
11	0.594	15.0	245.0	30.0	6	2.80	0.45
12	0.594	15.0	245.0	30.0	7	2.55	0.35
13	0.594	15.0	245.0	30.0	8	4.20	0.75
14	0.594	15.0	245.0	30.0	9	1.40	0.25
15	0.594	15.0	245.0	30.0	10	1.50	0.15
16	0.594	15.1	326.0	30.0	1	3.64	
17	0.594	15.1	245.0	45.0	1	3.03	
18	0.594	15.1	245.0	45.0	2	3.15	
19	0.594	15.1	245.0	45.0	3	3.15	
20	0.594	15.1	245.0	45.0	4	2.91	

21	0.594	15.1	245.0	45.0	5	3.09	
22	0.594	15.1	245.0	45.0	6	1.58	
23	0.594	15.1	245.0	45.0	7	1.58	
24	0.594	15.1	245.0	45.0	8	1.73	
25	0.594	15.1	245.0	45.0	9	1.58	
26	0.594	15.1	245.0	45.0	10	3.03	
27	0.594	15.1	245.0	45.0	11	2.88	
28	0.594	15.1	245.0	45.0	12	2.88	
29	0.594	15.1	245.0	45.0	13	1.58	
30	0.594	15.0	326.0	30.0	1	3.50	0.35
31	0.594	15.0	326.0	30.0	2	3.50	0.40
32	0.594	15.0	326.0	30.0	3	3.50	0.35
33	0.594	15.0	326.0	30.0	4	3.50	0.40
34	0.594	15.1	326.0	60.0	1	1.88	
35	0.594	15.1	326.0	60.0	2	1.97	
36	0.594	15.1	326.0	60.0	3	3.39	
37	0.594	15.1	326.0	60.0	4	3.64	
38	0.594	15.1	326.0	60.0	5	3.64	
39	0.594	15.1	326.0	60.0	6	3.64	
40	0.594	15.1	326.0	60.0	7	3.64	
41	0.594	15.1	326.0	60.0	8	1.97	
42	0.594	15.1	326.0	60.0	9	3.88	
43	0.594	15.1	326.0	60.0	10	3.88	
44	0.793	15.0	165.0	30.0	1	1.30	0.35
45	0.793	15.0	165.0	30.0	2	1.25	0.40
AWA	0.793	15.0	245.0	30.0	1	1.40	0.38
TIQUE	0.793	15.0	245.0	30.0	2	2.25	0.60
47	0.793	15.0	245.0	30.0	3	2.25	0.55
48	0.793	15.0	245.0	30.0	4	1.70	0.40
49	0.793	15.0	245.0	30.0	5	2.55	0.50
50	0.793	15.0	245.0	30.0	6	2.27	0.65
51	0.793	15.0	245.0	30.0	7	2.30	0.50
52	0.793	15.0	245.0	30.0	8	1.50	0.25
53	0.793	15.0	245.0	30.0	1	3.10	1.05
54	0.793	40.0	245.0	30.0	2	1.75	0.30
55	0.793	40.0	245.0	30.0	3	1.95	0.25
56	0.793	40.0	245.0	30.0	4	1.75	0.45
57	0.793	40.0	245.0	30.0	5	1.80	0.45
58	0.793	40.0	245.0	30.0	6	1.60	0.35
59	0.793	40.0	245.0	30.0	7	1.80	0.20
60	0.793	40.0	245.0	30.0	8	1.75	0.35
61	0.793	40.0	245.0	30.0	9	3.20	0.75
62	0.793	40.0	245.0	30.0	1	2.20	0.40
63	0.793	15.0	326.0	30.0	2	2.40	0.35
64	0.793	15.0	326.0	30.0	3	5.50	1.20
65	0.793	15.0	326.0	30.0	4	2.50	0.60
66	0.793	15.0	326.0	30.0	5	4.40	0.90
67	0.793	15.0	326.0	30.0	6	2.25	0.25
68	0.793	15.0	326.0	30.0	7	6.35	0.95
69	0.793	15.0	326.0	30.0	8	2.55	0.25
70	0.793	15.0	326.0	30.0	9	4.70	0.65
71	0.793	15.0	326.0	30.0	10	2.50	0.35
72	0.793	15.0	326.0	30.0	11	4.15	1.10
73	0.793	15.0	326.0	30.0	12	2.35	0.30
74	0.793	15.0	326.0	30.0	1	5.30	0.85
75	0.793	25.0	326.0	30.0			

76	0.793	25.0	326.0	30.0	2	5.75	0.80
77	0.793	25.0	326.0	30.0	3	2.75	0.25
78	0.793	25.0	326.0	30.0	4	5.40	0.85
79	0.793	25.0	326.0	30.0	5	8.15	0.95
80	0.793	25.0	326.0	30.0	6	7.55	1.40
81	0.793	25.0	326.0	30.0	7	5.50	0.90
82	0.793	25.0	326.0	30.0	8	5.50	0.90
83	0.793	25.0	326.0	30.0	9	2.80	0.25
84	0.793	15.1	165.0	45.0	1	2.14	
85	0.793	15.1	165.0	45.0	2	1.64	
86	0.793	15.1	165.0	45.0	3	2.91	
87	0.793	15.1	165.0	45.0	4	1.20	
88	0.793	15.1	165.0	45.0	5	1.23	
89	0.793	15.1	165.0	45.0	6	2.27	
90	0.793	15.1	165.0	45.0	7	2.27	
91	0.793	15.1	165.0	45.0	8	2.18	
92	0.793	15.1	165.0	45.0	9	1.27	
93	0.793	15.1	165.0	45.0	10	2.27	
94	0.793	15.1	245.0	45.0	1	3.68	
95	0.793	15.1	245.0	45.0	2	1.98	
96	0.793	15.1	245.0	45.0	3	2.68	
97	0.793	15.1	245.0	45.0	4	1.91	
98	0.793	15.1	245.0	45.0	5	2.89	
99	0.793	15.1	245.0	45.0	6	2.05	
100	0.793	15.1	245.0	45.0	7	2.86	
101	0.793	15.1	245.0	45.0	8	2.05	
102	0.793	15.1	245.0	45.0	9	2.95	
103	0.793	15.1	245.0	45.0	10	2.05	
104	0.793	15.1	326.0	45.0	1	2.95	
105	0.793	15.1	326.0	45.0	2	2.59	
106	0.793	15.1	326.0	45.0	3	3.09	
107	0.793	15.1	326.0	45.0	4	2.95	
108	0.793	15.1	326.0	45.0	5	2.73	
109	0.793	15.1	326.0	45.0	6	2.95	
110	0.793	15.1	326.0	45.0	7	3.18	
111	0.793	15.1	165.0	60.0	1	0.77	
112	0.793	15.1	165.0	60.0	2	0.45	
113	0.793	15.1	165.0	60.0	3	0.45	
114	0.793	15.1	165.0	60.0	4	0.50	
115	0.793	15.1	165.0	60.0	5	0.50	
116	0.793	15.1	245.0	60.0	1	2.59	
117	0.793	15.1	245.0	60.0	2	2.59	
118	0.793	15.1	245.0	60.0	3	2.59	
119	0.793	15.1	245.0	60.0	4	2.59	
120	0.793	15.1	326.0	60.0	1	3.23	
121	0.793	15.1	326.0	60.0	2	2.23	
122	0.793	15.1	326.0	60.0	3	2.36	
123	0.793	15.1	326.0	60.0	4	3.27	
124	0.793	15.1	326.0	60.0	5	2.32	
125	0.793	15.1	326.0	60.0	6	3.27	
126	0.793	15.1	326.0	60.0	7	2.27	
127	0.793	15.1	326.0	60.0	8	2.32	
128	0.793	15.1	326.0	60.0	9	2.00	
129	0.793	15.1	326.0	60.0	10	3.95	
130	1.000	15.0	165.0	30.0	1	1.70	0.75
131	1.000	15.0	165.0	30.0	2	1.70	0.90

	132	1.000	15.0	165.0	30.0	3	1.50	1.00
	133	1.000	15.0	165.0	30.0	4	1.55	0.75
	134	1.000	15.0	165.0	30.0	5	0.95	0.15
	135	1.000	15.0	165.0	30.0	6	1.70	0.70
	136	1.000	15.0	165.0	30.0	7	0.95	0.35
	137	1.000	15.0	245.0	30.0	1	2.05	0.45
	138	1.000	15.0	245.0	30.0	2	1.90	0.60
	139	1.000	15.0	245.0	30.0	3	3.65	1.25
	140	1.000	15.0	245.0	30.0	4	1.95	0.55
	141	1.000	15.0	245.0	30.0	5	2.70	1.20
	142	1.000	15.0	245.0	30.0	6	1.90	0.70
	143	1.000	15.0	326.0	30.0	1	3.40	1.30
	144	1.000	15.0	326.0	30.0	2	2.55	0.55
	145	1.000	15.0	326.0	30.0	3	2.50	0.50
	146	1.000	15.0	326.0	30.0	4	4.30	1.60
	147	1.000	15.0	326.0	30.0	5	9.25	0.50
AWA	148	1.000	15.0	326.0	30.0	6	1.35	0.15
TIQUE	149	1.000	15.0	326.0	30.0	7	4.40	1.60
	150	1.000	15.1	245.0	45.0	1	2.25	
	151	1.000	15.1	245.0	45.0	2	1.63	
	152	1.000	15.1	245.0	45.0	3	1.63	
	153	1.000	15.1	245.0	45.0	4	1.63	
	154	1.000	15.1	245.0	45.0	5	1.56	
	155	1.000	15.1	245.0	45.0	6	1.56	
	156	1.000	15.1	245.0	45.0	7	1.56	
	157	1.000	15.1	245.0	45.0	8	1.56	
	158	1.000	15.1	245.0	45.0	9	1.56	
	159	1.000	15.1	245.0	45.0	10	1.56	
	160	1.000	15.1	245.0	45.0	11	1.56	
	161	1.000	15.1	245.0	45.0	12	1.56	
	162	1.000	15.1	245.0	45.0	13	1.56	
	163	1.000	15.1	245.0	45.0	14	1.56	
	164	1.000	15.1	245.0	45.0	15	1.56	
	165	1.000	15.1	326.0	60.0	1	2.06	

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

	166	0.594	15.0	326.0	45.0	1	2.70	0.40
	167	0.594	15.0	326.0	45.0	2	2.70	0.35
	168	0.594	15.0	326.0	45.0	3	2.60	0.45
	169	0.594	15.0	326.0	45.0	4	2.60	0.40
	170	0.594	15.0	326.0	45.0	5	2.50	0.45
	171	0.594	15.0	326.0	45.0	6	2.60	0.35
	172	0.793	15.1	165.0	30.0	1	0.29	
	173	0.793	15.1	165.0	30.0	2	0.93	
	174	0.793	15.1	165.0	30.0	3	0.56	
	175	0.793	15.1	165.0	30.0	4	0.49	
	176	0.793	15.1	165.0	30.0	5	0.80	
	177	0.793	15.1	165.0	30.0	6	0.40	
	178	0.793	15.1	165.0	30.0	7	0.84	
	179	0.793	15.1	165.0	30.0	8	0.60	
	180	0.793	15.1	165.0	30.0	9	0.44	
	181	0.793	15.1	245.0	30.0	1	2.56	
	182	0.793	15.1	245.0	30.0	2	1.56	
	183	0.793	15.1	245.0	30.0	3	2.18	
	184	0.793	15.1	245.0	30.0	4	1.96	
	185	0.793	15.1	245.0	30.0	5	1.33	

186	0.793	15.1	245.0	30.0	6	1.56	
187	0.793	15.1	245.0	30.0	7	3.02	
188	0.793	15.1	245.0	30.0	8	2.11	
189	0.793	15.1	245.0	30.0	9	3.24	
190	0.793	15.1	326.0	30.0	1	1.55	
191	0.793	15.1	326.0	30.0	2	1.64	
192	0.793	15.1	326.0	30.0	3	3.27	
193	0.793	15.1	326.0	30.0	4	1.64	
194	0.793	15.1	326.0	30.0	5	1.73	
195	0.793	15.1	326.0	30.0	6	1.73	
196	0.793	15.1	326.0	30.0	7	1.73	
197	0.793	25.0	326.0	30.0	1	3.15	0.60
198	0.793	25.0	326.0	30.0	2	3.40	1.00
199	0.793	25.0	326.0	30.0	3	1.95	0.45
200	0.793	25.0	326.0	30.0	4	1.85	0.50
201	0.793	25.0	326.0	30.0	5	3.30	0.70
202	0.793	25.0	326.0	30.0	6	1.85	0.45
203	0.793	25.0	326.0	30.0	7	3.30	0.75
204	0.793	25.0	326.0	30.0	8	1.85	0.30
205	0.793	25.0	326.0	30.0	9	3.25	0.75
206	0.793	25.0	326.0	30.0	10	4.70	1.10
207	0.793	25.0	326.0	30.0	11	1.90	0.40
208	0.793	25.0	326.0	30.0	12	1.85	0.30
209	0.793	15.1	165.0	45.0	1	0.73	
AWA TIQUE	210	0.793	15.1	165.0	45.0	1	0.73
	211	0.793	15.0	245.0	45.0	1	1.10 0.55
	212	0.793	15.0	245.0	45.0	2	1.05 0.50
	213	0.793	15.0	245.0	45.0	3	1.10 1.05
	214	0.793	15.0	245.0	45.0	4	1.10 0.40
	215	0.793	15.0	245.0	45.0	5	1.10 0.15
	216	0.793	15.1	326.0	45.0	1	1.91
	217	0.793	15.1	326.0	45.0	2	1.91
	218	0.793	15.1	165.0	60.0	1	0.39
	219	0.793	15.1	165.0	60.0	2	0.39
	220	0.793	15.1	165.0	60.0	3	0.39
	221	0.793	15.1	245.0	60.0	1	1.02
	222	0.793	15.1	245.0	60.0	2	1.00
	223	0.793	15.1	245.0	60.0	3	1.77
	224	0.793	15.1	245.0	60.0	4	1.00
	225	0.793	15.1	245.0	60.0	5	1.00
	226	0.793	15.1	245.0	60.0	6	1.77
	227	0.793	15.1	245.0	60.0	7	1.00
	228	0.793	15.1	326.0	60.0	1	1.66
	229	0.793	15.1	326.0	60.0	2	1.66
	230	0.793	15.1	326.0	60.0	3	1.66
	231	1.000	15.1	245.0	30.0	1	2.19
	232	1.000	15.1	245.0	30.0	2	2.19
	233	1.000	15.1	245.0	30.0	3	2.19
	234	1.000	15.1	245.0	30.0	4	2.19
	235	1.000	15.1	245.0	30.0	5	2.19
	236	1.000	15.1	245.0	30.0	6	2.19
	237	1.000	15.1	245.0	30.0	7	2.19
	238	1.000	15.1	245.0	30.0	8	1.19
	239	1.000	15.1	245.0	30.0	9	1.19
	240	1.000	15.1	245.0	30.0	10	1.19
	241	1.000	15.1	326.0	30.0	1	2.88

	242	1.000	15.1	326.0	30.0	2	2.88
	243	1.000	15.1	326.0	30.0	3	1.72
	244	1.000	15.1	326.0	30.0	4	2.41
	245	1.000	15.1	326.0	30.0	5	1.41
	246	1.000	15.1	326.0	30.0	6	1.69
	247	1.000	15.1	326.0	30.0	7	1.69
	248	1.000	15.1	326.0	30.0	8	2.34
	249	1.000	15.1	326.0	30.0	9	1.63
	250	1.000	15.1	326.0	30.0	10	2.25
	251	1.000	15.1	326.0	30.0	11	1.72
	252	1.000	15.1	245.0	45.0	1	1.38
	253	1.000	15.1	245.0	45.0	2	1.33
	254	1.000	15.1	245.0	45.0	3	1.84
	255	1.000	15.1	245.0	45.0	4	1.91
	256	1.000	15.1	245.0	45.0	5	1.41
	257	1.000	15.1	245.0	45.0	6	1.81
	258	1.000	15.1	245.0	45.0	7	1.19
	259	1.000	15.1	245.0	45.0	8	1.16
	260	1.000	15.1	245.0	45.0	9	2.34
AWA TIOUE	261	1.000	15.1	245.0	45.0	10	1.16
	262	1.000	15.1	245.0	45.0	11	1.16
	263	1.000	15.1	245.0	45.0	12	0.66
	264	1.000	15.1	245.0	45.0	13	1.16
	265	1.000	15.1	326.0	60.0	1	1.69
	266	1.000	15.1	326.0	60.0	2	1.64
	267	1.000	15.1	326.0	60.0	3	1.47
	268	1.000	15.1	326.0	60.0	4	2.88
	269	1.000	15.1	326.0	60.0	5	1.72
	270	1.000	15.1	326.0	60.0	6	1.72
	271	1.000	15.1	326.0	60.0	7	1.69
	272	1.000	15.1	326.0	60.0	8	1.72
	273	1.000	15.1	326.0	60.0	9	1.69
	274	1.000	15.1	326.0	60.0	10	1.69
	275	1.000	15.1	326.0	60.0	11	1.69
	276	1.000	15.1	326.0	60.0	12	2.56
	277	1.000	15.1	326.0	60.0	13	1.72
	278	1.000	15.1	326.0	60.0	14	1.72

Table 1-6
Slug Rise Velocities

Run NO.	D _p	H	G	Q _L	Z	L _s	U _s	(U _s) mean
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL								
1	0.594	15.0	165.0	30.0	5.67	2.00	27.68	27.68
2	0.594	15.0	165.0	30.0	8.72	2.50	27.68	27.68
3	0.594	15.0	245.0	30.0	5.47	3.00	30.85	30.85
4	0.594	15.0	245.0	30.0	9.62	3.00	30.85	30.85
5	0.594	15.0	326.0	30.0	8.50	3.80	44.00	44.86
6	0.594	15.0	326.0	30.0	8.70	3.80	45.71	44.86
7	0.594	15.0	245.0	45.0	6.22	1.60	34.37	34.51
8	0.594	15.0	245.0	45.0	8.75	3.00	35.42	34.51
9	0.594	15.0	245.0	45.0	7.97	3.00	33.75	34.51
10	0.594	15.0	326.0	60.0	8.40	3.50	46.51	45.84

11	0.594	15.0	326.0	60.0	8.60	3.50	45.16	45.84
12	0.594	40.0	245.0	30.0	5.95	3.00	34.55	34.47
13	0.594	40.0	245.0	30.0	22.95	3.00	34.55	34.47
14	0.594	40.0	245.0	30.0	32.52	3.00	35.45	34.47
15	0.594	40.0	245.0	30.0	5.50	3.00	33.33	34.47
16	0.793	15.0	165.0	30.0	4.92	0.75	16.87	16.77
17	0.793	15.0	165.0	30.0	5.17	1.85	17.22	16.77
18	0.793	15.0	165.0	30.0	7.77	1.75	16.11	16.77
19	0.793	15.0	165.0	30.0	9.42	0.75	16.87	16.77
20	0.793	15.0	245.0	30.0	4.20	3.40	20.59	20.59
21	0.793	15.0	245.0	30.0	8.35	3.40	20.59	20.59
22	0.793	15.0	245.0	30.0	10.60	3.40	20.59	20.59
23	0.793	15.0	326.0	30.0	7.13	2.55	27.94	27.59
24	0.793	15.0	326.0	30.0	6.57	2.55	27.04	27.59
25	0.793	15.0	326.0	30.0	9.60	2.55	26.47	27.59
26	0.793	15.0	326.0	30.0	4.61	2.30	29.36	27.59
27	0.793	15.0	326.0	30.0	7.41	2.38	27.23	27.59
28	0.793	15.0	326.0	30.0	10.67	2.30	26.60	27.59
29	0.793	15.0	165.0	45.0	9.30	2.20	16.00	16.19
30	0.793	15.0	165.0	45.0	8.25	1.10	16.00	16.19
31	0.793	15.0	165.0	45.0	5.35	1.70	16.57	16.19
32	0.793	15.0	245.0	45.0	5.40	1.00	25.00	23.74
33	0.793	15.0	245.0	45.0	6.63	1.05	23.11	23.74
34	0.793	15.0	245.0	45.0	8.32	2.70	23.11	23.74
35	0.793	15.0	326.0	45.0	5.52	3.00	28.51	28.51
36	0.793	15.0	326.0	45.0	9.02	2.60	28.51	28.51
37	0.793	15.0	165.0	60.0	4.27	0.50	16.67	16.88
38	0.793	15.0	165.0	60.0	4.85	0.50	16.13	16.88
39	0.793	15.0	165.0	60.0	5.00	0.50	18.87	16.88
40	0.793	15.0	165.0	60.0	6.90	0.50	17.24	16.88
41	0.793	15.0	165.0	60.0	7.65	0.50	15.87	16.88
42	0.793	15.0	165.0	60.0	9.10	0.50	17.54	16.88
43	0.793	15.0	165.0	60.0	10.55	0.50	15.87	16.88
44	0.793	15.0	245.0	60.0	5.57	2.40	23.37	22.87
45	0.793	15.0	245.0	60.0	8.85	2.45	22.83	22.87
46	0.793	15.0	245.0	60.0	3.82	1.35	22.41	22.87
47	0.793	15.0	326.0	60.0	7.27	2.20	29.25	28.60
48	0.793	15.0	326.0	60.0	6.35	3.20	27.87	28.60
49	0.793	15.0	326.0	60.0	10.13	2.20	28.69	28.60
50	0.793	25.0	165.0	30.0	6.20	0.70	13.81	14.67
51	0.793	25.0	165.0	30.0	7.35	1.50	14.92	14.67
52	0.793	25.0	165.0	30.0	9.45	1.60	16.02	14.57
53	0.793	25.0	165.0	30.0	11.02	1.30	14.64	14.67
54	0.793	25.0	165.0	30.0	12.85	1.55	14.36	14.67
55	0.793	25.0	165.0	30.0	15.00	0.70	14.92	14.57
56	0.793	25.0	165.0	30.0	15.77	1.30	14.64	14.67
57	0.793	25.0	165.0	30.0	17.85	1.45	14.36	14.67
58	0.793	25.0	165.0	30.0	19.30	1.30	14.36	14.57
59	0.793	25.0	245.0	30.0	8.55	3.60	20.16	19.67
60	0.793	25.0	245.0	30.0	12.45	2.05	19.38	19.67
61	0.793	25.0	245.0	30.0	15.42	3.50	19.77	19.67
62	0.793	25.0	245.0	30.0	19.35	2.10	19.38	19.67
63	0.793	25.0	326.0	30.0	9.40	7.80	26.95	26.58
64	0.793	25.0	326.0	30.0	16.52	7.50	26.42	26.68
65	0.793	25.0	165.0	45.0	7.47	1.85	17.91	17.74
66	0.793	25.0	165.0	45.0	9.80	1.85	17.65	17.74

67	0.793	25.0	165.0	45.0	12.12	2.10	17.91	17.74
68	0.793	25.0	165.0	45.0	14.55	1.75	17.65	17.74
69	0.793	25.0	165.0	45.0	16.60	1.45	17.65	17.74
70	0.793	25.0	165.0	45.0	18.95	2.90	17.65	17.74
71	0.793	25.0	245.0	45.0	6.80	2.05	23.19	23.04
72	0.793	25.0	245.0	45.0	9.37	2.10	25.00	23.04
73	0.793	25.0	245.0	45.0	13.37	1.90	22.10	23.04
74	0.793	25.0	245.0	45.0	14.32	3.68	22.10	23.04
75	0.793	25.0	245.0	45.0	19.02	3.45	22.83	23.04
76	0.793	25.0	326.0	45.0	7.35	3.35	29.70	29.08
77	0.793	25.0	326.0	45.0	11.27	3.25	29.21	29.08
78	0.793	25.0	326.0	45.0	15.20	3.00	28.71	29.08
79	0.793	25.0	326.0	45.0	18.90	3.25	28.71	29.08
80	0.793	25.0	165.0	60.0	5.72	1.30	18.75	18.06
81	0.793	25.0	165.0	60.0	7.32	1.25	18.75	18.06
82	0.793	25.0	165.0	60.0	8.95	1.20	18.06	18.06
83	0.793	25.0	165.0	60.0	10.55	1.20	18.06	18.06
84	0.793	25.0	165.0	60.0	12.15	1.20	18.06	18.06
85	0.793	25.0	165.0	60.0	13.70	1.20	18.06	18.06
86	0.793	25.0	165.0	60.0	15.25	1.20	18.06	18.06
87	0.793	25.0	165.0	60.0	16.85	1.20	18.06	18.06
88	0.793	25.0	165.0	60.0	18.42	1.20	17.36	18.06
89	0.793	25.0	165.0	60.0	19.97	1.20	17.36	18.06
90	0.793	25.0	245.0	60.0	7.10	1.50	22.86	23.04
91	0.793	25.0	245.0	60.0	10.70	3.95	22.14	23.04
92	0.793	25.0	245.0	60.0	14.40	2.75	24.29	23.04
93	0.793	25.0	245.0	60.0	17.75	1.55	22.86	23.04
94	0.793	25.0	326.0	60.0	9.44	2.60	27.88	27.54
95	0.793	25.0	326.0	60.0	12.95	3.90	27.50	27.54
96	0.793	25.0	326.0	60.0	17.87	4.90	27.25	27.54
97	0.793	25.0	326.0	60.0	6.45	2.70	30.30	29.36
98	0.793	25.0	326.0	60.0	10.15	3.65	30.30	29.36
99	0.793	25.0	326.0	60.0	13.97	2.20	28.03	29.36
100	0.793	25.0	326.0	60.0	16.65	3.50	28.79	29.36
101	0.793	40.0	245.0	30.0	6.55	1.70	21.00	20.92
102	0.793	40.0	245.0	30.0	20.85	1.70	21.67	20.92
103	0.793	40.0	245.0	30.0	23.10	1.70	21.00	20.92
104	0.793	40.0	245.0	30.0	33.90	3.10	20.00	20.92
105	0.793	40.0	326.0	30.0	6.50	3.95	24.71	24.71
106	0.793	40.0	326.0	30.0	17.82	4.25	25.29	24.71
107	0.793	40.0	326.0	30.0	34.37	4.00	24.12	24.71
108	0.793	40.0	245.0	45.0	6.55	1.85	21.65	21.48
109	0.793	40.0	245.0	45.0	20.55	1.80	21.65	21.48
110	0.793	40.0	245.0	45.0	34.52	1.80	21.13	21.48
111	0.793	40.0	326.0	45.0	6.95	2.05	27.73	28.05
112	0.793	40.0	326.0	45.0	15.25	4.40	28.57	28.05
113	0.793	40.0	326.0	45.0	20.60	4.30	27.73	28.05
114	0.793	40.0	326.0	45.0	31.52	4.55	28.15	28.05
115	0.793	40.0	245.0	60.0	6.17	1.10	19.57	19.08
116	0.793	40.0	245.0	60.0	18.20	1.00	18.84	19.08
117	0.793	40.0	245.0	60.0	34.35	2.00	18.84	19.08
118	0.793	40.0	326.0	60.0	6.72	2.40	28.12	26.88
119	0.793	40.0	326.0	60.0	9.75	2.40	26.25	26.88
120	0.793	40.0	326.0	60.0	12.40	2.40	27.50	26.88
121	0.793	40.0	326.0	60.0	15.17	2.50	26.88	26.88
122	0.793	40.0	326.0	60.0	18.07	2.40	26.88	26.88

123	0.793	40.0	326.0	60.0	20.95	2.40	26.25	26.88
124	0.793	40.0	326.0	60.0	24.40	4.70	27.50	26.88
125	0.793	40.0	326.0	60.0	30.25	0.0	26.25	26.88
126	0.793	40.0	326.0	60.0	34.60	3.30	26.25	26.88
127	1.000	15.0	165.0	30.0	5.50	0.90	14.71	14.46
128	1.000	15.0	165.0	30.0	9.35	1.55	14.71	14.46
129	1.000	15.0	165.0	30.0	9.30	1.60	13.95	14.46
130	1.000	15.0	245.0	30.0	5.60	2.00	19.35	18.84
131	1.000	15.0	245.0	30.0	8.17	1.90	18.55	18.84
132	1.000	15.0	245.0	30.0	5.00	2.80	18.60	18.84
133	1.000	15.0	326.0	30.0	5.60	2.40	21.05	20.79
134	1.000	15.0	326.0	30.0	8.47	2.50	20.53	20.79
135	1.000	15.0	245.0	45.0	6.17	1.70	16.94	16.61
136	1.000	15.0	245.0	45.0	8.70	2.30	16.53	16.61
137	1.000	15.0	245.0	45.0	8.45	2.30	16.36	16.61
138	1.000	15.0	326.0	60.0	6.02	2.10	20.50	20.32
139	1.000	15.0	326.0	60.0	8.60	2.10	20.00	20.32
140	1.000	15.0	326.0	60.0	8.45	2.10	20.45	20.32
141	1.000	40.0	245.0	30.0	6.07	1.55	16.32	16.18
142	1.000	40.0	245.0	30.0	12.47	1.65	16.32	16.18
143	1.000	40.0	245.0	30.0	19.35	2.30	15.79	16.18
144	1.000	40.0	245.0	30.0	26.30	1.60	15.79	16.18
145	1.000	40.0	245.0	30.0	8.85	1.60	16.67	16.18

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 2 : 1)

146	0.793	15.0	245.0	30.0	6.78	2.65	20.47	20.61
147	0.793	15.0	245.0	30.0	9.77	1.90	20.75	20.61
148	0.793	40.0	245.0	30.0	22.50	3.45	20.83	18.52
149	0.793	40.0	245.0	30.0	34.15	0.50	20.83	18.52
150	0.793	40.0	245.0	30.0	47.20	1.70	13.89	18.52

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 1 : 1)

151	0.793	15.0	245.0	30.0	6.38	1.40	21.43	20.60
152	0.793	15.0	245.0	30.0	7.88	0.90	20.33	20.60
153	0.793	15.0	245.0	30.0	8.77	0.95	20.33	20.60
154	0.793	15.0	245.0	30.0	10.07	0.95	20.33	20.60
155	0.793	40.0	326.0	30.0	22.52	1.90	24.80	25.20
156	0.793	40.0	326.0	30.0	27.07	1.90	24.80	25.20
157	0.793	40.0	326.0	30.0	31.87	1.90	25.61	25.20
158	0.793	40.0	326.0	30.0	47.92	1.90	25.61	25.20

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 1 : 2)

159	0.793	15.0	245.0	30.0	5.95	0.95	20.29	19.02
160	0.793	15.0	245.0	30.0	6.97	0.95	18.12	19.02
161	0.793	15.0	245.0	30.0	8.25	1.65	18.84	19.02
162	0.793	15.0	245.0	30.0	10.30	1.65	18.84	19.02
163	0.793	40.0	326.0	30.0	22.30	1.90	25.21	24.93
164	0.793	40.0	326.0	30.0	31.20	1.90	25.21	24.93
165	0.793	40.0	326.0	30.0	46.50	1.90	24.37	24.93

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

166	0.594	15.0	165.0	30.0	5.65	0.80	18.06	18.34
167	0.594	15.0	165.0	30.0	9.05	0.80	18.06	18.34
168	0.594	15.0	165.0	30.0	9.05	0.80	18.92	18.34
169	0.594	15.0	245.0	30.0	5.90	2.50	30.77	30.77
170	0.594	15.0	245.0	30.0	8.90	2.50	30.77	30.77
171	0.594	15.0	326.0	30.0	5.90	2.70	38.46	38.46

172	0.594	15.0	326.0	30.0	9.40	2.70	38.46	38.46
173	0.594	15.0	245.0	45.0	5.60	2.50	32.51	32.85
174	0.594	15.0	245.0	45.0	9.25	2.50	32.61	32.85
175	0.594	15.0	245.0	45.0	8.30	2.50	33.33	32.85
176	0.594	15.0	326.0	45.0	5.55	3.20	39.02	38.40
177	0.594	15.0	326.0	45.0	9.25	2.50	39.02	38.40
178	0.594	15.0	326.0	45.0	8.25	2.50	37.14	38.40
179	0.594	40.0	326.0	30.0	6.82	2.80	40.20	40.07
180	0.594	40.0	326.0	30.0	16.55	5.00	39.22	40.07
181	0.594	40.0	326.0	30.0	28.50	5.00	39.22	40.07
182	0.594	40.0	326.0	30.0	6.25	2.80	41.57	40.07
183	0.594	40.0	326.0	60.0	5.55	4.70	40.00	34.79
184	0.594	40.0	326.0	60.0	19.22	2.20	16.25	34.79
185	0.594	40.0	326.0	60.0	28.67	4.70	41.25	34.79
186	0.594	40.0	326.0	60.0	20.00	2.40	41.67	34.79
187	0.793	15.0	165.0	30.0	5.10	0.40	16.39	15.88
188	0.793	15.0	165.0	30.0	7.10	0.40	15.50	15.88
189	0.793	15.0	165.0	30.0	9.10	0.40	15.63	15.88
190	0.793	15.0	165.0	30.0	7.40	1.00	16.39	15.88
191	0.793	15.0	165.0	30.0	9.40	1.00	15.50	15.88
192	0.793	15.0	245.0	30.0	5.82	1.35	21.85	21.85
193	0.793	15.0	245.0	30.0	7.82	1.35	21.85	21.85
194	0.793	15.0	245.0	30.0	9.62	2.20	21.85	21.85
195	0.793	15.0	326.0	30.0	5.20	1.70	24.76	24.91
196	0.793	15.0	326.0	30.0	7.42	1.70	25.24	24.91
197	0.793	15.0	326.0	30.0	9.17	1.60	24.29	24.91
198	0.793	15.0	326.0	30.0	5.88	1.75	26.00	24.91
199	0.793	15.0	326.0	30.0	7.82	1.60	24.53	24.91
200	0.793	15.0	326.0	30.0	10.27	1.60	24.67	24.91
201	0.793	15.0	165.0	45.0	9.55	0.70	16.28	15.70
202	0.793	15.0	165.0	45.0	8.75	0.70	16.28	15.70
203	0.793	15.0	165.0	45.0	4.95	0.65	13.95	15.70
204	0.793	15.0	165.0	45.0	4.00	0.65	16.28	15.70
205	0.793	15.0	165.0	45.0	7.75	0.65	16.33	16.33
206	0.793	15.0	245.0	45.0	5.27	1.10	21.23	21.41
207	0.793	15.0	245.0	45.0	6.75	1.10	21.92	21.41
208	0.793	15.0	245.0	45.0	8.17	1.10	21.23	21.41
209	0.793	15.0	245.0	45.0	9.27	1.10	21.23	21.41
210	0.793	15.0	245.0	45.0	5.05	1.10	21.43	21.41
211	0.793	15.0	326.0	45.0	5.05	1.70	26.44	26.44
212	0.793	15.0	326.0	45.0	7.35	1.75	26.44	26.44
213	0.793	15.0	326.0	45.0	9.60	1.80	26.44	26.44
214	0.793	15.0	165.0	60.0	4.80	0.40	19.18	18.76
215	0.793	15.0	165.0	60.0	10.65	0.40	18.33	18.76
216	0.793	15.0	245.0	60.0	5.72	1.00	23.24	22.68
217	0.793	15.0	245.0	60.0	5.95	0.90	22.54	22.68
218	0.793	15.0	245.0	60.0	7.15	0.90	22.54	22.68
219	0.793	15.0	245.0	60.0	8.37	0.90	23.24	22.68
220	0.793	15.0	245.0	60.0	9.52	0.90	21.83	22.68
221	0.793	15.0	326.0	60.0	4.46	1.60	26.40	25.60
222	0.793	15.0	326.0	60.0	6.50	1.60	26.00	25.60
223	0.793	15.0	326.0	60.0	8.57	1.60	25.00	25.60
224	0.793	15.0	326.0	60.0	10.57	1.60	25.00	25.60
225	0.793	25.0	165.0	30.0	5.72	0.80	7.92	13.27
226	0.793	25.0	165.0	30.0	6.67	0.75	7.08	13.27
227	0.793	25.0	165.0	30.0	7.65	0.80	7.50	13.27

228	0.793	25.0	165.0	30.0	8.97	0.75	15.42	13.27
229	0.793	25.0	165.0	30.0	9.90	0.75	15.00	13.27
230	0.793	25.0	165.0	30.0	10.90	0.75	15.00	13.27
231	0.793	25.0	165.0	30.0	11.67	0.75	15.42	13.27
232	0.793	25.0	165.0	30.0	12.85	0.85	15.00	13.27
233	0.793	25.0	165.0	30.0	13.70	0.70	15.00	13.27
234	0.793	25.0	165.0	30.0	14.47	0.75	14.58	13.27
235	0.793	25.0	165.0	30.0	15.70	1.30	15.00	13.27
236	0.793	25.0	165.0	30.0	17.57	1.30	14.58	13.27
237	0.793	25.0	165.0	30.0	19.70	1.85	15.00	13.27
238	0.793	25.0	165.0	30.0	11.87	0.75	14.81	14.81
239	0.793	25.0	165.0	30.0	18.67	0.75	14.81	14.81
240	0.793	25.0	245.0	30.0	5.20	1.10	20.00	19.37
241	0.793	25.0	245.0	30.0	6.85	1.50	20.00	19.37
242	0.793	25.0	245.0	30.0	8.75	1.60	20.00	19.37
243	0.793	25.0	245.0	30.0	11.00	1.70	20.00	19.37
244	0.793	25.0	245.0	30.0	12.77	1.55	19.17	19.37
245	0.793	25.0	245.0	30.0	16.17	2.60	19.17	19.37
246	0.793	25.0	245.0	30.0	18.17	1.60	19.17	19.37
247	0.793	25.0	245.0	30.0	20.07	1.55	17.50	19.37
248	0.793	25.0	245.0	30.0	7.15	1.60	20.65	19.66
249	0.793	25.0	245.0	30.0	9.25	1.60	18.48	19.66
250	0.793	25.0	245.0	30.0	12.65	2.35	20.65	19.66
251	0.793	25.0	245.0	30.0	13.67	1.05	19.02	19.66
252	0.793	25.0	245.0	30.0	16.65	2.35	19.57	19.66
253	0.793	25.0	245.0	30.0	19.70	2.40	19.57	19.66
254	0.793	25.0	326.0	30.0	7.22	1.85	25.95	25.82
255	0.793	25.0	326.0	30.0	9.57	1.90	25.95	25.82
256	0.793	25.0	326.0	30.0	13.47	3.30	25.95	25.82
257	0.793	25.0	326.0	30.0	15.22	1.70	25.95	25.82
258	0.793	25.0	326.0	30.0	19.60	3.30	25.32	25.82
259	0.793	25.0	326.0	30.0	7.25	1.85	26.52	25.95
260	0.793	25.0	326.0	30.0	9.77	2.65	26.14	25.95
261	0.793	25.0	326.0	30.0	13.50	4.70	25.76	25.95
262	0.793	25.0	326.0	30.0	18.92	3.10	25.38	25.95
263	0.793	25.0	165.0	45.0	5.57	0.75	17.47	17.58
264	0.793	25.0	165.0	45.0	6.38	0.75	17.47	17.58
265	0.793	25.0	165.0	45.0	7.50	1.30	18.07	17.58
266	0.793	25.0	165.0	45.0	9.70	1.00	18.07	17.58
267	0.793	25.0	165.0	45.0	10.87	1.40	17.47	17.58
268	0.793	25.0	165.0	45.0	12.80	0.75	18.07	17.58
269	0.793	25.0	165.0	45.0	13.55	0.40	16.87	17.58
270	0.793	25.0	165.0	45.0	14.32	1.80	17.47	17.58
271	0.793	25.0	165.0	45.0	16.97	0.90	17.47	17.58
272	0.793	25.0	165.0	45.0	18.17	0.90	17.47	17.58
273	0.793	25.0	165.0	45.0	19.87	0.90	17.47	17.58
274	0.793	25.0	245.0	45.0	6.32	1.00	21.37	20.85
275	0.793	25.0	245.0	45.0	7.80	1.75	20.97	20.85
276	0.793	25.0	245.0	45.0	10.10	1.80	20.97	20.85
277	0.793	25.0	245.0	45.0	12.40	1.75	20.97	20.85
278	0.793	25.0	245.0	45.0	14.67	1.75	20.56	20.85
279	0.793	25.0	245.0	45.0	16.97	1.75	20.56	20.85
280	0.793	25.0	245.0	45.0	19.32	1.75	20.56	20.85
281	0.793	25.0	326.0	45.0	6.77	1.90	26.62	26.08
282	0.793	25.0	326.0	45.0	9.07	1.90	26.52	26.08
283	0.793	25.0	326.0	45.0	11.45	1.90	25.97	26.08

284	0.793	25.0	326.0	45.0	13.65	1.90	25.97	26.08
285	0.793	25.0	326.0	45.0	16.02	1.90	25.32	26.08
286	0.793	25.0	326.0	45.0	18.35	1.80	25.97	26.08
287	0.793	25.0	245.0	60.0	6.92	1.45	21.02	20.74
288	0.793	25.0	245.0	60.0	9.02	1.45	21.02	20.74
289	0.793	25.0	245.0	60.0	11.05	1.40	20.45	20.74
290	0.793	25.0	245.0	60.0	13.02	1.45	21.02	20.74
291	0.793	25.0	245.0	60.0	15.10	1.45	20.45	20.74
292	0.793	25.0	245.0	60.0	17.07	0.95	21.02	20.74
293	0.793	25.0	245.0	60.0	18.65	0.80	20.45	20.74
294	0.793	25.0	245.0	60.0	19.45	1.50	20.45	20.74
295	0.793	25.0	326.0	60.0	6.57	2.05	26.35	26.08
296	0.793	25.0	326.0	60.0	9.47	2.90	26.35	26.08
297	0.793	25.0	326.0	60.0	12.57	1.02	26.35	26.08
298	0.793	25.0	326.0	60.0	14.85	4.25	25.68	26.08
299	0.793	25.0	326.0	60.0	19.65	1.90	25.68	26.08
300	0.793	40.0	245.0	30.0	6.50	1.90	19.80	19.72
301	0.793	40.0	245.0	30.0	10.17	1.10	19.31	19.72
302	0.793	40.0	245.0	30.0	12.15	2.20	19.80	19.72
303	0.793	40.0	245.0	30.0	17.95	1.20	19.80	19.72
304	0.793	40.0	245.0	30.0	24.25	2.00	19.80	19.72
305	0.793	40.0	245.0	30.0	34.10	2.30	19.80	19.72
306	0.793	40.0	326.0	30.0	6.82	2.95	24.50	24.24
307	0.793	40.0	326.0	30.0	10.06	1.75	24.20	24.24
308	0.793	40.0	326.0	30.0	18.42	1.75	24.50	24.24
309	0.793	40.0	326.0	30.0	24.70	1.70	24.00	24.24
310	0.793	40.0	326.0	30.0	31.80	3.40	24.00	24.24
311	0.793	40.0	245.0	45.0	6.32	2.00	21.43	21.41
312	0.793	40.0	245.0	45.0	8.77	1.20	21.30	21.41
313	0.793	40.0	245.0	45.0	10.28	1.20	20.78	21.41
314	0.793	40.0	245.0	45.0	15.42	2.00	21.43	21.41
315	0.793	40.0	245.0	45.0	24.02	2.00	21.43	21.41
316	0.793	40.0	245.0	45.0	34.75	2.00	22.08	21.41
317	0.793	40.0	326.0	45.0	6.67	1.85	25.54	25.33
318	0.793	40.0	326.0	45.0	15.42	1.85	25.54	25.33
319	0.793	40.0	326.0	45.0	19.95	1.65	25.00	25.33
320	0.793	40.0	326.0	45.0	24.65	1.85	25.00	25.33
321	0.793	40.0	326.0	45.0	32.82	1.85	25.54	25.33
322	0.793	40.0	245.0	60.0	6.15	0.40	16.92	15.96
323	0.793	40.0	245.0	60.0	17.02	0.40	16.15	15.96
324	0.793	40.0	245.0	60.0	27.30	0.40	15.38	15.96
325	0.793	40.0	245.0	60.0	34.55	0.40	15.38	15.96
326	0.793	40.0	245.0	60.0	6.35	1.55	21.92	21.92
327	0.793	40.0	245.0	60.0	9.70	1.20	21.92	21.92
328	0.793	40.0	245.0	60.0	13.37	1.60	22.60	21.92
329	0.793	40.0	245.0	60.0	20.02	1.30	21.23	21.92
330	0.793	40.0	245.0	60.0	26.12	1.60	22.60	21.92
331	0.793	40.0	245.0	60.0	33.72	1.30	21.23	21.92
332	0.793	40.0	326.0	60.0	6.77	1.90	31.44	26.75
333	0.793	40.0	326.0	60.0	9.32	1.85	26.29	26.75
334	0.793	40.0	326.0	60.0	11.97	2.00	28.35	26.75
335	0.793	40.0	326.0	60.0	14.05	1.50	25.77	26.75
336	0.793	40.0	326.0	60.0	16.10	1.80	25.77	26.75
337	0.793	40.0	326.0	60.0	18.42	1.90	26.29	26.75
338	0.793	40.0	326.0	60.0	20.77	1.85	26.29	26.75
339	0.793	40.0	326.0	60.0	23.17	1.70	25.26	26.75

340	0.793	40.0	326.0	60.0	25.97	3.00	26.29	26.75
341	0.793	40.0	326.0	60.0	33.75	1.85	25.77	26.75
342	1.000	15.0	165.0	30.0	5.72	0.40	19.33	15.84
343	1.000	15.0	165.0	30.0	6.25	0.60	16.00	15.84
344	1.000	15.0	165.0	30.0	10.10	0.70	13.33	15.84
345	1.000	15.0	165.0	30.0	5.70	0.30	16.88	15.84
346	1.000	15.0	165.0	30.0	9.32	0.70	13.54	15.84
347	1.000	15.0	245.0	30.0	5.45	1.40	16.67	16.67
348	1.000	15.0	245.0	30.0	7.50	1.40	16.67	16.67
349	1.000	15.0	245.0	30.0	9.65	1.40	16.67	16.67
350	1.000	15.0	245.0	30.0	9.15	1.40	16.67	16.67
351	1.000	15.0	326.0	30.0	6.21	1.70	19.52	19.45
352	1.000	15.0	326.0	30.0	8.50	1.70	19.23	19.45
353	1.000	15.0	326.0	30.0	8.30	2.80	19.51	19.45
354	1.000	15.0	245.0	45.0	5.90	1.30	17.44	17.42
355	1.000	15.0	245.0	45.0	8.45	1.85	17.44	17.42
356	1.000	15.0	245.0	45.0	8.90	1.85	17.39	17.42
357	1.000	15.0	326.0	60.0	5.77	1.60	21.20	20.82
358	1.000	15.0	326.0	60.0	10.36	1.70	20.43	20.82
359	1.000	15.0	326.0	60.0	8.20	2.85	20.83	20.82
360	1.000	40.0	245.0	30.0	5.75	1.10	16.85	16.95
361	1.000	40.0	245.0	30.0	11.30	1.10	16.85	16.95
362	1.000	40.0	245.0	30.0	18.55	1.10	16.85	16.95
363	1.000	40.0	245.0	30.0	25.07	1.10	16.29	16.95
364	1.000	40.0	245.0	30.0	6.88	1.10	18.29	16.95
365	1.000	40.0	245.0	30.0	7.80	1.40	17.07	16.95
366	1.000	40.0	245.0	30.0	21.97	1.80	16.46	16.95

SYSTEM: N-HEXANE-HELIUM-HEAVY PARAFFIN OIL

367	0.793	15.0	165.0	45.0	6.50	1.50	17.39	17.39
368	0.793	15.0	165.0	45.0	9.25	1.15	17.39	17.39
369	0.793	15.0	245.0	30.0	6.50	1.80	20.62	20.36
370	0.793	15.0	245.0	30.0	9.57	1.80	20.10	20.36
371	0.793	15.0	326.0	30.0	6.40	2.40	22.22	22.22
372	0.793	15.0	326.0	30.0	9.37	2.40	22.22	22.22
373	0.793	40.0	245.0	30.0	9.91	2.33	20.00	20.38
374	0.793	40.0	245.0	30.0	18.15	2.33	20.97	20.38
375	0.793	40.0	245.0	30.0	29.25	2.33	20.16	20.38
376	0.793	40.0	326.0	60.0	10.67	3.15	28.33	28.70
377	0.793	40.0	326.0	60.0	18.40	3.15	28.89	28.70
378	0.793	40.0	326.0	60.0	26.20	3.15	28.89	28.70

SYSTEM: N-HEXANE-HELIUM-LIGHT PARAFFIN OIL

379	0.793	15.0	165.0	30.0	8.65	0.40	15.18	15.53
380	0.793	15.0	165.0	30.0	7.70	0.40	15.87	15.53
381	0.793	15.0	245.0	45.0	6.90	2.00	25.32	25.42
382	0.793	15.0	245.0	45.0	10.40	1.90	25.53	25.42
383	0.793	15.0	326.0	60.0	6.82	1.80	27.48	27.25
384	0.793	15.0	326.0	60.0	9.50	1.70	27.03	27.25
385	0.793	40.0	245.0	30.0	9.24	1.90	21.27	21.17
386	0.793	40.0	245.0	30.0	20.72	1.90	22.15	21.17
387	0.793	40.0	245.0	30.0	30.17	0.90	20.89	21.17
388	0.793	40.0	245.0	30.0	28.44	1.90	20.36	21.17
389	0.793	40.0	326.0	30.0	9.80	2.10	26.32	26.32
390	0.793	40.0	326.0	30.0	19.55	2.10	26.32	26.32
391	0.793	40.0	326.0	30.0	30.00	2.10	26.32	26.32

SYSTEM: N-HEXANE-FREON-14-HEAVY PARAFFIN OIL

392	0.793	15.0	165.0	30.0	6.22	1.00	14.22	14.57
393	0.793	15.0	165.0	30.0	9.91	0.95	14.91	14.57
394	0.793	15.0	245.0	30.0	6.40	1.75	18.35	18.35
395	0.793	15.0	245.0	30.0	8.65	3.45	18.35	18.35
396	0.793	15.0	326.0	30.0	6.32	3.70	21.83	20.99
397	0.793	15.0	326.0	30.0	10.35	1.40	21.13	20.99
398	0.793	15.0	326.0	30.0	7.40	2.50	20.00	20.99
399	0.793	15.0	326.0	60.0	6.40	1.30	23.26	24.13
400	0.793	15.0	326.0	60.0	8.57	1.80	25.00	24.13
401	0.793	40.0	326.0	30.0	12.77	3.20	19.71	19.45
402	0.793	40.0	326.0	30.0	21.32	2.20	19.71	19.45
403	0.793	40.0	326.0	30.0	28.00	3.50	19.23	19.45
404	0.793	40.0	326.0	30.0	34.15	2.20	19.15	19.45

SYSTEM: N-HEXANE-FREON-14-LIGHT PARAFFIN OIL

405	0.793	15.0	165.0	30.0	6.50	0.25	12.50	12.50
406	0.793	15.0	165.0	30.0	8.90	0.25	12.50	12.50
407	0.793	15.0	245.0	30.0	6.75	0.40	17.44	17.44
408	0.793	15.0	326.0	30.0	6.40	1.30	19.42	19.18
409	0.793	15.0	326.0	30.0	6.40	2.40	18.69	19.17
410	0.793	15.0	326.0	30.0	9.20	1.30	19.42	19.18
411	0.793	40.0	326.0	30.0	20.70	1.25	17.50	18.44
412	0.793	40.0	326.0	30.0	27.37	1.20	18.12	18.44
413	0.793	40.0	326.0	30.0	21.40	1.90	19.23	18.44
414	0.793	40.0	326.0	30.0	21.75	1.90	18.89	18.44

Table 1-7

Bubble Formation Lengths h_o

Run NO.	D_p	H	G	Q_L	μ_L	ρ_g	h_o
1	0.793	15.1	165.0	30.0	142.0	0.0012850	0.546
2	0.793	15.1	245.0	30.0	142.0	0.0012850	0.909
3	0.793	15.1	326.0	30.0	142.0	0.0012850	1.485
4	0.793	40.0	245.0	30.0	142.0	0.0012850	1.005
5	0.793	15.1	245.0	45.0	142.0	0.0012850	0.754
6	0.793	40.0	326.0	30.0	142.0	0.0012850	1.183
7	0.793	40.0	326.0	60.0	142.0	0.0012850	1.354
8	0.793	15.1	245.0	30.0	40.0	0.0012850	0.652
9	0.793	15.1	326.0	30.0	40.0	0.0012850	1.046
10	0.793	15.1	326.0	60.0	40.0	0.0012850	0.908
11	0.793	15.1	165.0	30.0	40.0	0.0012850	0.492
12	0.793	40.0	245.0	30.0	40.0	0.0012850	0.706
13	0.793	40.0	326.0	30.0	40.0	0.0012850	0.794
14	0.793	40.0	326.0	60.0	40.0	0.0012850	1.008
15	0.793	15.1	245.0	30.0	92.1	0.0012850	0.898
16	0.793	15.1	245.0	30.0	72.2	0.0012850	0.793
17	0.793	15.1	245.0	30.0	61.5	0.0012850	0.742
18	0.793	40.0	245.0	30.0	142.0	0.0002185	1.104
19	0.793	40.0	245.0	30.0	40.0	0.0002185	0.915
20	0.793	15.1	165.0	30.0	40.0	0.0002185	0.597

21	0.793	15.1	245.0	45.0	40.0	0.0002185	0.871
22	0.793	15.1	326.0	60.0	40.0	0.0002185	0.855
23	0.793	15.1	245.0	30.0	142.0	0.0002185	1.169
24	0.793	15.1	165.0	45.0	142.0	0.0002185	0.790
25	0.793	15.1	165.0	45.0	142.0	0.0002185	0.790
26	0.793	15.1	165.0	30.0	142.0	0.0038810	0.758
27	0.793	15.1	245.0	30.0	142.0	0.0038810	1.129
28	0.793	15.1	326.0	60.0	142.0	0.0038810	1.174
29	0.793	15.1	165.0	30.0	40.0	0.0038810	0.323
30	0.793	15.1	245.0	30.0	40.0	0.0038810	0.484
31	0.793	15.1	326.0	30.0	40.0	0.0038810	0.758
32	1.000	15.1	165.0	30.0	142.0	0.0012850	0.812
33	1.000	15.1	245.0	30.0	142.0	0.0012850	1.078
34	1.000	15.1	326.0	30.0	142.0	0.0012850	1.187
35	1.000	15.1	245.0	45.0	142.0	0.0012850	0.922
36	1.000	15.1	326.0	60.0	142.0	0.0012850	1.289
37	1.000	15.1	165.0	30.0	43.0	0.0012850	0.391
38	1.000	15.1	165.0	30.0	43.0	0.0012850	0.424
39	1.000	15.1	245.0	30.0	43.0	0.0012850	0.580
40	1.000	15.1	326.0	30.0	43.0	0.0012850	1.047
41	1.000	15.1	245.0	45.0	43.0	0.0012850	0.719
42	1.000	15.1	326.0	60.0	43.0	0.0012850	0.734
43	0.594	15.1	165.0	30.0	43.0	0.0012850	0.682
44	0.594	15.1	245.0	30.0	43.0	0.0012850	1.061
45	0.594	15.1	326.0	30.0	43.0	0.0012850	1.205
46	0.594	15.1	245.0	45.0	43.0	0.0012850	1.116
47	0.594	15.1	326.0	45.0	43.0	0.0012850	1.197
48	0.594	15.1	165.0	30.0	142.0	0.0012850	0.879
49	0.594	15.1	245.0	30.0	142.0	0.0012850	1.364
50	0.594	15.1	326.0	30.0	142.0	0.0012850	1.506
51	0.594	15.1	245.0	45.0	142.0	0.0012850	1.439
52	0.594	15.1	326.0	60.0	142.0	0.0012850	1.394

Table 1-8

Total and Unit Pressure Drops

Run NO.	D _p	H	G	Q _L	Y _{on}	ΔP _T inch	ΔP _T cm	$\frac{1}{\rho_L} \left(\frac{\Delta P_T}{\Delta H} \right)$
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL								
1	0.594	7.8	165.0	30.0	0.0530	2.60	6.604	0.800
2	0.594	11.0	165.0	30.0	0.0530	3.55	9.017	0.770
3	0.594	14.0	165.0	30.0	0.0530	4.50	11.430	0.767
4	0.594	20.8	165.0	30.0	0.0530	7.10	18.034	0.814
5	0.594	20.8	165.0	30.0	0.0530	6.80	17.272	0.780
6	0.594	30.0	165.0	30.0	0.0530	9.30	23.622	0.739
7	0.594	7.8	165.0	45.0	0.0530	3.30	8.382	1.016
8	0.594	11.0	165.0	45.0	0.0530	4.90	12.446	1.063
9	0.594	14.0	165.0	45.0	0.0530	6.00	15.240	1.022
10	0.594	20.8	165.0	45.0	0.0530	9.30	23.622	1.067
11	0.594	20.8	165.0	45.0	0.0530	8.50	21.590	0.975
12	0.594	30.0	165.0	45.0	0.0530	18.00	45.720	1.431
13	0.594	30.0	165.0	45.0	0.0530	10.80	27.432	0.859
14	0.594	7.8	165.0	60.0	0.0530	4.00	10.160	1.231
15	0.594	11.0	165.0	60.0	0.0530	5.60	14.224	1.214

	16	0.594	14.0	165.0	60.0	0.0530	6.80	17.272	1.159
	17	0.594	20.8	165.0	60.0	0.0530	13.50	34.290	1.548
	18	0.594	20.8	165.0	60.0	0.0530	10.90	27.686	1.250
	19	0.594	7.8	245.0	30.0	0.0530	2.40	6.096	0.739
	20	0.594	14.0	245.0	30.0	0.0530	4.10	10.414	0.699
	21	0.594	30.0	245.0	30.0	0.0530	8.40	21.336	0.668
	22	0.594	40.0	245.0	30.0	0.0530	11.30	28.702	0.674
	23	0.594	7.8	245.0	45.0	0.0530	3.10	7.874	0.954
	24	0.594	14.0	245.0	45.0	0.0530	5.50	13.970	0.937
	25	0.594	30.0	245.0	45.0	0.0530	9.70	24.638	0.771
	26	0.594	40.0	245.0	45.0	0.0530	15.00	38.100	0.895
	27	0.594	40.0	245.0	45.0	0.0530	14.00	35.560	0.835
	28	0.594	7.8	245.0	60.0	0.0530	3.70	9.398	1.139
	29	0.594	11.0	245.0	60.0	0.0530	5.40	13.716	1.171
	30	0.594	14.0	245.0	60.0	0.0530	6.50	16.510	1.108
	31	0.594	30.0	245.0	60.0	0.0530	14.70	37.338	1.169
	32	0.594	7.8	326.0	30.0	0.0530	2.50	6.350	0.769
	33	0.594	14.0	326.0	30.0	0.0530	3.80	9.652	0.647
	34	0.594	30.0	326.0	30.0	0.0530	7.90	20.066	0.628
	35	0.594	40.0	326.0	30.0	0.0530	11.15	28.321	0.665
	36	0.594	7.8	326.0	45.0	0.0530	3.05	7.747	0.939
	37	0.594	14.0	326.0	45.0	0.0530	5.10	12.954	0.869
	38	0.594	30.0	326.0	45.0	0.0530	10.30	26.162	0.819
	39	0.594	40.0	326.0	45.0	0.0530	14.20	36.068	0.847
	40	0.594	7.8	326.0	60.0	0.0530	3.70	9.398	1.139
	41	0.594	14.0	326.0	60.0	0.0530	6.30	16.002	1.073
	42	0.594	30.0	326.0	60.0	0.0530	11.90	30.226	0.946
	43	0.594	40.0	326.0	60.0	0.0530	17.80	45.212	1.061
	44	0.594	40.0	326.0	60.0	0.0530	16.60	42.164	0.990
WA DUE	45	0.793	10.0	165.0	30.0	0.0530	2.70	6.858	0.644
	46	0.793	17.4	165.0	30.0	0.0529	4.60	11.684	0.631
	47	0.793	20.8	165.0	30.0	0.0	5.90	14.986	0.677
	48	0.793	20.8	165.0	30.0	0.0230	5.45	13.843	0.625
	49	0.793	20.8	165.0	30.0	0.0530	5.40	13.716	0.619
	50	0.793	20.8	165.0	30.0	0.0730	5.40	13.716	0.619
	51	0.793	26.5	165.0	30.0	0.0524	6.40	15.256	0.576
	52	0.793	30.0	165.0	30.0	0.0523	7.60	19.304	0.604
	53	0.793	30.0	165.0	30.0	0.0523	7.40	18.796	0.588
	54	0.793	40.0	165.0	30.0	0.0522	13.50	34.290	0.805
	55	0.793	40.0	165.0	30.0	0.0522	8.65	21.971	0.516
	56	0.793	10.0	165.0	45.0	0.0530	3.20	8.128	0.763
	57	0.793	17.4	165.0	45.0	0.0529	5.20	13.208	0.713
	58	0.793	20.8	165.0	45.0	0.0	7.30	18.542	0.837
	59	0.793	20.8	165.0	45.0	0.0230	6.20	15.748	0.711
	60	0.793	20.8	165.0	45.0	0.0530	6.25	15.875	0.717
	61	0.793	20.8	165.0	45.0	0.0730	6.20	15.748	0.711
	62	0.793	26.5	165.0	45.0	0.0524	7.85	19.939	0.707
	63	0.793	26.5	165.0	45.0	0.0524	7.25	18.415	0.653
	64	0.793	30.0	165.0	45.0	0.0523	11.00	27.940	0.875
	65	0.793	30.0	165.0	45.0	0.0523	7.20	18.288	0.572
	66	0.793	10.0	165.0	60.0	0.0530	3.60	9.144	0.859
	67	0.793	17.4	165.0	60.0	0.0529	5.85	14.859	0.802
	68	0.793	20.8	165.0	60.0	0.0	7.75	19.685	0.889
	69	0.793	20.8	165.0	60.0	0.0230	6.65	16.891	0.763
	70	0.793	20.8	165.0	60.0	0.0530	6.75	17.145	0.774
	71	0.793	26.5	165.0	60.0	0.0524	8.50	21.590	0.765

	72	0.793	26.5	165.0	60.0	0.0524	5.10	12.954	0.459
	73	0.793	30.0	165.0	60.0	0.0523	13.00	33.020	1.034
	74	0.793	30.0	165.0	60.0	0.0523	7.90	20.066	0.628
	75	0.793	10.0	245.0	30.0	0.0530	2.45	6.223	0.584
	76	0.793	17.4	245.0	30.0	0.0529	3.80	9.652	0.521
	77	0.793	20.8	245.0	30.0	0.0	5.10	12.954	0.585
	78	0.793	20.8	245.0	30.0	0.0230	4.55	11.557	0.522
	79	0.793	20.8	245.0	30.0	0.0530	4.55	11.557	0.522
	80	0.793	20.8	245.0	30.0	0.0730	4.50	11.430	0.516
	81	0.793	26.5	245.0	30.0	0.0524	5.50	13.970	0.495
	82	0.793	30.0	245.0	30.0	0.0523	5.90	14.986	0.469
	83	0.793	50.0	245.0	30.0	0.0523	10.20	25.908	0.487
	84	0.793	10.0	245.0	45.0	0.0530	2.80	7.112	0.658
	85	0.793	17.4	245.0	45.0	0.0529	4.65	11.811	0.637
	86	0.793	26.5	245.0	45.0	0.0524	6.65	15.891	0.599
	87	0.793	30.0	245.0	45.0	0.0523	7.30	18.542	0.580
	88	0.793	40.0	245.0	45.0	0.0522	10.40	26.416	0.620
	89	0.793	50.0	245.0	45.0	0.0523	11.90	30.226	0.568
	90	0.793	10.0	245.0	60.0	0.0530	3.05	7.747	0.728
	91	0.793	17.4	245.0	60.0	0.0509	5.10	12.954	0.699
	92	0.793	20.8	245.0	60.0	0.0	6.65	15.891	0.753
	93	0.793	20.8	245.0	60.0	0.0230	6.05	15.367	0.694
	94	0.793	20.8	245.0	60.0	0.0530	6.00	15.240	0.688
	95	0.793	20.8	245.0	60.0	0.0730	6.05	15.367	0.694
WA	96	0.793	26.5	245.0	60.0	0.0524	7.50	19.050	0.675
QUE	97	0.793	30.0	245.0	60.0	0.0523	8.80	22.352	0.700
	98	0.793	30.0	245.0	60.0	0.0523	8.05	20.447	0.640
	99	0.793	40.0	245.0	60.0	0.0522	12.60	32.004	0.751
	100	0.793	40.0	245.0	60.0	0.0522	10.50	26.924	0.632
	101	0.793	50.0	245.0	60.0	0.0523	14.70	37.338	0.701
	102	0.793	50.0	245.0	60.0	0.0523	12.70	32.258	0.606
	103	0.793	10.0	326.0	30.0	0.0530	2.10	5.334	0.501
	104	0.793	17.4	326.0	30.0	0.0529	3.50	8.890	0.480
	105	0.793	20.8	326.0	30.0	0.0	4.80	12.192	0.550
	106	0.793	20.8	326.0	30.0	0.0230	4.30	10.922	0.493
	107	0.793	20.8	326.0	30.0	0.0530	4.20	10.668	0.482
	108	0.793	20.8	326.0	30.0	0.0730	4.25	10.795	0.487
	109	0.793	26.5	326.0	30.0	0.0524	5.00	12.700	0.450
	110	0.793	30.0	326.0	30.0	0.0523	5.65	14.351	0.449
	111	0.793	40.0	326.0	30.0	0.0522	8.55	21.717	0.510
	112	0.793	40.0	326.0	30.0	0.0522	7.55	19.177	0.450
	113	0.793	50.0	326.0	30.0	0.0523	9.12	23.165	0.435
	114	0.793	10.0	326.0	45.0	0.0530	2.50	6.350	0.595
	115	0.793	17.4	326.0	45.0	0.0529	4.10	10.414	0.562
	116	0.793	20.8	326.0	45.0	0.0	5.40	13.716	0.619
	117	0.793	20.8	326.0	45.0	0.0230	5.05	12.827	0.579
	118	0.793	20.8	326.0	45.0	0.0530	5.00	12.700	0.573
	119	0.793	20.8	326.0	45.0	0.0730	5.00	12.700	0.573
	120	0.793	26.5	326.0	45.0	0.0524	5.80	14.732	0.522
	121	0.793	30.0	326.0	45.0	0.0523	6.90	17.526	0.549
	122	0.793	40.0	326.0	45.0	0.0522	8.34	21.184	0.497
	123	0.793	50.0	326.0	45.0	0.0523	10.90	27.686	0.520
	124	0.793	10.0	326.0	60.0	0.0523	2.85	7.239	0.680
	125	0.793	17.4	326.0	60.0	0.0529	4.70	11.938	0.644
	126	0.793	20.8	326.0	60.0	0.0	6.30	16.002	0.722
	127	0.793	20.8	326.0	60.0	0.0230	5.65	14.351	0.648
	128	0.793	20.8	326.0	60.0	0.0530	5.60	14.224	0.642

	129	0.793	26.5	326.0	60.0	0.0524	6.60	16.764	0.594
	130	0.793	30.0	326.0	60.0	0.0523	7.50	19.050	0.596
	131	0.793	40.0	326.0	60.0	0.0522	9.90	25.146	0.590
	132	0.793	50.0	326.0	60.0	0.0523	12.40	31.496	0.592
	133	1.000	7.6	165.0	30.0	0.0530	2.65	6.731	0.825
	134	1.000	11.0	165.0	30.0	0.0530	3.35	8.509	0.726
	135	1.000	15.5	165.0	30.0	0.0530	4.30	10.922	0.662
	136	1.000	30.0	165.0	30.0	0.0530	8.00	20.320	0.636
	137	1.000	40.0	165.0	30.0	0.0530	12.70	32.258	0.757
	138	1.000	40.0	165.0	30.0	0.0530	8.00	20.320	0.477
	139	1.000	7.6	165.0	45.0	0.0530	2.70	6.858	0.842
	140	1.000	11.0	165.0	45.0	0.0530	3.45	8.763	0.748
	141	1.000	15.5	165.0	45.0	0.0530	4.60	11.684	0.708
	142	1.000	30.0	165.0	45.0	0.0530	8.20	20.828	0.652
	143	1.000	7.6	165.0	60.0	0.0530	2.80	7.112	0.873
	144	1.000	11.0	165.0	60.0	0.0530	3.55	9.017	0.770
	145	1.000	15.5	165.0	60.0	0.0530	4.80	12.192	0.739
	146	1.000	30.0	165.0	60.0	0.0530	9.40	23.876	0.747
	147	1.000	30.0	165.0	60.0	0.0530	8.40	21.336	0.668
WA	148	1.000	7.6	245.0	30.0	0.0530	2.25	5.715	0.702
QUE	149	1.000	15.5	245.0	30.0	0.0530	3.90	9.906	0.600
	150	1.000	30.0	245.0	30.0	0.0530	6.90	17.526	0.549
	151	1.000	40.0	245.0	30.0	0.0530	8.40	21.336	0.501
	152	1.000	7.6	245.0	45.0	0.0530	2.40	6.096	0.748
	153	1.000	15.5	245.0	45.0	0.0530	4.10	10.414	0.631
	154	1.000	30.0	245.0	45.0	0.0530	7.30	18.542	0.580
	155	1.000	40.0	245.0	45.0	0.0530	9.10	23.114	0.543
	156	1.000	7.6	245.0	60.0	0.0530	2.60	6.604	0.811
	157	1.000	15.5	245.0	60.0	0.0530	4.30	10.922	0.662
	158	1.000	30.0	245.0	60.0	0.0530	7.80	19.812	0.620
	159	1.000	40.0	245.0	60.0	0.0530	9.70	24.638	0.578
	160	1.000	7.6	326.0	30.0	0.0530	1.75	4.445	0.546
	161	1.000	15.5	326.0	30.0	0.0530	3.50	8.890	0.539
	162	1.000	30.0	326.0	30.0	0.0530	6.10	15.494	0.485
	163	1.000	40.0	326.0	30.0	0.0530	7.60	19.304	0.453
	164	1.000	7.6	326.0	45.0	0.0530	1.85	4.699	0.577
	165	1.000	15.5	326.0	45.0	0.0530	3.60	9.144	0.554
	166	1.000	30.0	326.0	45.0	0.0530	6.70	17.018	0.533
	167	1.000	40.0	326.0	45.0	0.0530	8.20	20.828	0.489
	168	1.000	7.6	326.0	60.0	0.0530	2.00	5.080	0.624
	169	1.000	15.5	326.0	60.0	0.0530	3.90	9.906	0.600
	170	1.000	30.0	326.0	60.0	0.0530	7.15	18.161	0.569
	171	1.000	40.0	326.0	60.0	0.0530	8.90	22.606	0.531

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

	172	0.594	7.8	165.0	30.0	0.0530	1.80	4.572	0.568
	173	0.594	11.0	165.0	30.0	0.0530	2.90	7.366	0.645
	174	0.594	14.0	165.0	30.0	0.0530	3.80	9.652	0.664
	175	0.594	30.0	165.0	30.0	0.0530	7.70	19.558	0.628
	176	0.594	30.0	165.0	30.0	0.0530	5.40	13.716	0.440
	177	0.594	7.8	165.0	45.0	0.0530	2.30	5.842	0.726
	178	0.594	14.0	165.0	45.0	0.0530	4.80	12.192	0.839
	179	0.594	14.0	165.0	45.0	0.0530	3.80	9.652	0.664
	180	0.594	30.0	165.0	45.0	0.0530	10.80	27.432	0.881
	181	0.594	30.0	165.0	45.0	0.0530	6.30	16.002	0.514
	182	0.594	11.0	165.0	45.0	0.0530	3.20	8.128	0.712

183	0.594	7.8	165.0	60.0	0.0530	2.80	7.112	0.884
184	0.594	11.0	165.0	60.0	0.0530	3.50	8.890	0.778
185	0.594	14.0	165.0	60.0	0.0530	5.30	13.462	0.926
186	0.594	14.0	165.0	60.0	0.0530	4.20	10.668	0.734
187	0.594	30.0	165.0	60.0	0.0530	7.20	18.288	0.587
188	0.594	30.0	165.0	60.0	0.0530	12.00	30.480	0.979
189	0.594	11.0	165.0	60.0	0.0530	4.00	10.160	0.890
190	0.594	7.8	245.0	30.0	0.0530	1.70	4.318	0.537
191	0.594	11.0	245.0	30.0	0.0530	2.20	5.588	0.489
192	0.594	14.0	245.0	30.0	0.0530	3.20	8.128	0.559
193	0.594	14.0	245.0	30.0	0.0530	2.70	6.858	0.472
194	0.594	30.0	245.0	30.0	0.0530	5.60	14.224	0.457
195	0.594	30.0	245.0	30.0	0.0530	5.00	12.700	0.408
196	0.594	7.8	245.0	45.0	0.0530	2.00	5.080	0.631
197	0.594	11.0	245.0	45.0	0.0530	2.70	6.858	0.601
198	0.594	14.0	245.0	45.0	0.0530	3.80	9.652	0.664
199	0.594	14.0	245.0	45.0	0.0530	3.30	8.382	0.577
200	0.594	30.0	245.0	45.0	0.0530	7.80	19.812	0.636
201	0.594	30.0	245.0	45.0	0.0530	6.50	16.510	0.530
202	0.594	7.8	245.0	60.0	0.0530	2.25	5.715	0.710
203	0.594	11.0	245.0	60.0	0.0530	3.20	8.128	0.712
204	0.594	14.0	245.0	60.0	0.0530	4.20	10.668	0.734
205	0.594	14.0	245.0	60.0	0.0530	3.80	9.652	0.664
206	0.594	30.0	245.0	60.0	0.0530	9.40	23.876	0.767
207	0.594	30.0	245.0	60.0	0.0530	7.30	18.542	0.595
208	0.594	7.8	326.0	30.0	0.0530	1.60	4.064	0.505
209	0.594	14.0	326.0	30.0	0.0530	2.30	5.842	0.402
210	0.594	30.0	326.0	30.0	0.0530	4.70	11.938	0.383
211	0.594	40.0	326.0	30.0	0.0530	6.60	16.764	0.404
212	0.594	7.8	326.0	45.0	0.0530	1.95	4.953	0.616
213	0.594	14.0	326.0	45.0	0.0530	3.00	7.620	0.524
214	0.594	30.0	326.0	45.0	0.0530	5.90	14.986	0.481
215	0.594	40.0	326.0	45.0	0.0530	7.90	20.066	0.483
216	0.594	7.8	326.0	45.0	0.0530	2.30	5.842	0.726
WA 217	0.594	14.0	326.0	45.0	0.0530	3.50	8.890	0.612
DUE 218	0.594	30.0	326.0	45.0	0.0530	6.70	17.018	0.546
219	0.594	40.0	326.0	45.0	0.0530	8.90	22.606	0.544
220	0.793	10.0	165.0	30.0	0.0525	2.80	7.112	0.685
221	0.793	17.4	165.0	30.0	0.0526	4.45	11.303	0.626
222	0.793	30.0	165.0	30.0	0.0524	8.70	22.098	0.709
223	0.793	30.0	165.0	30.0	0.0524	5.70	14.478	0.465
224	0.793	35.1	165.0	30.0	0.0523	11.50	29.210	0.802
225	0.793	35.1	165.0	30.0	0.0523	6.75	17.145	0.470
226	0.793	40.0	165.0	30.0	0.0521	14.40	36.576	0.881
227	0.793	40.0	165.0	30.0	0.0521	7.34	18.644	0.449
228	0.793	10.0	165.0	45.0	0.0525	3.10	7.874	0.758
229	0.793	17.4	165.0	45.0	0.0526	5.45	13.843	0.766
230	0.793	17.4	165.0	45.0	0.0526	4.45	11.303	0.626
231	0.793	10.0	165.0	60.0	0.0525	3.25	8.255	0.795
232	0.793	17.4	165.0	60.0	0.0526	5.45	13.843	0.766
233	0.793	10.0	245.0	30.0	0.0525	2.30	5.842	0.563
234	0.793	17.4	245.0	30.0	0.0526	3.45	8.763	0.485
235	0.793	20.8	245.0	30.0	0.0	5.15	13.081	0.606
236	0.793	20.8	245.0	30.0	0.0230	4.25	10.795	0.500
237	0.793	20.8	245.0	30.0	0.0530	4.25	10.795	0.500
238	0.793	30.0	245.0	30.0	0.0524	6.30	16.002	0.514
239	0.793	30.0	245.0	30.0	0.0524	5.30	13.462	0.432

	240	0.793	35.1	245.0	30.0	0.0523	7.45	18.923	0.519
	241	0.793	35.1	245.0	30.0	0.0523	5.95	15.113	0.415
	242	0.793	40.0	245.0	30.0	0.0521	9.44	23.978	0.577
	243	0.793	40.0	245.0	30.0	0.0521	6.74	17.120	0.412
	244	0.793	50.0	245.0	30.0	0.0520	13.30	33.782	0.651
	245	0.793	50.0	245.0	30.0	0.0520	7.90	20.066	0.387
	246	0.793	10.0	245.0	45.0	0.0525	2.60	6.604	0.636
	247	0.793	17.4	245.0	45.0	0.0525	4.15	10.541	0.584
	248	0.793	17.4	245.0	45.0	0.0526	3.95	10.033	0.555
	249	0.793	20.8	245.0	45.0	0.0	5.60	14.224	0.659
	250	0.793	20.8	245.0	45.0	0.0230	4.75	12.065	0.559
	251	0.793	20.8	245.0	45.0	0.0530	4.75	12.065	0.559
	252	0.793	30.0	245.0	45.0	0.0524	7.60	19.304	0.620
	253	0.793	30.0	245.0	45.0	0.0524	5.90	14.986	0.481
	254	0.793	35.1	245.0	45.0	0.0523	9.95	25.273	0.694
	255	0.793	35.1	245.0	45.0	0.0523	6.45	16.383	0.450
	256	0.793	40.0	245.0	45.0	0.0521	11.50	29.210	0.703
	257	0.793	40.0	245.0	45.0	0.0521	7.35	18.669	0.450
	258	0.793	10.0	245.0	60.0	0.0525	2.90	7.366	0.709
	259	0.793	17.4	245.0	60.0	0.0526	4.70	11.938	0.661
	260	0.793	20.8	245.0	60.0	0.0	5.90	14.986	0.694
	261	0.793	20.8	245.0	60.0	0.0230	5.15	13.081	0.605
	262	0.793	20.8	245.0	60.0	0.0530	5.15	13.081	0.606
	263	0.793	30.0	245.0	60.0	0.0524	8.50	21.590	0.693
	264	0.793	30.0	245.0	60.0	0.0524	6.30	16.002	0.514
	265	0.793	40.0	245.0	60.0	0.0521	12.40	31.496	0.758
	266	0.793	40.0	245.0	60.0	0.0521	7.84	19.914	0.480
	267	0.793	25.5	245.0	60.0	0.0720	4.95	12.573	0.475
NA	268	0.793	25.5	245.0	60.0	0.0720	7.55	19.177	0.724
UE	269	0.793	10.0	326.0	30.0	0.0525	1.85	4.699	0.453
	270	0.793	17.4	326.0	30.0	0.0526	2.90	7.366	0.408
	271	0.793	20.8	326.0	30.0	0.0	4.00	10.160	0.470
	272	0.793	20.8	326.0	30.0	0.0230	3.75	9.525	0.441
	273	0.793	20.8	326.0	30.0	0.0530	3.80	9.652	0.447
	274	0.793	20.8	326.0	30.0	0.0730	3.65	9.271	0.429
	275	0.793	30.0	326.0	30.0	0.0524	4.80	12.192	0.391
	276	0.793	35.1	326.0	30.0	0.0523	5.75	14.605	0.401
	277	0.793	35.1	326.0	30.0	0.0523	5.65	14.351	0.394
	278	0.793	40.0	326.0	30.0	0.0521	6.44	16.358	0.394
	279	0.793	40.0	326.0	30.0	0.0521	6.34	16.104	0.388
	280	0.793	50.0	326.0	30.0	0.0520	8.30	21.082	0.405
	281	0.793	50.0	326.0	30.0	0.0520	7.90	20.066	0.387
	282	0.793	10.0	326.0	45.0	0.0525	2.20	5.588	0.538
	283	0.793	17.4	326.0	45.0	0.0526	3.25	8.255	0.457
	284	0.793	20.8	326.0	45.0	0.0	4.45	11.303	0.523
	285	0.793	20.8	326.0	45.0	0.0230	4.10	10.414	0.482
	286	0.793	20.8	326.0	45.0	0.0530	4.15	10.541	0.488
	287	0.793	30.0	326.0	45.0	0.0524	5.40	13.716	0.440
	288	0.793	35.1	326.0	45.0	0.0523	6.35	16.129	0.443
	289	0.793	40.0	326.0	45.0	0.0521	7.25	18.415	0.443
	290	0.793	50.0	326.0	45.0	0.0520	9.10	23.114	0.445
	291	0.793	10.0	326.0	60.0	0.0525	2.50	6.350	0.612
	292	0.793	17.4	326.0	60.0	0.0526	3.90	9.906	0.548
	293	0.793	20.8	326.0	60.0	0.0	4.80	12.192	0.565
	294	0.793	20.8	326.0	60.0	0.0230	4.50	11.430	0.529
	295	0.793	20.8	326.0	60.0	0.0530	4.50	11.430	0.529

	296	0.793	20.8	326.0	60.0	0.0730	4.50	11.430	0.529
	297	0.793	30.0	326.0	60.0	0.0524	5.80	14.732	0.473
	298	0.793	40.0	326.0	60.0	0.0521	7.74	19.660	0.473
	299	0.793	50.0	326.0	60.0	0.0520	9.70	24.638	0.475
	300	0.793	25.5	326.0	60.0	0.0720	4.80	12.192	0.461
	301	1.000	7.6	165.0	30.0	0.0530	2.65	6.731	0.847
	302	1.000	11.0	165.0	30.0	0.0530	3.40	8.636	0.756
	303	1.000	15.5	165.0	30.0	0.0530	4.75	12.065	0.750
	304	1.000	7.6	165.0	45.0	0.0530	2.70	6.858	0.863
	305	1.000	11.0	165.0	45.0	0.0530	3.50	8.890	0.778
	306	1.000	15.5	165.0	45.0	0.0530	4.85	12.319	0.766
	307	1.000	7.6	165.0	60.0	0.0530	2.75	6.985	0.879
	308	1.000	11.0	165.0	60.0	0.0530	3.60	9.144	0.801
	309	1.000	15.5	165.0	60.0	0.0530	4.95	12.573	0.781
	310	1.000	7.6	245.0	30.0	0.0530	2.40	6.096	0.768
	311	1.000	15.5	245.0	30.0	0.0530	4.00	10.160	0.631
	312	1.000	30.0	245.0	30.0	0.0530	7.30	18.542	0.595
	313	1.000	40.0	245.0	30.0	0.0530	9.30	23.622	0.569
	314	1.000	7.6	245.0	45.0	0.0530	2.45	6.223	0.784
	315	1.000	15.5	245.0	45.0	0.0530	4.00	10.160	0.631
	316	1.000	30.0	245.0	45.0	0.0530	7.60	19.304	0.620
	317	1.000	40.0	245.0	45.0	0.0530	9.55	24.257	0.584
	318	1.000	7.6	245.0	60.0	0.0530	2.50	6.350	0.800
NA	319	1.000	15.5	245.0	60.0	0.0530	4.30	10.922	0.679
YUE	320	1.000	30.0	245.0	60.0	0.0530	7.85	19.939	0.640
	321	1.000	40.0	245.0	60.0	0.0530	9.80	24.892	0.599
	322	1.000	7.6	326.0	30.0	0.0530	1.75	4.445	0.560
	323	1.000	15.5	326.0	30.0	0.0530	3.50	8.890	0.552
	324	1.000	30.0	326.0	30.0	0.0530	6.40	16.256	0.522
	325	1.000	40.0	326.0	30.0	0.0530	8.00	20.320	0.489
	326	1.000	7.6	326.0	45.0	0.0530	1.85	4.699	0.592
	327	1.000	15.5	326.0	45.0	0.0530	3.70	9.398	0.584
	328	1.000	30.0	326.0	45.0	0.0530	6.70	17.018	0.546
	329	1.000	40.0	326.0	45.0	0.0530	8.40	21.336	0.514
	330	1.000	7.6	326.0	60.0	0.0530	2.00	5.080	0.640
	331	1.000	15.5	326.0	60.0	0.0530	3.80	9.652	0.600
	332	1.000	30.0	326.0	60.0	0.0530	6.95	17.653	0.567
	333	1.000	40.0	326.0	60.0	0.0530	8.70	22.098	0.532

1-B. Consistency of Experimental Data

Because of the continually changing general characteristics of unstable vertical two phase flow, it was not possible to compare directly the results obtained by previous investigators (3,5,6). The consistency of the data can be however checked by comparisons of independently measured experimental data.

From material balance :

$$\alpha A_p H = n \bar{V}_s$$

where n is the number of slugs in the tube

$$\alpha A_p H = \frac{H}{U_s} \bar{F} \bar{V}_s$$

or
$$\frac{\alpha A_p U_s}{\bar{F} \bar{V}_s} = 1.0$$

as
$$\bar{V}_s = (a_v \bar{L}_s - b_v D_p) A_p$$

$$\therefore \frac{\alpha U_s}{\bar{F} (a_v \bar{L}_s - b_v D_p)} = 1.0 \quad (1-1)$$

The consistency of the independently measured quantities α , U_s , $\bar{F}$ and $\bar{L}_s$ was then tested noting the deviation from unity. In general, the consistency of the data was fairly good and some of the results are shown in Table 1-9. The mean square deviation of the results from 1.0 was ± 0.18 which seem reasonable due to the inherent nature of the slug flow.

Table 1-9

CONSISTENCY OF EXPERIMENTAL DATA

G	Dp	α	Us	$\bar{F}$	$\bar{L}_s$	av	bv	$\frac{\alpha U_s}{\bar{F}(a_v \bar{L}_s - b_v D_p)}$
165.0	0.793	0.322	15.80	24.74	0.530	0.597	-0.078	0.81
245.0	0.793	0.393	21.85	8.25	1.800	0.597	-0.078	1.03
245.0	0.793	0.362	21.40	11.34	1.160	0.597	-0.078	1.08
245.0	0.793	0.362	22.68	17.53	1.200	0.597	-0.078	0.72
326.0	0.793	0.403	24.91	11.68	1.200	0.597	-0.078	1.31
326.0	0.793	0.393	26.40	13.40	1.900	0.597	-0.078	0.72
326.0	0.793	0.383	25.60	11.34	1.650	0.597	-0.078	0.94
326.0	0.793	0.362	16.70	12.37	1.100	0.552	-0.076	0.89
165.0	0.793	0.342	16.30	8.25	1.850	0.552	-0.076	0.70
165.0	0.793	0.322	16.50	22.33	0.500	0.552	-0.076	1.10
165.0	0.793	0.423	20.58	9.27	2.450	0.552	-0.076	0.73
245.0	0.793	0.372	23.74	8.59	2.350	0.552	-0.076	0.83
245.0	0.793	0.443	27.60	7.20	3.500	0.552	-0.076	0.91
326.0	0.793	0.423	28.50	8.25	2.900	0.552	-0.076	0.95
326.0	0.793	0.320	16.70	8.24	1.500	0.616	-0.096	0.78
245.0	1.000	0.351	19.45	7.90	2.000	0.616	-0.096	0.76
326.0	1.000	0.351	14.00	8.25	1.450	0.596	-0.096	0.78
165.0	1.000	0.380	17.50	6.53	1.900	0.596	-0.096	1.00
245.0	1.000	0.417	20.80	6.53	2.650	0.596	-0.096	0.90
326.0	1.000	0.484	18.30	24.70	0.700	0.599	-0.071	0.95
165.0	0.594	0.523	30.77	16.50	1.700	0.599	-0.071	1.00
245.0	0.594	0.531	38.46	12.37	2.730	0.599	-0.071	1.04
326.0	0.594	0.457	24.60	11.68	1.590	0.510	-0.054	1.24
165.0	0.594	0.459	30.85	8.93	3.410	0.510	-0.054	0.93
245.0	0.594	0.484	44.86	10.30	3.640	0.510	-0.054	1.16

MEAN SQUARE DEVIATION = 0.18

1-C. Mass Transfer Efficiencies

Table 1-10 experimental mass transfer data.

Table 1-10
Experimental Mass Transfer Data

Run NO.	H	P _s	Y _{on} x10 ²	Y _{off} x10 ²	Y _{off} * x10 ²	E _{OT}	-ln(1-E _{OT})	θ _Z
ABSORBER DIAMETER = 0.793 CM								
SATURATOR TEMPERATURE = -15°C								
SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL								
GAS RATE = 165.0 CC/MIN			LIQUID RATE = 30.0 CC/MIN					
1	5.7	761.1	2.3650	0.1243	0.0538	0.9695	3.443	0.24
2	5.7	761.1	2.3650	0.1311	0.0536	0.9665	3.443	0.24
3	10.0	765.0	2.3530	0.0978	0.0541	0.9810	3.904	0.53
4	10.0	765.0	2.3530	0.1032	0.0540	0.9786	3.904	0.53
5	15.0	765.6	2.3510	0.0859	0.0544	0.9863	4.215	0.87
6	15.0	765.6	2.3510	0.0908	0.0542	0.9841	4.215	0.87
7	17.4	772.5	2.3300	0.0810	0.0540	0.9881	4.351	1.03
8	17.4	772.5	2.3300	0.0856	0.0538	0.9860	4.351	1.03
9	20.0	767.9	2.3440	0.0770	0.0544	0.9901	4.528	1.20
10	20.0	767.9	2.3440	0.0814	0.0543	0.9882	4.528	1.20
11	26.5	782.6	2.3000	0.0688	0.0535	0.9932	4.869	1.64
12	26.5	782.6	2.3000	0.0728	0.0534	0.9914	4.869	1.64
GAS RATE = 165.0 CC/MIN			LIQUID RATE = 45.0 CC/MIN					
13	5.7	760.5	2.3670	0.1103	0.0362	0.9682	3.408	0.23
14	5.7	760.5	2.3670	0.1164	0.0361	0.9655	3.408	0.23
15	10.0	765.0	2.3530	0.0932	0.0362	0.9754	3.660	0.49
16	10.0	765.0	2.3530	0.0985	0.0361	0.9731	3.660	0.49
17	17.4	772.5	2.3300	0.0766	0.0361	0.9824	3.985	0.95
18	17.4	772.5	2.3300	0.0809	0.0360	0.9804	3.985	0.95
19	20.0	760.5	2.3670	0.0721	0.0367	0.9848	4.132	1.11
20	20.0	760.5	2.3670	0.0762	0.0367	0.9830	4.132	1.11
21	25.0	782.6	2.3000	0.0686	0.0357	0.9855	4.173	1.42
22	25.0	782.6	2.3000	0.0726	0.0356	0.9837	4.173	1.42
23	26.5	782.6	2.3000	0.0668	0.0357	0.9863	4.229	1.51
24	26.5	782.6	2.3000	0.0707	0.0357	0.9845	4.229	1.51
GAS RATE = 165.0 CC/MIN			LIQUID RATE = 60.0 CC/MIN					
25	5.7	758.5	2.3730	0.0973	0.0274	0.9702	3.475	0.21
26	5.7	758.5	2.3730	0.1027	0.0273	0.9678	3.475	0.21
27	10.0	764.0	2.3560	0.0843	0.0273	0.9755	3.670	0.46
28	10.0	764.0	2.3560	0.0891	0.0272	0.9735	3.670	0.46
29	15.0	772.5	2.3300	0.0694	0.0272	0.9817	3.953	0.74
30	15.0	772.5	2.3300	0.0734	0.0271	0.9799	3.953	0.74
31	17.4	772.5	2.3300	0.0688	0.0272	0.9819	3.966	0.88
32	17.4	772.5	2.3300	0.0728	0.0271	0.9801	3.966	0.88
33	20.0	764.3	2.3550	0.0648	0.0275	0.9840	4.086	1.03
34	20.0	764.3	2.3550	0.0685	0.0275	0.9824	4.086	1.03
GAS RATE = 245.0 CC/MIN			LIQUID RATE = 30.0 CC/MIN					
35	5.7	761.1	2.3650	0.2274	0.0786	0.9349	2.709	0.17
36	5.7	761.1	2.3650	0.2343	0.0784	0.9318	2.709	0.17
37	10.0	765.0	2.3530	0.1947	0.0793	0.9493	2.950	0.38
38	10.0	765.0	2.3530	0.2020	0.0791	0.9460	2.950	0.38
39	15.0	765.6	2.3510	0.1601	0.0805	0.9649	3.310	0.63

40	15.0	765.6	2.3510	0.1665	0.0803	0.9620	3.310	0.63
41	17.4	772.5	2.3300	0.1470	0.0802	0.9703	3.472	0.75
42	17.4	772.5	2.3300	0.1530	0.0800	0.9675	3.472	0.75
43	25.0	782.6	2.3000	0.1362	0.0795	0.9745	3.605	1.13
44	25.0	782.6	2.3000	0.1435	0.0792	0.9710	3.605	1.13
45	26.5	782.6	2.3000	0.1217	0.0800	0.9812	3.898	1.21
46	26.5	782.6	2.3000	0.1283	0.0797	0.9781	3.898	1.21
47	30.0	769.2	2.3400	0.0973	0.0823	0.9934	4.858	1.38
48	30.0	769.2	2.3400	0.1027	0.0821	0.9909	4.858	1.38

GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

49	5.7	760.5	2.3670	0.2153	0.0528	0.9298	2.633	0.16
50	5.7	760.5	2.3670	0.2230	0.0526	0.9264	2.633	0.16
51	10.0	765.3	2.3520	0.1590	0.0538	0.9542	3.054	0.36
52	10.0	765.3	2.3520	0.1653	0.0536	0.9514	3.054	0.36
53	15.0	772.5	2.3300	0.1380	0.0537	0.9630	3.254	0.60
54	15.0	772.5	2.3300	0.1454	0.0536	0.9597	3.254	0.60
55	17.4	772.5	2.3300	0.1192	0.0542	0.9714	3.506	0.71
56	17.4	772.5	2.3300	0.1258	0.0540	0.9685	3.506	0.71
57	20.0	761.4	2.3640	0.1127	0.0552	0.9751	3.640	0.83
58	20.0	761.4	2.3640	0.1190	0.0551	0.9723	3.640	0.83
59	26.5	782.6	2.3000	0.1013	0.0539	0.9789	3.799	1.14
60	26.5	782.6	2.3000	0.1070	0.0537	0.9763	3.799	1.14
61	30.0	769.2	2.3400	0.0753	0.0555	0.9913	4.645	1.30
62	30.0	769.2	2.3400	0.0797	0.0554	0.9894	4.645	1.30
63	40.0	780.9	2.3050	0.0632	0.0549	0.9963	5.420	1.77
64	40.0	780.9	2.3050	0.0668	0.0548	0.9947	5.420	1.77

GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

65	5.7	760.1	2.3680	0.1963	0.0400	0.9328	2.677	0.15
66	5.7	760.1	2.3680	0.2037	0.0399	0.9296	2.677	0.15
67	10.0	765.3	2.3520	0.1387	0.0407	0.9576	3.124	0.34
68	10.0	765.3	2.3520	0.1461	0.0406	0.9543	3.124	0.34
69	15.0	772.5	2.3300	0.1095	0.0409	0.9700	3.464	0.57
70	15.0	772.5	2.3300	0.1155	0.0407	0.9673	3.464	0.57
71	17.4	772.5	2.3300	0.0921	0.0412	0.9777	3.755	0.67
72	17.4	772.5	2.3300	0.0974	0.0411	0.9754	3.755	0.67
73	20.0	767.3	2.3460	0.0861	0.0416	0.9807	3.894	0.79
74	20.0	767.3	2.3460	0.0909	0.0415	0.9785	3.894	0.79
75	26.5	782.6	2.3000	0.0680	0.0410	0.9880	4.358	1.08
76	26.5	782.6	2.3000	0.0720	0.0410	0.9863	4.358	1.08

AWA
TIQUE GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

77	5.7	761.1	2.3650	0.3329	0.0976	0.8962	2.245	0.12
78	5.7	761.1	2.3650	0.3421	0.0971	0.8920	2.245	0.12
79	10.0	765.0	2.3530	0.2480	0.1010	0.9347	2.703	0.30
80	10.0	765.0	2.3530	0.2554	0.1006	0.9313	2.703	0.30
81	15.0	765.6	2.3510	0.2070	0.1028	0.9536	3.034	0.50
82	15.0	765.6	2.3510	0.2146	0.1024	0.9501	3.034	0.50
83	17.4	772.5	2.3300	0.1881	0.1024	0.9615	3.216	0.59
84	17.4	772.5	2.3300	0.1952	0.1021	0.9582	3.216	0.59
85	24.0	767.9	2.3440	0.1716	0.1041	0.9698	3.452	0.85
86	24.0	767.9	2.3440	0.1784	0.1038	0.9667	3.452	0.85
87	26.5	782.6	2.3000	0.1552	0.1025	0.9760	3.671	0.95
88	26.5	782.6	2.3000	0.1615	0.1022	0.9730	3.671	0.95
89	30.0	769.2	2.3400	0.1298	0.1056	0.9892	4.392	1.09
90	30.0	769.2	2.3400	0.1369	0.1053	0.9859	4.392	1.09
91	40.0	780.9	2.3050	0.1176	0.1045	0.9940	4.913	1.49
92	40.0	780.9	2.3050	0.1241	0.1042	0.9910	4.913	1.49

GAS RATE = 326.0 CC/MIN					LIQUID RATE = 45.0 CC/MIN				
93	5.7	760.5	2.3670	0.2867	0.0667	0.9043	2.328	0.12	
94	5.7	760.5	2.3670	0.2949	0.0664	0.9007	2.328	0.12	
95	10.0	766.3	2.3490	0.2128	0.0684	0.9367	2.733	0.28	
96	10.0	766.3	2.3490	0.2205	0.0681	0.9332	2.733	0.28	
97	15.0	772.5	2.3300	0.1675	0.0692	0.9565	3.102	0.47	
98	15.0	772.5	2.3300	0.1741	0.0690	0.9535	3.102	0.47	
99	17.4	772.5	2.3300	0.1552	0.0694	0.9620	3.235	0.56	
100	17.4	772.5	2.3300	0.1615	0.0692	0.9592	3.235	0.56	
101	20.0	767.3	2.3460	0.1453	0.0704	0.9671	3.363	0.66	
102	20.0	767.3	2.3460	0.1530	0.0702	0.9636	3.363	0.66	
103	26.5	782.6	2.3000	0.1152	0.0697	0.9706	3.825	0.91	
104	26.5	782.6	2.3000	0.1215	0.0695	0.9767	3.825	0.91	
105	30.0	769.2	2.3400	0.1086	0.0712	0.9835	4.027	1.04	
106	30.0	769.2	2.3400	0.1147	0.0710	0.9807	4.027	1.04	

GAS RATE = 326.0 CC/MIN					LIQUID RATE = 60.0 CC/MIN				
107	5.7	760.1	2.3680	0.2463	0.0510	0.9157	2.455	0.11	
108	5.7	760.1	2.3680	0.2537	0.0508	0.9125	2.455	0.11	
109	10.0	766.3	2.3490	0.1840	0.0520	0.9425	2.830	0.27	
110	10.0	766.3	2.3490	0.1910	0.0518	0.9394	2.830	0.27	
111	15.0	772.5	2.3300	0.1445	0.0525	0.9596	3.168	0.45	
112	15.0	772.5	2.3300	0.1522	0.0523	0.9561	3.168	0.45	
113	17.4	772.5	2.3300	0.1339	0.0527	0.9644	3.291	0.54	
114	17.4	772.5	2.3300	0.1411	0.0525	0.9611	3.291	0.54	
115	20.0	766.6	2.3480	0.1257	0.0534	0.9685	3.410	0.64	
116	20.0	766.6	2.3480	0.1326	0.0532	0.9654	3.410	0.64	
117	26.5	782.6	2.3000	0.1013	0.0526	0.9783	3.776	0.87	
118	26.5	782.6	2.3000	0.1070	0.0525	0.9757	3.776	0.87	
119	30.0	769.2	2.3400	0.0932	0.0538	0.9828	3.997	1.00	
120	30.0	769.2	2.3400	0.0985	0.0537	0.9804	3.997	1.00	
121	40.0	780.9	2.3050	0.0851	0.0531	0.9858	4.183	1.37	
122	40.0	780.9	2.3050	0.0899	0.0530	0.9836	4.183	1.37	

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2°C

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

GAS RATE = 165.0 CC/MIN					LIQUID RATE = 30.0 CC/MIN				
123	5.7	770.8	5.2540	0.2463	0.1236	0.9761	3.703	0.24	
124	5.7	770.8	5.2540	0.2537	0.1234	0.9746	3.703	0.24	
125	7.5	770.8	5.2540	0.2085	0.1245	0.9836	4.067	0.36	
126	7.5	770.8	5.2540	0.2161	0.1243	0.9821	4.067	0.36	
127	10.0	765.6	5.2900	0.1758	0.1262	0.9904	4.580	0.53	
128	10.0	765.6	5.2900	0.1826	0.1260	0.9890	4.580	0.53	
129	12.0	767.0	5.2800	0.1593	0.1263	0.9936	4.961	0.67	
130	12.0	767.0	5.2800	0.1657	0.1262	0.9923	4.961	0.67	
131	17.4	770.0	5.2600	0.1420	0.1262	0.9969	5.582	1.03	
132	17.4	770.0	5.2600	0.1496	0.1260	0.9954	5.582	1.03	
133	20.0	768.9	5.2670	0.1362	0.1265	0.9981	5.990	1.20	
134	20.0	768.9	5.2670	0.1435	0.1263	0.9967	5.990	1.20	
135	25.0	775.9	5.2200	0.1323	0.1254	0.9987	6.247	1.54	
136	25.0	775.9	5.2200	0.1394	0.1252	0.9972	6.247	1.54	
GAS RATE = 165.0 CC/MIN					LIQUID RATE = 45.0 CC/MIN				
137	5.7	768.6	5.2690	0.2112	0.0834	0.9754	3.674	0.23	
138	5.7	768.6	5.2690	0.2188	0.0833	0.9739	3.674	0.23	
139	10.0	765.6	5.2900	0.1675	0.0844	0.9840	4.099	0.49	
140	10.0	765.6	5.2900	0.1741	0.0843	0.9827	4.099	0.49	
141	14.0	767.0	5.2800	0.1388	0.0847	0.9896	4.500	0.74	

142	14.0	767.0	5.2800	0.1462	0.0846	0.9881	4.500	0.74
143	17.4	770.0	5.2600	0.1298	0.0845	0.9912	4.665	0.95
144	17.4	770.0	5.2600	0.1369	0.0844	0.9899	4.665	0.95
145	20.0	768.9	5.2670	0.1257	0.0847	0.9921	4.760	1.11
146	20.0	768.9	5.2670	0.1326	0.0846	0.9907	4.760	1.11
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
147	5.7	766.6	5.2830	0.2005	0.0629	0.9737	3.610	0.21
148	5.7	766.6	5.2830	0.2079	0.0628	0.9722	3.610	0.21
149	10.0	765.6	5.2900	0.1536	0.0636	0.9828	4.028	0.46
150	10.0	765.6	5.2900	0.1598	0.0635	0.9816	4.028	0.46
AW 151	14.0	767.0	5.2800	0.1233	0.0638	0.9886	4.419	0.68
HOU 152	14.0	767.0	5.2800	0.1300	0.0637	0.9873	4.419	0.68
153	17.4	770.0	5.2600	0.1135	0.0636	0.9904	4.586	0.88
154	17.4	770.0	5.2600	0.1198	0.0636	0.9892	4.586	0.88
155	20.0	768.9	5.2670	0.1009	0.0639	0.9929	4.873	1.03
156	20.0	768.9	5.2670	0.1066	0.0638	0.9918	4.873	1.03
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
157	5.7	770.8	5.2540	0.4905	0.1801	0.9388	2.777	0.17
158	5.7	770.8	5.2540	0.5011	0.1797	0.9367	2.777	0.17
159	10.0	770.8	5.2540	0.3123	0.1864	0.9752	3.661	0.38
160	10.0	770.8	5.2540	0.3210	0.1861	0.9734	3.661	0.38
161	14.0	767.0	5.2800	0.2541	0.1895	0.9873	4.310	0.58
162	14.0	767.0	5.2800	0.2616	0.1892	0.9858	4.310	0.58
163	18.0	770.0	5.2600	0.2299	0.1896	0.9921	4.753	0.78
164	18.0	770.0	5.2600	0.2368	0.1893	0.9906	4.753	0.78
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
165	5.7	770.8	5.2540	0.3996	0.1226	0.9460	2.903	0.16
166	5.7	770.8	5.2540	0.4087	0.1224	0.9442	2.903	0.16
167	10.0	765.6	5.2900	0.2711	0.1266	0.9720	3.549	0.36
168	10.0	765.6	5.2900	0.2789	0.1264	0.9705	3.549	0.36
169	14.0	767.0	5.2800	0.2128	0.1277	0.9835	4.059	0.55
170	14.0	767.0	5.2800	0.2205	0.1275	0.9820	4.059	0.55
171	18.5	770.0	5.2600	0.1809	0.1280	0.9897	4.510	0.76
172	18.5	770.0	5.2600	0.1879	0.1278	0.9883	4.510	0.76
173	20.0	768.9	5.2670	0.1679	0.1285	0.9923	4.791	0.83
174	20.0	768.9	5.2670	0.1745	0.1283	0.9910	4.791	0.83
175	25.0	775.9	5.2200	0.1608	0.1274	0.9934	4.937	1.07
176	25.0	775.9	5.2200	0.1672	0.1272	0.9922	4.937	1.07
177	30.0	773.5	5.2360	0.1339	0.1284	0.9989	6.415	1.30
178	30.0	773.5	5.2360	0.1411	0.1283	0.9975	6.415	1.30
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
179	5.7	768.6	5.2690	0.3610	0.0931	0.9482	2.943	0.15
180	5.7	768.6	5.2690	0.3706	0.0929	0.9463	2.943	0.15
181	10.0	765.6	5.2900	0.2463	0.0956	0.9710	3.515	0.34
182	10.0	765.6	5.2900	0.2537	0.0954	0.9695	3.515	0.34
183	14.0	767.0	5.2800	0.1876	0.0964	0.9824	4.002	0.52
184	14.0	767.0	5.2800	0.1947	0.0963	0.9810	4.002	0.52
185	17.4	770.0	5.2600	0.1536	0.0966	0.9890	4.455	0.67
186	17.4	770.0	5.2600	0.1598	0.0965	0.9877	4.455	0.67
187	20.0	768.9	5.2670	0.1412	0.0970	0.9914	4.681	0.79
188	20.0	768.9	5.2670	0.1488	0.0968	0.9900	4.681	0.79
189	25.0	775.9	5.2200	0.1270	0.0963	0.9940	5.015	1.01
190	25.0	775.9	5.2200	0.1339	0.0962	0.9926	5.015	1.01
191	30.0	773.5	5.2360	0.1176	0.0968	0.9959	5.371	1.23
192	30.0	773.5	5.2360	0.1241	0.0967	0.9947	5.371	1.23
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
193	5.7	770.0	5.2600	0.6338	0.2276	0.9193	2.507	0.12

194	5.7	770.0	5.2600	0.6412	0.2272	0.9178	2.507	0.12
195	10.0	765.6	5.2900	0.4120	0.2399	0.9659	3.351	0.30
196	10.0	765.6	5.2900	0.4213	0.2395	0.9640	3.351	0.30
197	14.0	767.0	5.2800	0.3255	0.2428	0.9836	4.056	0.46
198	14.0	767.0	5.2800	0.3345	0.2424	0.9817	4.056	0.46
199	17.4	770.0	5.2600	0.2999	0.2430	0.9887	4.406	0.59
200	17.4	770.0	5.2600	0.3084	0.2426	0.9869	4.406	0.59
201	20.0	770.0	5.2600	0.2823	0.2438	0.9923	4.771	0.69
202	20.0	770.0	5.2600	0.2904	0.2434	0.9906	4.771	0.69
203	25.0	775.9	5.2200	0.2587	0.2428	0.9968	5.546	0.89
204	25.0	775.9	5.2200	0.2663	0.2425	0.9952	5.546	0.89

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

205	5.7	770.0	5.2600	0.5673	0.1544	0.9191	2.506	0.12
206	5.7	770.0	5.2600	0.5744	0.1542	0.9177	2.506	0.12
207	10.0	765.6	5.2900	0.3619	0.1621	0.9611	3.221	0.28
208	10.0	765.6	5.2900	0.3715	0.1618	0.9591	3.221	0.28
209	14.0	767.0	5.2800	0.2735	0.1642	0.9786	3.809	0.44
210	14.0	767.0	5.2800	0.2815	0.1639	0.9770	3.809	0.44
211	17.4	770.0	5.2600	0.2422	0.1644	0.9847	4.137	0.56
212	17.4	770.0	5.2600	0.2495	0.1642	0.9833	4.137	0.56
213	20.0	768.9	5.2670	0.2330	0.1650	0.9867	4.267	0.66
214	20.0	768.9	5.2670	0.2400	0.1648	0.9852	4.267	0.66
215	25.0	775.9	5.2200	0.2112	0.1640	0.9907	4.598	0.85
216	25.0	775.9	5.2200	0.2188	0.1638	0.9891	4.598	0.85
217	30.0	773.5	5.2360	0.2046	0.1648	0.9922	4.759	1.04
218	30.0	773.5	5.2360	0.2121	0.1646	0.9906	4.759	1.04
219	35.5	773.9	5.2330	0.1922	0.1651	0.9946	5.108	1.25
220	35.5	773.9	5.2330	0.1995	0.1648	0.9932	5.108	1.25

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

221	5.7	770.0	5.2600	0.5029	0.1175	0.9251	2.577	0.11
222	5.7	770.0	5.2600	0.5137	0.1173	0.9229	2.577	0.11
223	10.0	765.6	5.2900	0.3098	0.1231	0.9639	3.297	0.27
224	10.0	765.6	5.2900	0.3185	0.1229	0.9621	3.297	0.27
225	14.0	767.0	5.2800	0.2419	0.1241	0.9772	3.749	0.42
226	14.0	767.0	5.2800	0.2491	0.1239	0.9757	3.749	0.42
227	17.4	770.0	5.2600	0.2128	0.1243	0.9828	4.018	0.54
228	17.4	770.0	5.2600	0.2205	0.1241	0.9812	4.018	0.54
229	20.0	768.9	5.2670	0.2005	0.1247	0.9853	4.170	0.64
230	20.0	768.9	5.2670	0.2079	0.1246	0.9838	4.170	0.64
231	25.0	775.9	5.2200	0.1889	0.1238	0.9872	4.307	0.82
232	25.0	775.9	5.2200	0.1961	0.1236	0.9858	4.307	0.82
233	30.0	773.5	5.2360	0.1790	0.1244	0.9893	4.478	1.00
234	30.0	773.5	5.2360	0.1860	0.1243	0.9879	4.478	1.00
235	40.0	773.5	5.2360	0.1634	0.1248	0.9924	4.806	1.37
236	40.0	773.5	5.2360	0.1699	0.1247	0.9911	4.806	1.37

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = 4° C

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

237	5.7	775.5	7.1950	0.3065	0.1733	0.9810	3.932	0.24
238	5.7	775.5	7.1950	0.3151	0.1731	0.9798	3.932	0.24
239	10.0	785.9	7.1000	0.2356	0.1724	0.9909	4.642	0.53
240	10.0	785.9	7.1000	0.2427	0.1722	0.9898	4.642	0.53
241	14.0	788.4	7.0780	0.2005	0.1726	0.9960	5.392	0.80
242	14.0	788.4	7.0780	0.2079	0.1724	0.9949	5.392	0.80

243	16.5	788.4	7.0780	0.1840	0.1730	0.9984	6.190	0.97
244	16.5	788.4	7.0780	0.1910	0.1728	0.9974	6.190	0.97
245	17.4	787.4	7.0870	0.1741	0.1734	0.9999	8.025	1.03
246	17.4	787.4	7.0870	0.1809	0.1733	0.9989	8.025	1.03
GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
247	5.7	775.5	7.1950	0.2752	0.1163	0.9776	3.772	0.23
248	5.7	775.5	7.1950	0.2832	0.1162	0.9764	3.772	0.23
249	10.0	785.9	7.1000	0.1963	0.1159	0.9885	4.419	0.49
250	10.0	785.9	7.1000	0.2037	0.1157	0.9874	4.419	0.49
251	14.0	788.4	7.0780	0.1614	0.1160	0.9935	4.967	0.74
252	14.0	788.4	7.0780	0.1678	0.1159	0.9925	4.967	0.74
253	17.4	787.4	7.0870	0.1380	0.1165	0.9969	5.634	0.95
254	17.4	787.4	7.0870	0.1454	0.1164	0.9958	5.634	0.95
255	20.0	768.2	7.2640	0.1306	0.1198	0.9985	6.239	1.11
256	20.0	768.2	7.2640	0.1377	0.1197	0.9975	6.239	1.11
GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
257	5.7	776.3	7.1880	0.2768	0.0873	0.9733	3.602	0.21
258	5.7	776.3	7.1880	0.2848	0.0872	0.9722	3.602	0.21
259	10.0	785.9	7.1000	0.1963	0.0870	0.9844	4.128	0.46
260	10.0	785.9	7.1000	0.2037	0.0869	0.9834	4.128	0.46
261	14.0	788.4	7.0780	0.1532	0.0872	0.9906	4.618	0.68
262	14.0	788.4	7.0780	0.1594	0.0872	0.9897	4.618	0.68
263	17.4	787.4	7.0870	0.1298	0.0876	0.9940	5.033	0.88
264	17.4	787.4	7.0870	0.1369	0.0875	0.9930	5.033	0.88
265	20.0	768.2	7.2640	0.1192	0.0901	0.9959	5.405	1.03
266	20.0	768.2	7.2640	0.1258	0.0901	0.9950	5.405	1.03
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
267	5.4	775.5	7.1950	0.5631	0.2552	0.9556	3.103	0.15
268	5.4	775.5	7.1950	0.5702	0.2549	0.9546	3.103	0.15
269	7.5	775.5	7.1950	0.4327	0.2598	0.9751	3.664	0.26
270	7.5	775.5	7.1950	0.4423	0.2594	0.9736	3.664	0.26
271	11.5	785.9	7.1000	0.3371	0.2593	0.9886	4.419	0.46
272	11.5	785.9	7.1000	0.3463	0.2590	0.9872	4.419	0.46
273	14.0	788.4	7.0780	0.3082	0.2594	0.9928	4.856	0.58
274	14.0	788.4	7.0780	0.3168	0.2591	0.9915	4.856	0.58
275	17.4	787.4	7.0870	0.2958	0.2602	0.9948	5.148	0.75
276	17.4	787.4	7.0870	0.3042	0.2599	0.9935	5.148	0.75
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
277	5.7	775.5	7.1950	0.5232	0.1718	0.9500	2.985	0.16
278	5.7	775.5	7.1950	0.5301	0.1716	0.9490	2.985	0.16
279	17.4	787.4	7.0870	0.2340	0.1757	0.9916	4.718	0.71
280	17.4	787.4	7.0870	0.2410	0.1755	0.9905	4.718	0.71
281	10.0	785.9	7.1000	0.3189	0.1741	0.9791	3.837	0.36
282	10.0	785.9	7.1000	0.3278	0.1738	0.9778	3.837	0.36
283	14.0	788.4	7.0780	0.2620	0.1748	0.9874	4.328	0.55
284	14.0	788.4	7.0780	0.2697	0.1746	0.9862	4.328	0.55
285	20.0	768.2	7.2640	0.2164	0.1810	0.9950	5.195	0.83
286	20.0	768.2	7.2640	0.2242	0.1808	0.9939	5.195	0.83
287	25.0	776.1	7.1900	0.2018	0.1793	0.9968	5.596	1.07
288	25.0	776.1	7.1900	0.2092	0.1791	0.9957	5.596	1.07
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
289	5.7	775.5	7.1950	0.4616	0.1302	0.9531	3.044	0.15
290	5.7	775.5	7.1950	0.4717	0.1300	0.9516	3.044	0.15
291	10.0	785.9	7.1000	0.2683	0.1317	0.9804	3.904	0.34
292	10.0	785.9	7.1000	0.2762	0.1316	0.9793	3.904	0.34
293	14.0	788.4	7.0780	0.2054	0.1324	0.9895	4.506	0.52

294	14.0	788.4	7.0780	0.2129	0.1323	0.9884	4.506	0.52
295	17.4	787.4	7.0870	0.1716	0.1332	0.9945	5.116	0.67
296	17.4	787.4	7.0870	0.1784	0.1331	0.9935	5.116	0.67
297	20.0	768.2	7.2640	0.1651	0.1369	0.9961	5.429	0.79
298	20.0	768.2	7.2640	0.1716	0.1368	0.9951	5.429	0.79
299	25.0	776.1	7.1900	0.1633	0.1355	0.9960	5.428	1.01
300	25.0	776.1	7.1900	0.1698	0.1353	0.9951	5.428	1.01
301	30.0	785.9	7.1000	0.1511	0.1338	0.9975	5.845	1.23
302	30.0	785.9	7.1000	0.1572	0.1337	0.9966	5.845	1.23

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

303	5.7	775.5	7.1950	0.7652	0.3225	0.9356	2.739	0.12
304	5.7	775.5	7.1950	0.7681	0.3223	0.9351	2.739	0.12
305	10.0	785.9	7.1000	0.4856	0.3296	0.9770	3.737	0.30
306	10.0	785.9	7.1000	0.4961	0.3291	0.9753	3.737	0.30
307	7.5	775.5	7.1950	0.5631	0.3318	0.9663	3.374	0.20
308	7.5	775.5	7.1950	0.5702	0.3314	0.9652	3.374	0.20
309	14.0	788.4	7.0780	0.4024	0.3322	0.9896	4.502	0.46
310	14.0	788.4	7.0780	0.4116	0.3318	0.9882	4.502	0.46
AW 311	17.4	787.4	7.0870	0.3619	0.3346	0.9960	5.354	0.59
312	17.4	787.4	7.0870	0.3715	0.3341	0.9945	5.354	0.59
THOU 313	25.0	776.1	7.1900	0.3594	0.3401	0.9972	5.663	0.89
314	25.0	776.1	7.1900	0.3690	0.3396	0.9957	5.663	0.89

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

315	5.7	774.2	7.2070	0.7251	0.2178	0.9274	2.620	0.12
316	5.7	774.2	7.2070	0.7282	0.2177	0.9270	2.620	0.12
317	10.0	785.9	7.1000	0.4310	0.2226	0.9697	3.473	0.28
318	10.0	785.9	7.1000	0.4407	0.2223	0.9683	3.473	0.28
319	14.0	788.4	7.0780	0.3329	0.2249	0.9842	4.108	0.44
320	14.0	788.4	7.0780	0.3421	0.2246	0.9829	4.108	0.44
321	17.4	787.4	7.0870	0.2958	0.2263	0.9899	4.534	0.56
322	17.4	787.4	7.0870	0.3042	0.2261	0.9886	4.534	0.56
323	25.0	768.2	7.2640	0.2636	0.2336	0.9957	5.338	0.85
324	25.0	768.2	7.2640	0.2714	0.2334	0.9946	5.338	0.85

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

325	5.7	776.3	7.1880	0.5964	0.1663	0.9387	2.784	0.11
326	5.7	776.3	7.1880	0.6036	0.1662	0.9377	2.784	0.11
327	10.0	785.9	7.1000	0.3453	0.1694	0.9746	3.647	0.27
328	10.0	785.9	7.1000	0.3547	0.1692	0.9732	3.647	0.27
329	14.0	788.4	7.0780	0.2966	0.1700	0.9817	3.966	0.42
330	14.0	788.4	7.0780	0.3050	0.1698	0.9804	3.966	0.42
331	17.4	787.4	7.0870	0.2810	0.1706	0.9840	4.102	0.54
332	17.4	787.4	7.0870	0.2890	0.1704	0.9828	4.102	0.54
333	20.0	768.2	7.2640	0.2416	0.1762	0.9908	4.633	0.64
334	20.0	768.2	7.2640	0.2488	0.1761	0.9897	4.633	0.64
335	25.0	776.1	7.1900	0.2169	0.1748	0.9940	5.029	0.82
336	25.0	776.1	7.1900	0.2247	0.1746	0.9929	5.029	0.82
337	30.0	785.9	7.1000	0.2005	0.1728	0.9960	5.402	1.00
338	30.0	785.9	7.1000	0.2079	0.1726	0.9949	5.402	1.00

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -15°C

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

339	5.7	755.4	2.3830	0.2876	0.0504	0.8983	2.269	0.22
340	5.7	755.4	2.3830	0.2958	0.0502	0.8947	2.269	0.22
341	10.0	758.2	2.3740	0.2422	0.0513	0.9178	2.479	0.50

342	10.0	758.2	2.3740	0.2495	0.0511	0.9146	2.479	0.50
343	17.4	754.7	2.3850	0.2046	0.0524	0.9348	2.705	0.98
344	17.4	754.7	2.3850	0.2121	0.0522	0.9315	2.705	0.98
345	22.4	760.5	2.3670	0.1840	0.0525	0.9432	2.841	1.30
346	22.4	760.5	2.3670	0.1910	0.0523	0.9401	2.841	1.30
347	26.5	764.7	2.3540	0.1716	0.0524	0.9482	2.932	1.56
348	26.5	764.7	2.3540	0.1784	0.0523	0.9452	2.932	1.56
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
349	5.7	755.4	2.3830	0.2373	0.0344	0.9136	2.432	0.20
350	5.7	755.4	2.3830	0.2444	0.0343	0.9106	2.432	0.20
351	10.0	758.2	2.3740	0.1774	0.0352	0.9392	2.776	0.46
352	10.0	758.2	2.3740	0.1843	0.0351	0.9362	2.776	0.46
353	17.4	754.7	2.3850	0.1552	0.0357	0.9491	2.953	0.90
354	17.4	754.7	2.3850	0.1615	0.0356	0.9464	2.953	0.90
355	22.4	760.5	2.3670	0.1367	0.0357	0.9567	3.103	1.20
356	22.4	760.5	2.3670	0.1441	0.0356	0.9535	3.103	1.20
357	26.5	764.7	2.3540	0.1486	0.0353	0.9511	2.992	1.44
358	26.5	764.7	2.3540	0.1547	0.0352	0.9485	2.992	1.44
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
359	5.7	756.9	2.3780	0.2128	0.0261	0.9206	2.513	0.19
360	5.7	756.9	2.3780	0.2205	0.0260	0.9173	2.513	0.19
361	10.0	758.2	2.3740	0.1634	0.0266	0.9417	2.819	0.43
362	10.0	758.2	2.3740	0.1699	0.0265	0.9389	2.819	0.43
363	17.4	754.7	2.3850	0.1296	0.0271	0.9565	3.102	0.83
364	17.4	754.7	2.3850	0.1367	0.0270	0.9535	3.102	0.83
365	22.4	760.5	2.3670	0.1190	0.0270	0.9607	3.202	1.11
366	22.4	760.5	2.3670	0.1255	0.0269	0.9579	3.202	1.11
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
367	5.7	755.4	2.3830	0.4947	0.0697	0.8163	1.682	0.15
368	5.7	755.4	2.3830	0.5053	0.0693	0.8115	1.682	0.15
369	10.0	758.2	2.3740	0.4037	0.0726	0.8561	1.925	0.35
370	10.0	758.2	2.3740	0.4129	0.0723	0.8520	1.925	0.35
371	17.4	756.9	2.3780	0.3453	0.0749	0.8826	2.124	0.71
372	17.4	756.9	2.3780	0.3547	0.0745	0.8784	2.124	0.71
373	22.4	760.5	2.3670	0.3082	0.0758	0.8986	2.270	0.95
374	22.4	760.5	2.3670	0.3168	0.0755	0.8947	2.270	0.95
375	26.5	764.7	2.3540	0.2876	0.0760	0.9072	2.357	1.15
376	26.5	764.7	2.3540	0.2958	0.0758	0.9034	2.357	1.15
377	30.0	762.7	2.3600	0.2463	0.0778	0.9261	2.584	1.32
378	30.0	762.7	2.3600	0.2537	0.0775	0.9228	2.584	1.32
379	35.0	762.7	2.3600	0.2216	0.0786	0.9373	2.746	1.56
380	35.0	762.7	2.3600	0.2284	0.0784	0.9343	2.746	1.56
381	40.0	761.7	2.3630	0.2299	0.0785	0.9337	2.691	1.80
382	40.0	761.7	2.3630	0.2368	0.0782	0.9306	2.691	1.80
383	50.0	762.7	2.3600	0.2128	0.0790	0.9413	2.807	2.28
384	50.0	762.7	2.3600	0.2205	0.0787	0.9378	2.807	2.28
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
385	5.7	756.9	2.3780	0.4450	0.0476	0.8294	1.756	0.14
386	5.7	756.9	2.3780	0.4549	0.0473	0.8251	1.756	0.14
387	10.0	758.2	2.3740	0.3701	0.0493	0.8620	1.965	0.33
388	10.0	758.2	2.3740	0.3799	0.0490	0.8577	1.965	0.33
389	17.4	754.7	2.3850	0.2958	0.0513	0.8952	2.239	0.67
390	17.4	754.7	2.3850	0.3042	0.0511	0.8916	2.239	0.67
391	22.4	760.5	2.3670	0.2587	0.0518	0.9106	2.397	0.90
392	22.4	760.5	2.3670	0.2663	0.0516	0.9073	2.397	0.90
393	26.5	764.7	2.3540	0.2463	0.0518	0.9155	2.452	1.08
394	26.5	764.7	2.3540	0.2537	0.0516	0.9122	2.452	1.08

395	30.0	762.7	2.3600	0.2216	0.0525	0.9267	2.593	1.24
396	30.0	762.7	2.3600	0.2284	0.0523	0.9237	2.593	1.24
397	35.0	762.7	2.3600	0.2958	0.0507	0.8939	2.226	1.47
398	35.0	762.7	2.3600	0.3042	0.0505	0.8902	2.226	1.47
399	40.0	761.7	2.3630	0.2087	0.0529	0.9326	2.672	1.70
400	40.0	761.7	2.3630	0.2163	0.0527	0.9292	2.672	1.70
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
401	5.7	755.9	2.3780	0.3660	0.0371	0.8595	1.948	0.13
402	5.7	756.9	2.3780	0.3757	0.0370	0.8553	1.948	0.13
403	10.0	758.2	2.3740	0.3082	0.0381	0.8844	2.141	0.32
404	10.0	758.2	2.3740	0.3168	0.0379	0.8806	2.141	0.32
405	17.4	754.7	2.3850	0.2711	0.0390	0.9011	2.296	0.63
406	17.4	754.7	2.3850	0.2789	0.0388	0.8977	2.296	0.63
407	22.4	760.5	2.3670	0.2669	0.0387	0.9020	2.306	0.85
408	22.4	760.5	2.3670	0.2747	0.0386	0.8986	2.306	0.85
409	26.5	764.7	2.3540	0.2381	0.0390	0.9140	2.435	1.03
410	26.5	764.7	2.3540	0.2452	0.0389	0.9109	2.435	1.03
411	30.0	762.7	2.3600	0.2087	0.0396	0.9271	2.597	1.18
412	30.0	762.7	2.3600	0.2163	0.0395	0.9238	2.597	1.18
413	35.0	762.7	2.3600	0.1963	0.0399	0.9326	2.673	1.39
414	35.0	762.7	2.3600	0.2037	0.0397	0.9293	2.673	1.39
415	40.0	761.7	2.3630	0.1922	0.0400	0.9345	2.702	1.61
416	40.0	761.7	2.3630	0.1995	0.0399	0.9313	2.702	1.61
GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
417	5.7	756.9	2.3780	0.6380	0.0839	0.7585	1.414	0.10
418	5.7	756.9	2.3780	0.6453	0.0835	0.7551	1.414	0.10
419	10.0	758.2	2.3740	0.5216	0.0890	0.8107	1.656	0.27
420	10.0	758.2	2.3740	0.5284	0.0886	0.8076	1.656	0.27
421	17.4	754.7	2.3850	0.4037	0.0950	0.8652	1.989	0.55
422	17.4	754.7	2.3850	0.4129	0.0946	0.8610	1.989	0.55
423	22.4	760.5	2.3670	0.3660	0.0959	0.8811	2.111	0.75
424	22.4	760.5	2.3670	0.3757	0.0955	0.8766	2.111	0.75
425	26.5	764.7	2.3540	0.3453	0.0962	0.8897	2.185	0.90
426	26.5	764.7	2.3540	0.3547	0.0958	0.8854	2.185	0.90
427	30.0	762.7	2.3600	0.3041	0.0985	0.9091	2.377	1.04
428	30.0	762.7	2.3600	0.3126	0.0981	0.9051	2.377	1.04
429	35.0	762.7	2.3600	0.2876	0.0992	0.9167	2.463	1.23
430	35.0	762.7	2.3600	0.2958	0.0988	0.9129	2.463	1.23
431	40.0	761.7	2.3630	0.2752	0.0999	0.9226	2.535	1.43
432	40.0	761.7	2.3630	0.2832	0.0996	0.9189	2.535	1.43
433	50.0	762.7	2.3600	0.2546	0.1008	0.9319	2.662	1.81
434	50.0	762.7	2.3600	0.2621	0.1004	0.9284	2.662	1.81
GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
435	5.7	752.5	2.3920	0.5341	0.0597	0.7966	1.585	0.10
436	5.7	752.5	2.3920	0.5409	0.0595	0.7936	1.585	0.10
437	10.0	758.2	2.3740	0.4450	0.0618	0.8342	1.784	0.26
438	10.0	758.2	2.3740	0.4549	0.0615	0.8299	1.784	0.26
439	13.5	758.2	2.3740	0.3714	0.0641	0.8669	2.003	0.39
440	13.5	758.2	2.3740	0.3801	0.0638	0.8631	2.003	0.39
441	17.4	754.7	2.3850	0.3387	0.0655	0.8822	2.122	0.53
442	17.4	754.7	2.3850	0.3479	0.0652	0.8781	2.122	0.53
443	22.4	760.5	2.3670	0.3123	0.0657	0.8928	2.216	0.71
444	22.4	760.5	2.3670	0.3210	0.0654	0.8890	2.216	0.71
445	26.5	764.7	2.3540	0.2999	0.0657	0.8976	2.261	0.87
446	26.5	764.7	2.3540	0.3084	0.0654	0.8938	2.261	0.87
447	30.0	762.7	2.3600	0.2669	0.0669	0.9128	2.420	0.99

448	30.0	762.7	2.3600	0.2747	0.0667	0.9093	2.420	0.99
449	35.0	762.7	2.3600	0.2579	0.0672	0.9168	2.467	1.18
450	35.0	762.7	2.3600	0.2655	0.0670	0.9134	2.467	1.18
451	40.0	761.7	2.3630	0.2529	0.0674	0.9192	2.495	1.36
452	40.0	761.7	2.3630	0.2604	0.0672	0.9158	2.495	1.36
453	50.0	762.7	2.3600	0.2422	0.0678	0.9239	2.555	1.73
454	50.0	762.7	2.3600	0.2495	0.0676	0.9207	2.555	1.73
GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
455	5.7	757.6	2.3760	0.5153	0.0449	0.7982	1.589	0.09
456	5.7	757.6	2.3760	0.5263	0.0446	0.7934	1.589	0.09
457	8.0	758.2	2.3740	0.4699	0.0458	0.8179	1.691	0.18
458	8.0	758.2	2.3740	0.4801	0.0456	0.8134	1.691	0.18
459	10.0	758.2	2.3740	0.4368	0.0466	0.8323	1.773	0.25
460	10.0	758.2	2.3740	0.4465	0.0463	0.8281	1.773	0.25
461	13.0	758.2	2.3740	0.3649	0.0483	0.8638	1.979	0.35
462	13.0	758.2	2.3740	0.3746	0.0480	0.8596	1.979	0.35
AW 463	17.4	754.7	2.3850	0.3206	0.0496	0.8840	2.137	0.51
LIQUID 464	17.4	754.7	2.3850	0.3294	0.0494	0.8801	2.137	0.51
465	22.4	760.5	2.3670	0.2999	0.0496	0.8920	2.209	0.68
466	22.4	760.5	2.3670	0.3084	0.0494	0.8883	2.209	0.68
467	26.5	764.7	2.3540	0.2917	0.0495	0.8949	2.236	0.83
468	26.5	764.7	2.3540	0.3000	0.0493	0.8912	2.236	0.83
469	30.0	762.7	2.3600	0.2628	0.0503	0.9080	2.368	0.95
470	30.0	762.7	2.3600	0.2705	0.0501	0.9046	2.368	0.95
471	35.0	762.7	2.3600	0.2546	0.0505	0.9116	2.408	1.13
472	35.0	762.7	2.3600	0.2621	0.0503	0.9083	2.408	1.13
473	40.0	761.7	2.3630	0.2356	0.0510	0.9202	2.508	1.31
474	40.0	761.7	2.3630	0.2427	0.0509	0.9170	2.508	1.31
475	50.0	762.7	2.3600	0.2257	0.0512	0.9244	2.563	1.66
476	50.0	762.7	2.3600	0.2326	0.0510	0.9214	2.563	1.66

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2° C

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
477	5.7	764.2	5.3000	0.7778	0.1123	0.8717	2.051	0.22
478	5.7	764.2	5.3000	0.7806	0.1123	0.8712	2.051	0.22
479	10.0	764.2	5.3000	0.5631	0.1174	0.9140	2.445	0.50
480	10.0	764.2	5.3000	0.5702	0.1172	0.9126	2.445	0.50
481	14.2	766.0	5.2870	0.4947	0.1187	0.9272	2.606	0.77
482	14.2	766.0	5.2870	0.5053	0.1184	0.9251	2.606	0.77
483	17.4	766.0	5.2870	0.4368	0.1200	0.9387	2.776	0.98
484	17.4	766.0	5.2870	0.4465	0.1198	0.9368	2.776	0.98
485	22.6	773.0	5.2390	0.3806	0.1201	0.9491	2.961	1.31
486	22.6	773.0	5.2390	0.3894	0.1199	0.9474	2.961	1.31
487	26.5	766.5	5.2840	0.3453	0.1221	0.9568	3.120	1.56
488	26.5	766.5	5.2840	0.3547	0.1219	0.9549	3.120	1.56
GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
489	5.7	764.2	5.3000	0.6775	0.0766	0.8850	2.160	0.20
490	5.7	764.2	5.3000	0.6808	0.0766	0.8843	2.160	0.20
491	10.0	764.2	5.3000	0.5382	0.0788	0.9120	2.423	0.46
492	10.0	764.2	5.3000	0.5451	0.0787	0.9107	2.423	0.46
493	17.4	766.0	5.2870	0.3955	0.0808	0.9396	2.792	0.90
494	17.4	766.0	5.2870	0.4045	0.0807	0.9378	2.792	0.90
495	22.6	773.0	5.2390	0.3396	0.0809	0.9498	2.975	1.21

496	22.6	773.0	5.2390	0.3488	0.0807	0.9480	2.975	1.21
497	26.5	766.5	5.2840	0.3288	0.0818	0.9525	3.029	1.44
498	26.5	766.5	5.2840	0.3379	0.0817	0.9508	3.029	1.44
GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
499	5.7	764.2	5.3000	0.6338	0.0580	0.8902	2.202	0.19
500	5.7	764.2	5.3000	0.6412	0.0580	0.8887	2.202	0.19
501	10.0	764.2	5.3000	0.4740	0.0599	0.9210	2.526	0.43
502	10.0	764.2	5.3000	0.4843	0.0598	0.9190	2.526	0.43
503	17.4	766.0	5.2870	0.3619	0.0611	0.9424	2.839	0.83
504	17.4	766.0	5.2870	0.3715	0.0610	0.9406	2.839	0.83
AW 505	22.6	773.0	5.2390	0.3123	0.0610	0.9515	3.008	1.12
506	22.6	773.0	5.2390	0.3210	0.0609	0.9498	3.008	1.12
507	26.5	766.5	5.2840	0.3082	0.0617	0.9528	3.036	1.34
508	26.5	766.5	5.2840	0.3168	0.0616	0.9511	3.036	1.34
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
509	5.7	764.2	5.3000	0.9997	0.1636	0.8372	1.815	0.15
510	5.7	764.2	5.3000	1.0003	0.1636	0.8371	1.815	0.15
511	10.0	764.2	5.3000	0.8196	0.1701	0.8734	2.065	0.35
512	10.0	764.2	5.3000	0.8221	0.1700	0.8729	2.065	0.35
513	17.4	766.0	5.2870	0.6463	0.1758	0.9079	2.377	0.71
514	17.4	766.0	5.2870	0.6537	0.1755	0.9065	2.377	0.71
515	22.6	773.0	5.2390	0.5631	0.1769	0.9237	2.564	0.96
516	22.6	773.0	5.2390	0.5702	0.1766	0.9223	2.564	0.96
517	26.5	766.5	5.2840	0.5382	0.1796	0.9297	2.646	1.15
518	26.5	766.5	5.2840	0.5451	0.1793	0.9283	2.646	1.15
519	30.0	774.4	5.2300	0.4120	0.1819	0.9544	3.068	1.32
520	30.0	774.4	5.2300	0.4213	0.1816	0.9525	3.068	1.32
521	35.0	774.4	5.2300	0.4037	0.1822	0.9561	3.105	1.56
522	35.0	774.4	5.2300	0.4129	0.1819	0.9542	3.105	1.56
523	40.0	775.1	5.2250	0.3872	0.1826	0.9594	3.183	1.80
524	40.0	775.1	5.2250	0.3961	0.1823	0.9576	3.183	1.80
525	50.0	774.4	5.2300	0.3371	0.1846	0.9698	3.469	2.28
526	50.0	774.4	5.2300	0.3463	0.1843	0.9679	3.469	2.28
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
527	5.7	764.2	5.3000	0.9209	0.1113	0.8440	1.857	0.14
528	5.7	764.2	5.3000	0.9225	0.1113	0.8437	1.857	0.14
529	10.0	764.2	5.3000	0.7368	0.1157	0.8802	2.119	0.33
530	10.0	764.2	5.3000	0.7399	0.1157	0.8796	2.119	0.33
531	17.4	766.0	5.2870	0.5881	0.1190	0.9092	2.392	0.67
532	17.4	766.0	5.2870	0.5952	0.1188	0.9078	2.392	0.67
533	22.6	773.0	5.2390	0.5029	0.1197	0.9251	2.578	0.91
534	22.6	773.0	5.2390	0.5137	0.1195	0.9230	2.578	0.91
535	26.5	766.5	5.2840	0.4781	0.1215	0.9309	2.658	1.08
536	26.5	766.5	5.2840	0.4885	0.1213	0.9289	2.658	1.08
537	30.0	774.4	5.2300	0.4079	0.1218	0.9440	2.866	1.24
538	30.0	774.4	5.2300	0.4171	0.1215	0.9421	2.866	1.24
539	35.0	774.4	5.2300	0.3701	0.1227	0.9515	3.007	1.47
540	35.0	774.4	5.2300	0.3799	0.1224	0.9496	3.007	1.47
541	40.0	775.1	5.2250	0.3412	0.1232	0.9573	3.132	1.70
542	40.0	775.1	5.2250	0.3505	0.1230	0.9554	3.132	1.70
543	50.0	774.4	5.2300	0.2999	0.1243	0.9656	3.346	2.15
544	50.0	774.4	5.2300	0.3084	0.1241	0.9639	3.346	2.15
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
545	5.7	764.2	5.3000	0.8614	0.0847	0.8511	1.903	0.13
546	5.7	764.2	5.3000	0.8636	0.0846	0.8506	1.903	0.13
547	10.0	764.2	5.3000	0.6959	0.0877	0.8833	2.146	0.32

548	10.0	764.2	5.3000	0.6991	0.0876	0.8827	2.146	0.32
549	17.4	766.0	5.2870	0.5631	0.0898	0.9089	2.389	0.63
550	17.4	766.0	5.2870	0.5702	0.0897	0.9075	2.389	0.63
551	22.6	773.0	5.2390	0.4740	0.0905	0.9255	2.583	0.86
552	22.6	773.0	5.2390	0.4843	0.0903	0.9235	2.583	0.86
553	26.5	766.5	5.2840	0.4302	0.0921	0.9349	2.717	1.03
554	26.5	766.5	5.2840	0.4398	0.0920	0.9330	2.717	1.03
555	30.0	774.4	5.2300	0.3872	0.0918	0.9425	2.841	1.18
556	30.0	774.4	5.2300	0.3961	0.0917	0.9407	2.841	1.18
557	40.0	775.1	5.2250	0.3156	0.0930	0.9566	3.118	1.61
558	40.0	775.1	5.2250	0.3244	0.0929	0.9549	3.118	1.61
559	50.0	774.4	5.2300	0.2711	0.0939	0.9655	3.345	2.04
560	50.0	774.4	5.2300	0.2789	0.0938	0.9639	3.345	2.04

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

561	5.7	764.2	5.3000	1.2853	0.1992	0.7871	1.549	0.10
562	5.7	764.2	5.3000	1.2813	0.1994	0.7879	1.549	0.10
563	10.0	764.2	5.3000	1.0693	0.2093	0.8311	1.778	0.27
564	10.0	764.2	5.3000	1.0690	0.2093	0.8311	1.778	0.27
565	15.0	766.0	5.2870	0.8782	0.2176	0.8697	2.036	0.46
566	15.0	766.0	5.2870	0.8802	0.2175	0.8693	2.036	0.46
567	17.4	766.0	5.2870	0.7952	0.2215	0.8867	2.176	0.55
568	17.4	766.0	5.2870	0.7978	0.2213	0.8862	2.176	0.55
569	22.8	773.0	5.2390	0.7067	0.2231	0.9036	2.336	0.76
570	22.8	773.0	5.2390	0.7099	0.2230	0.9029	2.336	0.76
571	26.5	766.5	5.2840	0.6463	0.2282	0.9173	2.483	0.90
572	26.5	766.5	5.2840	0.6537	0.2279	0.9158	2.483	0.90
573	30.0	774.4	5.2300	0.5382	0.2305	0.9384	2.776	1.04
574	30.0	774.4	5.2300	0.5451	0.2302	0.9370	2.776	1.04
575	35.0	774.4	5.2300	0.4947	0.2325	0.9475	2.927	1.23
576	35.0	774.4	5.2300	0.5053	0.2320	0.9453	2.927	1.23
577	40.0	775.1	5.2250	0.4864	0.2326	0.9492	2.958	1.43
578	40.0	775.1	5.2250	0.4969	0.2321	0.9470	2.958	1.43
579	50.0	774.4	5.2300	0.4302	0.2355	0.9610	3.219	1.81
580	50.0	774.4	5.2300	0.4398	0.2350	0.9590	3.219	1.81

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

581	5.7	764.2	5.3000	1.2096	0.1356	0.7920	1.572	0.10
582	5.7	764.2	5.3000	1.2071	0.1357	0.7925	1.572	0.10
583	10.0	764.2	5.3000	0.9159	0.1449	0.8504	1.899	0.26
584	10.0	764.2	5.3000	0.9175	0.1448	0.8501	1.899	0.26
585	17.4	766.0	5.2870	0.7920	0.1483	0.8747	2.075	0.53
586	17.4	766.0	5.2870	0.7947	0.1482	0.8742	2.075	0.53
587	22.6	773.0	5.2390	0.6688	0.1505	0.8981	2.277	0.72
588	22.6	773.0	5.2390	0.6762	0.1503	0.8966	2.277	0.72
589	26.5	766.5	5.2840	0.6380	0.1530	0.9055	2.351	0.87
590	26.5	766.5	5.2840	0.6453	0.1528	0.9040	2.351	0.87
591	30.0	774.4	5.2300	0.5112	0.1551	0.9298	2.641	0.99
592	30.0	774.4	5.2300	0.5221	0.1547	0.9276	2.641	0.99
593	35.0	774.4	5.2300	0.4533	0.1569	0.9416	2.823	1.18
594	35.0	774.4	5.2300	0.4633	0.1566	0.9395	2.823	1.18
595	40.0	775.1	5.2250	0.4244	0.1576	0.9474	2.926	1.36
596	40.0	775.1	5.2250	0.4339	0.1573	0.9454	2.926	1.36
597	50.0	774.4	5.2300	0.4037	0.1584	0.9516	3.010	1.73
598	50.0	774.4	5.2300	0.4129	0.1581	0.9498	3.010	1.73

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

599	5.7	764.2	5.3000	1.1508	0.1033	0.7984	1.602	0.09
600	5.7	764.2	5.3000	1.1492	0.1033	0.7987	1.602	0.09

601	10.0	764.2	5.3000	0.8865	0.1095	0.8503	1.898	0.25
602	10.0	764.2	5.3000	0.8885	0.1095	0.8499	1.898	0.25
603	17.4	766.0	5.2870	0.6917	0.1138	0.8883	2.189	0.51
604	17.4	766.0	5.2870	0.6950	0.1137	0.8876	2.189	0.51
605	22.6	773.0	5.2390	0.6172	0.1143	0.9019	2.314	0.69
606	22.6	773.0	5.2390	0.6245	0.1141	0.9004	2.314	0.69
607	26.5	766.5	5.2840	0.5964	0.1159	0.9070	2.368	0.83
608	26.5	766.5	5.2840	0.6036	0.1158	0.9056	2.368	0.83
609	30.0	774.4	5.2300	0.4988	0.1168	0.9253	2.580	0.95
610	30.0	774.4	5.2300	0.5095	0.1166	0.9232	2.580	0.95
611	35.0	774.4	5.2300	0.4616	0.1177	0.9327	2.684	1.13
612	35.0	774.4	5.2300	0.4717	0.1175	0.9307	2.684	1.13
613	40.0	775.1	5.2250	0.4285	0.1183	0.9393	2.786	1.31
614	40.0	775.1	5.2250	0.4381	0.1181	0.9373	2.786	1.31
615	50.0	774.4	5.2300	0.4037	0.1191	0.9443	2.872	1.66
616	50.0	774.4	5.2300	0.4129	0.1188	0.9425	2.872	1.66

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = 4°C

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL.

GAS RATE = 165.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
617	5.7	756.1	7.3800	1.2180	0.1569	0.8531	1.919	0.22
618	5.7	756.1	7.3800	1.2153	0.1569	0.8535	1.919	0.22
619	10.0	764.4	7.3000	0.8572	0.1632	0.9028	2.329	0.50
620	10.0	764.4	7.3000	0.8594	0.1632	0.9024	2.329	0.50
621	17.4	762.3	7.3200	0.5798	0.1703	0.9427	2.851	0.98
622	17.4	762.3	7.3200	0.5869	0.1701	0.9417	2.851	0.98
623	20.9	766.0	7.2850	0.4781	0.1717	0.9569	3.128	1.20
624	20.9	766.0	7.2850	0.4885	0.1714	0.9554	3.128	1.20
625	25.0	758.2	7.3600	0.4575	0.1742	0.9606	3.216	1.47
626	25.0	758.2	7.3600	0.4675	0.1739	0.9591	3.216	1.47
627	26.5	758.2	7.3600	0.3872	0.1758	0.9706	3.505	1.56
628	26.5	758.2	7.3600	0.3961	0.1756	0.9693	3.505	1.56
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
629	5.7	756.1	7.3800	1.0584	0.1074	0.8692	2.034	0.20
630	5.7	756.1	7.3800	1.0583	0.1074	0.8693	2.034	0.20
631	10.0	764.4	7.3000	0.7652	0.1106	0.9089	2.394	0.46
632	10.0	764.4	7.3000	0.7681	0.1105	0.9085	2.394	0.46
633	17.4	762.3	7.3200	0.4699	0.1155	0.9508	2.998	0.90
634	17.4	762.3	7.3200	0.4801	0.1154	0.9494	2.998	0.90
635	20.3	766.0	7.2850	0.4037	0.1160	0.9599	3.199	1.07
636	20.3	766.0	7.2850	0.4129	0.1158	0.9586	3.199	1.07
637	25.0	758.2	7.3600	0.3901	0.1175	0.9624	3.263	1.35
638	25.0	758.2	7.3600	0.3991	0.1174	0.9611	3.263	1.35
639	26.5	758.2	7.3600	0.3577	0.1180	0.9669	3.388	1.44
640	26.5	758.2	7.3600	0.3673	0.1179	0.9656	3.388	1.44
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
641	5.7	756.1	7.3800	0.9997	0.0813	0.8742	2.073	0.19
642	5.7	756.1	7.3800	1.0003	0.0813	0.8741	2.073	0.19
643	10.0	764.4	7.3000	0.7276	0.0835	0.9107	2.414	0.43
644	10.0	764.4	7.3000	0.7307	0.0834	0.9103	2.414	0.43
645	12.5	764.4	7.3000	0.5963	0.0850	0.9291	2.640	0.56
646	12.5	764.4	7.3000	0.6035	0.0849	0.9281	2.640	0.56
647	17.4	762.3	7.3200	0.4699	0.0868	0.9470	2.925	0.83
648	17.4	762.3	7.3200	0.4801	0.0867	0.9456	2.925	0.83
649	20.9	766.0	7.2850	0.3955	0.0872	0.9572	3.136	1.03

650	20.9	766.0	7.2850	0.4045	0.0871	0.9559	3.136	1.03
651	25.0	758.2	7.3600	0.3485	0.0888	0.9643	3.314	1.25
652	25.0	758.2	7.3600	0.3579	0.0886	0.9630	3.314	1.25
653	26.5	758.2	7.3600	0.3453	0.0888	0.9647	3.326	1.34
654	26.5	758.2	7.3600	0.3547	0.0887	0.9634	3.326	1.34
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
655	5.7	756.1	7.3800	1.4876	0.2296	0.8241	1.741	0.15
656	5.7	756.1	7.3800	1.4790	0.2299	0.8253	1.741	0.15
657	10.0	764.4	7.3000	1.1928	0.2370	0.8647	2.001	0.35
658	10.0	764.4	7.3000	1.1905	0.2370	0.8650	2.001	0.35
659	13.5	764.4	7.3000	0.9552	0.2455	0.8994	2.296	0.52
660	13.5	764.4	7.3000	0.9564	0.2454	0.8992	2.296	0.52
661	17.4	762.3	7.3200	0.8740	0.2492	0.9116	2.425	0.71
662	17.4	762.3	7.3200	0.8760	0.2491	0.9113	2.425	0.71
663	20.9	766.0	7.2850	0.7485	0.2522	0.9294	2.648	0.88
664	20.9	766.0	7.2850	0.7515	0.2521	0.9290	2.648	0.88
665	25.0	758.2	7.3600	0.7241	0.2562	0.9341	2.717	1.08
666	25.0	758.2	7.3600	0.7272	0.2561	0.9337	2.717	1.08
667	26.5	758.2	7.3600	0.6463	0.2589	0.9454	2.899	1.15
668	26.5	758.2	7.3600	0.6537	0.2587	0.9444	2.899	1.15
669	30.0	768.6	7.2600	0.5382	0.2587	0.9601	3.208	1.32
670	30.0	768.6	7.2600	0.5451	0.2584	0.9591	3.208	1.32
671	35.0	768.6	7.2600	0.4781	0.2608	0.9690	3.448	1.56
672	35.0	768.6	7.2600	0.4885	0.2604	0.9674	3.448	1.56
673	40.0	771.8	7.2300	0.4244	0.2615	0.9766	3.727	1.80
674	40.0	771.8	7.2300	0.4339	0.2612	0.9752	3.727	1.80
675	50.0	772.3	7.2250	0.3955	0.2623	0.9809	3.923	2.28
676	50.0	772.3	7.2250	0.4045	0.2620	0.9795	3.923	2.28
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
677	5.7	756.1	7.3800	1.3022	0.1582	0.8416	1.845	0.14
678	5.7	756.1	7.3800	1.2978	0.1583	0.8422	1.845	0.14
679	10.0	764.4	7.3000	1.0416	0.1623	0.8768	2.094	0.33
680	10.0	764.4	7.3000	1.0417	0.1623	0.8768	2.094	0.33
681	17.4	762.3	7.3200	0.7903	0.1688	0.9131	2.441	0.67
682	17.4	762.3	7.3200	0.7930	0.1688	0.9127	2.441	0.67
683	20.9	766.0	7.2850	0.6775	0.1706	0.9287	2.638	0.83
684	20.9	766.0	7.2850	0.6808	0.1705	0.9283	2.638	0.83
685	25.0	758.2	7.3600	0.6205	0.1740	0.9379	2.770	1.02
686	25.0	758.2	7.3600	0.6278	0.1738	0.9368	2.770	1.02
687	26.5	758.2	7.3600	0.6630	0.1730	0.9318	2.678	1.08
688	26.5	758.2	7.3600	0.6704	0.1728	0.9308	2.678	1.08
689	30.0	768.6	7.2600	0.4616	0.1750	0.9596	3.190	1.24
690	30.0	768.6	7.2600	0.4717	0.1748	0.9581	3.190	1.24
691	35.0	768.6	7.2600	0.4368	0.1756	0.9631	3.282	1.47
692	35.0	768.6	7.2600	0.4465	0.1754	0.9617	3.282	1.47
693	40.0	771.8	7.2300	0.4079	0.1755	0.9671	3.393	1.70
694	40.0	771.8	7.2300	0.4171	0.1753	0.9657	3.393	1.70
695	50.0	772.3	7.2250	0.3806	0.1760	0.9710	3.518	2.15
696	50.0	772.3	7.2250	0.3894	0.1758	0.9697	3.518	2.15
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
697	5.7	756.1	7.3800	1.1592	0.1215	0.8570	1.946	0.13
698	5.7	756.1	7.3800	1.1575	0.1215	0.8573	1.946	0.13
699	10.0	764.4	7.3000	0.9159	0.1242	0.8897	2.203	0.32
700	10.0	764.4	7.3000	0.9175	0.1242	0.8894	2.203	0.32
701	17.4	762.3	7.3200	0.7276	0.1280	0.9166	2.482	0.63
702	17.4	762.3	7.3200	0.7307	0.1280	0.9162	2.482	0.63

703	20.9	766.0	7.2850	0.6338	0.1290	0.9295	2.644	0.79
704	20.9	766.0	7.2850	0.6412	0.1289	0.9284	2.644	0.79
705	26.5	758.2	7.3600	0.6105	0.1310	0.9337	2.705	1.03
706	26.5	758.2	7.3600	0.6178	0.1308	0.9326	2.705	1.03
707	30.0	768.6	7.2600	0.4120	0.1325	0.9608	3.222	1.18
708	30.0	768.6	7.2600	0.4213	0.1323	0.9594	3.222	1.18
709	40.0	771.8	7.2300	0.4161	0.1318	0.9599	3.201	1.61
710	40.0	771.8	7.2300	0.4255	0.1316	0.9586	3.201	1.61
711	50.0	772.3	7.2250	0.3660	0.1326	0.9671	3.393	2.04
712	50.0	772.3	7.2250	0.3757	0.1324	0.9657	3.393	2.04

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

713	5.7	756.1	7.3800	1.7328	0.2865	0.7961	1.596	0.10
714	5.7	756.1	7.3800	1.7172	0.2872	0.7984	1.596	0.10
715	10.0	764.4	7.3000	1.3156	0.3018	0.8551	1.934	0.27
716	10.0	764.4	7.3000	1.3110	0.3020	0.8558	1.934	0.27
717	13.0	764.4	7.3000	1.1676	0.3087	0.8771	2.098	0.38
718	13.0	764.4	7.3000	1.1658	0.3088	0.8774	2.098	0.38
719	17.4	762.3	7.3200	1.0584	0.3148	0.8939	2.243	0.55
720	17.4	762.3	7.3200	1.0583	0.3148	0.8939	2.243	0.55
721	20.9	766.0	7.2850	0.9410	0.3184	0.9106	2.414	0.69
722	20.9	766.0	7.2850	0.9423	0.3183	0.9104	2.414	0.69
723	26.5	758.2	7.3600	0.8991	0.3243	0.9183	2.503	0.90
724	26.5	758.2	7.3600	0.9009	0.3242	0.9180	2.503	0.90
725	30.0	768.6	7.2600	0.6917	0.3286	0.9476	2.944	1.04
726	30.0	768.6	7.2600	0.6950	0.3284	0.9471	2.944	1.04
727	35.0	768.6	7.2600	0.5798	0.3337	0.9645	3.323	1.23
728	35.0	768.6	7.2600	0.5869	0.3334	0.9634	3.323	1.23
729	40.0	771.8	7.2300	0.5341	0.3342	0.9710	3.523	1.43
730	40.0	771.8	7.2300	0.5409	0.3339	0.9700	3.523	1.43
731	50.0	772.3	7.2250	0.4575	0.3374	0.9826	4.008	1.81
732	50.0	772.3	7.2250	0.4675	0.3370	0.9810	4.008	1.81

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

733	5.7	756.1	7.3800	1.6143	0.1957	0.8025	1.627	0.10
734	5.7	756.1	7.3800	1.6023	0.1960	0.8042	1.627	0.10
735	10.0	764.4	7.3000	1.2517	0.2042	0.8524	1.915	0.26
736	10.0	764.4	7.3000	1.2483	0.2043	0.8529	1.915	0.26
737	17.4	762.3	7.3200	1.0081	0.2126	0.8881	2.190	0.53
738	17.4	762.3	7.3200	1.0086	0.2125	0.8880	2.190	0.53
739	20.9	766.0	7.2850	0.8782	0.2154	0.9062	2.366	0.66
740	20.9	766.0	7.2850	0.8802	0.2153	0.9060	2.366	0.66
741	26.5	758.2	7.3600	0.7485	0.2221	0.9262	2.604	0.87
742	26.5	758.2	7.3600	0.7515	0.2220	0.9258	2.604	0.87
743	30.0	768.6	7.2600	0.6172	0.2226	0.9439	2.872	0.99
744	30.0	768.6	7.2600	0.6245	0.2223	0.9429	2.872	0.99
745	35.0	768.6	7.2600	0.5715	0.2240	0.9506	2.998	1.18
746	35.0	768.6	7.2600	0.5785	0.2238	0.9496	2.998	1.18
747	40.0	771.8	7.2300	0.5029	0.2250	0.9603	3.207	1.36
748	40.0	771.8	7.2300	0.5137	0.2247	0.9587	3.207	1.36
749	50.0	772.3	7.2250	0.4161	0.2275	0.9730	3.589	1.73
750	50.0	772.3	7.2250	0.4255	0.2272	0.9717	3.589	1.73

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

751	5.0	756.1	7.3800	1.7709	0.1434	0.7751	1.497	0.07
752	5.0	756.1	7.3800	1.7541	0.1438	0.7775	1.497	0.07
753	5.7	756.1	7.3800	1.4961	0.1499	0.8138	1.684	0.09
754	5.7	756.1	7.3800	1.4873	0.1501	0.8151	1.684	0.09
755	10.0	764.4	7.3000	1.1340	0.1564	0.8632	1.990	0.25

756	10.0	764.4	7.3000	1.1327	0.1564	0.8633	1.990	0.25
757	13.5	764.4	7.3000	0.9594	0.1605	0.8881	2.189	0.37
758	13.5	764.4	7.3000	0.9606	0.1604	0.8879	2.189	0.37
759	17.4	762.3	7.3200	0.8196	0.1643	0.9084	2.389	0.51
760	17.4	762.3	7.3200	0.8221	0.1642	0.9081	2.389	0.51
761	20.9	766.0	7.2850	0.7920	0.1640	0.9118	2.426	0.63
762	20.9	766.0	7.2850	0.7947	0.1639	0.9114	2.426	0.63
763	26.5	758.2	7.3600	0.7485	0.1670	0.9192	2.513	0.83
764	26.5	758.2	7.3600	0.7515	0.1669	0.9187	2.513	0.83
765	30.0	768.6	7.2600	0.5839	0.1682	0.9414	2.828	0.95
766	30.0	768.6	7.2600	0.5911	0.1680	0.9403	2.828	0.95
767	35.0	768.6	7.2600	0.4947	0.1703	0.9542	3.068	1.13
768	35.0	768.6	7.2600	0.5053	0.1700	0.9527	3.068	1.13
769	40.0	771.8	7.2300	0.4533	0.1704	0.9599	3.199	1.31
770	40.0	771.8	7.2300	0.4633	0.1702	0.9585	3.199	1.31
771	50.0	772.3	7.2250	0.4161	0.1711	0.9653	3.341	1.66
772	50.0	772.3	7.2250	0.4255	0.1709	0.9639	3.341	1.66

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2°C

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 2 : 1)

GAS RATE = 165.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
773	5.7	764.2	5.3000	0.6580	0.1152	0.8953	2.250	0.23
774	5.7	764.2	5.3000	0.6654	0.1150	0.8939	2.250	0.23
775	10.0	764.2	5.3000	0.4450	0.1202	0.9373	2.754	0.51
776	10.0	764.2	5.3000	0.4549	0.1199	0.9353	2.754	0.51
777	17.3	766.0	5.2870	0.3041	0.1231	0.9650	3.328	0.99
778	17.3	766.0	5.2870	0.3126	0.1229	0.9633	3.328	0.99
779	22.3	773.0	5.2390	0.2612	0.1229	0.9730	3.583	1.31
780	22.3	773.0	5.2390	0.2688	0.1227	0.9714	3.583	1.31
781	26.5	766.5	5.2840	0.2356	0.1246	0.9785	3.808	1.59
782	26.5	766.5	5.2840	0.2427	0.1245	0.9771	3.808	1.59
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
783	5.7	764.2	5.3000	0.3872	0.0812	0.9414	2.822	0.21
784	5.7	764.2	5.3000	0.3961	0.0810	0.9396	2.822	0.21
785	10.0	764.2	5.3000	0.3288	0.0821	0.9527	3.033	0.47
786	10.0	764.2	5.3000	0.3379	0.0819	0.9510	3.033	0.47
787	14.0	764.2	5.3000	0.2807	0.0828	0.9621	3.252	0.71
788	14.0	764.2	5.3000	0.2888	0.0827	0.9605	3.252	0.71
789	17.3	766.0	5.2870	0.2587	0.0830	0.9662	3.367	0.91
790	17.3	766.0	5.2870	0.2663	0.0828	0.9647	3.367	0.91
791	22.3	773.0	5.2390	0.2332	0.0825	0.9708	3.510	1.21
792	22.3	773.0	5.2390	0.2402	0.0824	0.9694	3.510	1.21
793	26.5	766.5	5.2840	0.2169	0.0836	0.9744	3.635	1.47
794	26.5	766.5	5.2840	0.2247	0.0834	0.9728	3.635	1.47
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
795	5.7	764.2	5.3000	0.3230	0.0617	0.9501	2.981	0.20
796	5.7	764.2	5.3000	0.3320	0.0616	0.9484	2.981	0.20
797	10.0	764.2	5.3000	0.2422	0.0626	0.9657	3.353	0.44
798	10.0	764.2	5.3000	0.2495	0.0626	0.9643	3.353	0.44
799	17.3	766.0	5.2870	0.2128	0.0628	0.9713	3.525	0.84
800	17.3	766.0	5.2870	0.2205	0.0627	0.9698	3.525	0.84
801	22.3	773.0	5.2390	0.2005	0.0623	0.9733	3.597	1.12
802	22.3	773.0	5.2390	0.2079	0.0623	0.9719	3.597	1.12
803	26.5	766.5	5.2840	0.1922	0.0630	0.9753	3.672	1.36

804	26.5	766.5	5.2840	0.1995	0.0629	0.9739	3.672	1.36
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
805	5.7	764.2	5.3000	0.7652	0.1721	0.8843	2.154	0.16
806	5.7	764.2	5.3000	0.7681	0.1720	0.8837	2.154	0.16
807	10.0	764.2	5.3000	0.5673	0.1792	0.9242	2.570	0.37
808	10.0	764.2	5.3000	0.5744	0.1789	0.9228	2.570	0.37
809	17.3	766.0	5.2870	0.4864	0.1815	0.9403	2.801	0.72
810	17.3	766.0	5.2870	0.4969	0.1812	0.9382	2.801	0.72
811	22.3	773.0	5.2390	0.4327	0.1816	0.9504	2.983	0.97
812	22.3	773.0	5.2390	0.4423	0.1812	0.9484	2.983	0.97
813	26.5	766.5	5.2840	0.4037	0.1844	0.9570	3.125	1.17
814	26.5	766.5	5.2840	0.4129	0.1840	0.9551	3.125	1.17
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
815	5.7	764.2	5.3000	0.7527	0.1153	0.8771	2.094	0.15
816	5.7	764.2	5.3000	0.7557	0.1153	0.8765	2.094	0.15
817	10.0	764.2	5.3000	0.5153	0.1210	0.9239	2.561	0.34
818	10.0	764.2	5.3000	0.5263	0.1208	0.9217	2.561	0.34
819	17.3	766.0	5.2870	0.4310	0.1227	0.9403	2.803	0.68
820	17.3	766.0	5.2870	0.4407	0.1225	0.9384	2.803	0.68
821	22.3	773.0	5.2390	0.4203	0.1217	0.9417	2.825	0.91
822	22.3	773.0	5.2390	0.4297	0.1215	0.9398	2.825	0.91
823	26.5	766.5	5.2840	0.4037	0.1233	0.9457	2.896	1.10
824	26.5	766.5	5.2840	0.4129	0.1231	0.9438	2.896	1.10
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
825	5.7	764.2	5.3000	0.5341	0.0906	0.9149	2.456	0.14
826	5.7	764.2	5.3000	0.5409	0.0905	0.9135	2.456	0.14
827	10.0	764.2	5.3000	0.4351	0.0924	0.9342	2.707	0.33
828	10.0	764.2	5.3000	0.4449	0.0922	0.9323	2.707	0.33
829	17.3	766.0	5.2870	0.3519	0.0936	0.9503	2.983	0.64
830	17.3	766.0	5.2870	0.3614	0.0934	0.9484	2.983	0.64
831	22.3	773.0	5.2390	0.3247	0.0931	0.9550	3.082	0.86
832	22.3	773.0	5.2390	0.3336	0.0930	0.9532	3.082	0.86
833	26.5	766.5	5.2840	0.3082	0.0943	0.9588	3.169	1.05
834	26.5	766.5	5.2840	0.3168	0.0942	0.9571	3.169	1.05
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
835	5.7	764.2	5.3000	1.1088	0.2079	0.8231	1.733	0.11
836	5.7	764.2	5.3000	1.1079	0.2080	0.8233	1.733	0.11
837	10.0	764.2	5.3000	0.7652	0.2240	0.8934	2.236	0.28
838	10.0	764.2	5.3000	0.7681	0.2239	0.8928	2.236	0.28
839	17.3	766.0	5.2870	0.6338	0.2295	0.9200	2.517	0.56
840	17.3	766.0	5.2870	0.6412	0.2291	0.9185	2.517	0.56
841	22.3	773.0	5.2390	0.5798	0.2295	0.9301	2.650	0.76
842	22.3	773.0	5.2390	0.5869	0.2292	0.9286	2.650	0.76
843	26.5	766.5	5.2840	0.5465	0.2334	0.9380	2.769	0.92
844	26.5	766.5	5.2840	0.5535	0.2330	0.9366	2.769	0.92
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
845	5.7	764.2	5.3000	1.0081	0.1423	0.8321	1.784	0.11
846	5.7	764.2	5.3000	1.0086	0.1423	0.8320	1.784	0.11
AW 847	10.0	764.2	5.3000	0.7318	0.1510	0.8872	2.179	0.27
LIQU 848	10.0	764.2	5.3000	0.7349	0.1509	0.8866	2.179	0.27
849	17.3	766.0	5.2870	0.5257	0.1569	0.9281	2.623	0.54
850	17.3	766.0	5.2870	0.5326	0.1567	0.9267	2.623	0.54
851	22.3	773.0	5.2390	0.5029	0.1560	0.9317	2.669	0.73
852	22.3	773.0	5.2390	0.5137	0.1557	0.9296	2.669	0.73
853	26.5	766.5	5.2840	0.4864	0.1581	0.9359	2.732	0.88
854	26.5	766.5	5.2840	0.4969	0.1577	0.9338	2.732	0.88

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

855	5.7	764.2	5.3000	0.9159	0.1091	0.8446	1.861	0.10
856	5.7	764.2	5.3000	0.9175	0.1090	0.8443	1.861	0.10
857	10.0	764.2	5.3000	0.5548	0.1176	0.9156	2.464	0.26
858	10.0	764.2	5.3000	0.5618	0.1174	0.9142	2.464	0.26
859	17.3	766.0	5.2870	0.4632	0.1194	0.9335	2.695	0.52
860	17.3	766.0	5.2870	0.4734	0.1192	0.9314	2.695	0.52
861	22.3	773.0	5.2390	0.4508	0.1185	0.9351	2.720	0.69
862	22.3	773.0	5.2390	0.4608	0.1182	0.9331	2.720	0.69
863	24.0	766.5	5.2840	0.4203	0.1201	0.9419	2.829	0.76
864	24.0	766.5	5.2840	0.4297	0.1198	0.9400	2.829	0.76
865	26.5	766.5	5.2840	0.4368	0.1197	0.9386	2.775	0.84
866	26.5	766.5	5.2840	0.4465	0.1194	0.9367	2.775	0.84

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2°C

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 1 : 1)

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

867	5.7	764.2	5.3000	0.4492	0.1201	0.9365	2.741	0.23
868	5.7	764.2	5.3000	0.4591	0.1198	0.9345	2.741	0.23
869	10.0	764.2	5.3000	0.3577	0.1222	0.9545	3.070	0.52
870	10.0	764.2	5.3000	0.3673	0.1220	0.9526	3.070	0.52
871	14.0	764.2	5.3000	0.2995	0.1236	0.9660	3.358	0.78
872	14.0	764.2	5.3000	0.3080	0.1234	0.9643	3.358	0.78
873	17.3	766.0	5.2870	0.2711	0.1239	0.9715	3.531	1.00
874	17.3	766.0	5.2870	0.2789	0.1237	0.9699	3.531	1.00
875	22.3	773.0	5.2390	0.2546	0.1230	0.9743	3.632	1.33
876	22.3	773.0	5.2390	0.2621	0.1229	0.9728	3.632	1.33
877	26.5	766.5	5.2840	0.1684	0.1262	0.9918	4.732	1.60
878	26.5	766.5	5.2840	0.1750	0.1261	0.9905	4.732	1.60

GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

879	5.7	764.2	5.3000	0.3789	0.0813	0.9430	2.849	0.22
880	5.7	764.2	5.3000	0.3877	0.0812	0.9413	2.849	0.22
881	10.0	764.2	5.3000	0.2917	0.0827	0.9599	3.198	0.48
882	10.0	764.2	5.3000	0.3000	0.0825	0.9583	3.198	0.48
883	14.0	764.2	5.3000	0.2294	0.0836	0.9721	3.554	0.72
884	14.0	764.2	5.3000	0.2363	0.0835	0.9707	3.554	0.72
885	17.3	766.0	5.2870	0.2062	0.0838	0.9765	3.719	0.92
886	17.3	766.0	5.2870	0.2138	0.0837	0.9750	3.719	0.92
887	22.3	773.0	5.2390	0.1758	0.0834	0.9821	3.986	1.22
888	22.3	773.0	5.2390	0.1826	0.0833	0.9807	3.986	1.22
889	26.5	766.5	5.2840	0.1601	0.0844	0.9854	4.189	1.48
890	26.5	766.5	5.2840	0.1665	0.0843	0.9842	4.189	1.48

GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

891	5.7	764.2	5.3000	0.4269	0.0605	0.9301	2.647	0.20
892	5.7	764.2	5.3000	0.4365	0.0604	0.9282	2.647	0.20
893	10.0	764.2	5.3000	0.2793	0.0622	0.9586	3.165	0.44
894	10.0	764.2	5.3000	0.2874	0.0621	0.9570	3.165	0.44
AW 895	17.3	766.0	5.2870	0.2046	0.0629	0.9729	3.581	0.85
LIQU 896	17.3	766.0	5.2870	0.2121	0.0628	0.9714	3.581	0.85
897	22.3	773.0	5.2390	0.1716	0.0627	0.9789	3.831	1.13
898	22.3	773.0	5.2390	0.1784	0.0626	0.9776	3.831	1.13
899	26.5	766.5	5.2840	0.1470	0.0636	0.9840	4.101	1.37
900	26.5	766.5	5.2840	0.1530	0.0635	0.9829	4.101	1.37
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
901	5.7	764.2	5.3000	0.7318	0.1733	0.8911	2.214	0.16

902	5.7	764.2	5.3000	0.7349	0.1732	0.8904	2.214	0.16
903	10.0	764.2	5.3000	0.5087	0.1812	0.9360	2.732	0.37
904	10.0	764.2	5.3000	0.5196	0.1809	0.9338	2.732	0.37
905	17.3	766.0	5.2870	0.4037	0.1845	0.9570	3.126	0.73
906	17.3	766.0	5.2870	0.4129	0.1841	0.9552	3.126	0.73
907	22.3	773.0	5.2390	0.3495	0.1845	0.9674	3.394	0.97
908	22.3	773.0	5.2390	0.3589	0.1842	0.9654	3.394	0.97
909	26.5	766.5	5.2840	0.3206	0.1873	0.9739	3.611	1.18
910	26.5	766.5	5.2840	0.3294	0.1870	0.9721	3.611	1.18
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
911	5.7	764.2	5.3000	0.7360	0.1157	0.8804	2.121	0.15
912	5.7	764.2	5.3000	0.7390	0.1157	0.8798	2.121	0.15
913	10.0	764.2	5.3000	0.4765	0.1220	0.9315	2.667	0.35
914	10.0	764.2	5.3000	0.4869	0.1217	0.9295	2.667	0.35
915	17.3	766.0	5.2870	0.3536	0.1246	0.9556	3.095	0.69
916	17.3	766.0	5.2870	0.3631	0.1243	0.9538	3.095	0.69
917	22.3	773.0	5.2390	0.3041	0.1245	0.9649	3.325	0.92
918	22.3	773.0	5.2390	0.3126	0.1243	0.9632	3.325	0.92
919	26.5	766.5	5.2840	0.2760	0.1263	0.9710	3.513	1.11
920	26.5	766.5	5.2840	0.2840	0.1261	0.9694	3.513	1.11
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
921	5.7	764.2	5.3000	0.5029	0.0911	0.9209	2.524	0.14
922	5.7	764.2	5.3000	0.5137	0.0909	0.9188	2.524	0.14
923	10.0	764.2	5.3000	0.3789	0.0934	0.9452	2.888	0.33
924	10.0	764.2	5.3000	0.3877	0.0932	0.9434	2.888	0.33
925	17.3	766.0	5.2870	0.3288	0.0940	0.9548	3.077	0.65
926	17.3	766.0	5.2870	0.3379	0.0939	0.9530	3.077	0.65
927	22.3	773.0	5.2390	0.2678	0.0942	0.9663	3.367	0.87
928	22.3	773.0	5.2390	0.2756	0.0940	0.9647	3.367	0.87
929	25.0	766.5	5.2840	0.2820	0.0948	0.9639	3.300	0.99
930	25.0	766.5	5.2840	0.2901	0.0946	0.9623	3.300	0.99
931	26.5	766.5	5.2840	0.2587	0.0952	0.9685	3.434	1.05
932	26.5	766.5	5.2840	0.2663	0.0951	0.9670	3.434	1.05
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
933	5.7	764.2	5.3000	0.9661	0.2146	0.8522	1.911	0.12
934	5.7	764.2	5.3000	0.9672	0.2146	0.8520	1.911	0.12
935	10.0	764.2	5.3000	0.7376	0.2253	0.8990	2.290	0.28
936	10.0	764.2	5.3000	0.7407	0.2252	0.8984	2.290	0.28
937	14.0	764.2	5.3000	0.5846	0.2324	0.9305	2.656	0.44
938	14.0	764.2	5.3000	0.5917	0.2321	0.9290	2.656	0.44
939	17.3	766.0	5.2870	0.5216	0.2347	0.9432	2.856	0.57
940	17.3	766.0	5.2870	0.5284	0.2343	0.9418	2.856	0.57
941	22.3	773.0	5.2390	0.4583	0.2351	0.9554	3.087	0.77
AW 942	22.3	773.0	5.2390	0.4684	0.2347	0.9533	3.087	0.77
NOU 943	26.5	766.5	5.2840	0.4203	0.2392	0.9641	3.301	0.93
944	26.5	766.5	5.2840	0.4297	0.2388	0.9621	3.301	0.93
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
945	5.7	764.2	5.3000	0.8614	0.1469	0.8613	1.974	0.11
946	5.7	764.2	5.3000	0.8636	0.1468	0.8609	1.974	0.11
947	10.0	764.2	5.3000	0.5939	0.1553	0.9147	2.454	0.27
948	10.0	764.2	5.3000	0.6011	0.1550	0.9133	2.454	0.27
949	17.3	766.0	5.2870	0.4327	0.1598	0.9468	2.916	0.55
950	17.3	766.0	5.2870	0.4423	0.1595	0.9448	2.916	0.55
951	22.3	773.0	5.2390	0.4037	0.1591	0.9518	3.014	0.73
952	22.3	773.0	5.2390	0.4129	0.1588	0.9500	3.014	0.73
953	26.5	766.5	5.2840	0.3831	0.1613	0.9567	3.120	0.89

954	26.5	766.5	5.2840	0.3919	0.1610	0.9549	3.120	0.89
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
955	5.7	764.2	5.3000	0.8907	0.1097	0.8495	1.893	0.11
956	5.7	764.2	5.3000	0.8926	0.1096	0.8491	1.893	0.11
957	10.0	764.2	5.3000	0.5673	0.1173	0.9132	2.436	0.26
958	10.0	764.2	5.3000	0.5744	0.1171	0.9118	2.436	0.26
959	17.3	766.0	5.2870	0.4079	0.1207	0.9444	2.874	0.52
960	17.3	766.0	5.2870	0.4171	0.1205	0.9426	2.874	0.52
961	22.3	773.0	5.2390	0.3536	0.1207	0.9545	3.070	0.70
962	22.3	773.0	5.2390	0.3631	0.1205	0.9526	3.070	0.70
963	26.5	766.5	5.2840	0.3305	0.1224	0.9597	3.189	0.85
964	26.5	766.5	5.2840	0.3395	0.1222	0.9579	3.189	0.85

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = - 2° C

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN
OIL MIXTURE (RATIO 1 : 2)

GAS RATE = 165.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
965	5.7	764.2	5.3000	0.3831	0.1216	0.9495	2.969	0.24
966	5.7	764.2	5.3000	0.3919	0.1214	0.9478	2.969	0.24
967	10.0	764.2	5.3000	0.3206	0.1231	0.9619	3.244	0.52
968	10.0	764.2	5.3000	0.3294	0.1229	0.9601	3.244	0.52
969	13.5	764.2	5.3000	0.2473	0.1248	0.9763	3.713	0.75
970	13.5	764.2	5.3000	0.2547	0.1246	0.9749	3.713	0.75
971	17.3	766.0	5.2870	0.2299	0.1249	0.9797	3.862	1.00
972	17.3	766.0	5.2870	0.2368	0.1247	0.9783	3.862	1.00
973	22.3	773.0	5.2390	0.1922	0.1245	0.9868	4.272	1.33
974	22.3	773.0	5.2390	0.1995	0.1243	0.9853	4.272	1.33
975	25.0	766.5	5.2840	0.2012	0.1254	0.9853	4.173	1.51
976	25.0	766.5	5.2840	0.2086	0.1253	0.9838	4.173	1.51
977	26.5	766.5	5.2840	0.1684	0.1262	0.9918	4.732	1.61
978	26.5	766.5	5.2840	0.1750	0.1261	0.9905	4.732	1.61
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
979	5.7	764.2	5.3000	0.2628	0.0831	0.9656	3.347	0.22
980	5.7	764.2	5.3000	0.2705	0.0830	0.9641	3.347	0.22
981	10.0	764.2	5.3000	0.2087	0.0840	0.9761	3.703	0.48
982	10.0	764.2	5.3000	0.2163	0.0838	0.9746	3.703	0.48
983	17.3	766.0	5.2870	0.1634	0.0844	0.9848	4.148	0.93
984	17.3	766.0	5.2870	0.1699	0.0843	0.9836	4.148	0.93
985	18.0	766.0	5.2870	0.1478	0.0847	0.9879	4.365	0.97
986	18.0	766.0	5.2870	0.1538	0.0846	0.9867	4.365	0.97
987	22.3	773.0	5.2390	0.1380	0.0840	0.9895	4.494	1.23
988	22.3	773.0	5.2390	0.1454	0.0839	0.9881	4.494	1.23
989	25.0	773.0	5.2390	0.1377	0.0840	0.9896	4.499	1.39
990	25.0	773.0	5.2390	0.1451	0.0839	0.9881	4.499	1.39
991	26.5	766.5	5.2840	0.1217	0.0850	0.9930	4.871	1.49
992	26.5	766.5	5.2840	0.1283	0.0849	0.9917	4.871	1.49
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
993	5.7	764.2	5.3000	0.2422	0.0626	0.9657	3.353	0.20
994	5.7	764.2	5.3000	0.2495	0.0626	0.9643	3.353	0.20
995	10.0	764.2	5.3000	0.1881	0.0633	0.9762	3.708	0.45
996	10.0	764.2	5.3000	0.1952	0.0632	0.9748	3.708	0.45
997	17.3	766.0	5.2870	0.1470	0.0636	0.9840	4.102	0.86
998	17.3	766.0	5.2870	0.1530	0.0635	0.9829	4.102	0.86
999	20.0	766.0	5.2870	0.1266	0.0638	0.9880	4.369	1.01
1000	20.0	766.0	5.2870	0.1334	0.0638	0.9867	4.369	1.01
1001	22.3	773.0	5.2390	0.1217	0.0633	0.9887	4.430	1.14
1002	22.3	773.0	5.2390	0.1283	0.0632	0.9874	4.430	1.14

1003	25.0	773.0	5.2390	0.1149	0.0633	0.9900	4.550	1.29
1004	25.0	773.0	5.2390	0.1213	0.0633	0.9888	4.550	1.29
1005	26.5	766.5	5.2840	0.1013	0.0641	0.9929	4.871	1.38
1006	26.5	766.5	5.2840	0.1070	0.0640	0.9918	4.871	1.38
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1007	5.7	764.2	5.3000	0.5839	0.1786	0.9208	2.527	0.16
1008	5.7	764.2	5.3000	0.5911	0.1783	0.9194	2.527	0.16
1009	10.0	764.2	5.3000	0.4037	0.1850	0.9572	3.131	0.37
1010	10.0	764.2	5.3000	0.4129	0.1847	0.9554	3.131	0.37
1011	13.0	764.2	5.3000	0.3660	0.1863	0.9649	3.321	0.52
1012	13.0	764.2	5.3000	0.3757	0.1860	0.9629	3.321	0.52
1013	17.3	766.0	5.2870	0.3536	0.1863	0.9672	3.389	0.73
1014	17.3	766.0	5.2870	0.3631	0.1859	0.9653	3.389	0.73
1015	18.0	766.0	5.2870	0.3371	0.1868	0.9705	3.494	0.77
1016	18.0	766.0	5.2870	0.3463	0.1865	0.9687	3.494	0.77
1017	22.3	766.0	5.2870	0.3313	0.1870	0.9717	3.534	0.98
1018	22.3	766.0	5.2870	0.3404	0.1867	0.9699	3.534	0.98
1019	26.5	766.5	5.2840	0.2958	0.1882	0.9789	3.819	1.19
1020	26.5	766.5	5.2840	0.3042	0.1879	0.9772	3.819	1.19
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1021	5.7	764.2	5.3000	0.4533	0.1225	0.9361	2.735	0.15
1022	5.7	764.2	5.3000	0.4633	0.1223	0.9341	2.735	0.15
1023	10.0	764.2	5.3000	0.3748	0.1244	0.9516	3.011	0.35
1024	10.0	764.2	5.3000	0.3835	0.1242	0.9499	3.011	0.35
1025	13.0	764.2	5.3000	0.3416	0.1252	0.9582	3.153	0.49
1026	13.0	764.2	5.3000	0.3509	0.1250	0.9563	3.153	0.49
1027	17.3	766.0	5.2870	0.3082	0.1256	0.9646	3.318	0.69
1028	17.3	766.0	5.2870	0.3168	0.1254	0.9629	3.318	0.69
1029	22.3	773.0	5.2390	0.3024	0.1245	0.9652	3.335	0.93
1030	22.3	773.0	5.2390	0.3109	0.1243	0.9635	3.335	0.93
1031	22.5	773.0	5.2390	0.2843	0.1249	0.9688	3.443	0.94
1032	22.5	773.0	5.2390	0.2924	0.1248	0.9672	3.443	0.94
1033	26.5	766.5	5.2840	0.2711	0.1264	0.9720	3.547	1.12
1034	26.5	766.5	5.2840	0.2789	0.1263	0.9704	3.547	1.12
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1035	5.0	764.2	5.3000	0.4368	0.0923	0.9339	2.702	0.11
1036	5.0	764.2	5.3000	0.4465	0.0922	0.9320	2.702	0.11
1037	5.7	764.2	5.3000	0.3701	0.0935	0.9469	2.917	0.15
1038	5.7	764.2	5.3000	0.3799	0.0934	0.9450	2.917	0.15
1039	10.0	764.2	5.3000	0.3156	0.0945	0.9575	3.139	0.33
1040	10.0	764.2	5.3000	0.3244	0.0944	0.9558	3.139	0.33
1041	17.3	766.0	5.2870	0.2628	0.0952	0.9677	3.410	0.66
1042	17.3	766.0	5.2870	0.2705	0.0951	0.9662	3.410	0.66
1043	22.3	773.0	5.2390	0.2257	0.0949	0.9746	3.646	0.88
1044	22.3	773.0	5.2390	0.2326	0.0948	0.9732	3.646	0.88
1045	26.5	766.5	5.2840	0.2087	0.0961	0.9783	3.797	1.06
1046	26.5	766.5	5.2840	0.2163	0.0960	0.9768	3.797	1.06
GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1047	5.7	764.2	5.3000	0.8489	0.2201	0.8762	2.087	0.12
1048	5.7	764.2	5.3000	0.8511	0.2200	0.8758	2.087	0.12
1049	10.0	764.2	5.3000	0.6214	0.2307	0.9229	2.554	0.29
1050	10.0	764.2	5.3000	0.6286	0.2304	0.9214	2.554	0.29
1051	17.3	766.0	5.2870	0.4575	0.2376	0.9565	3.111	0.58
1052	17.3	766.0	5.2870	0.4675	0.2372	0.9544	3.111	0.58
1053	22.3	773.0	5.2390	0.4037	0.2377	0.9668	3.377	0.77
1054	22.3	773.0	5.2390	0.4129	0.2372	0.9649	3.377	0.77

1055	26.5	766.5	5.2840	0.3789	0.2411	0.9727	3.567	0.94
1056	26.5	766.5	5.2840	0.3877	0.2407	0.9708	3.567	0.94
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1057	5.7	764.2	5.3000	0.7819	0.1494	0.8772	2.095	0.11
1058	5.7	764.2	5.3000	0.7847	0.1493	0.8766	2.095	0.11
1059	10.0	764.2	5.3000	0.4781	0.1589	0.9379	2.763	0.28
1060	10.0	764.2	5.3000	0.4885	0.1585	0.9358	2.763	0.28
1061	17.3	766.0	5.2870	0.3701	0.1618	0.9593	3.179	0.55
1062	17.3	766.0	5.2870	0.3799	0.1615	0.9574	3.179	0.55
1063	22.3	773.0	5.2390	0.3288	0.1614	0.9670	3.385	0.74
1064	22.3	773.0	5.2390	0.3379	0.1611	0.9652	3.385	0.74
1065	26.5	766.5	5.2840	0.3164	0.1633	0.9701	3.481	0.90
1066	26.5	766.5	5.2840	0.3252	0.1631	0.9683	3.481	0.90
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
1067	5.7	764.2	5.3000	0.7418	0.1132	0.8788	2.108	0.11
1068	5.7	764.2	5.3000	0.7449	0.1131	0.8782	2.108	0.11
1069	10.0	764.2	5.3000	0.4285	0.1206	0.9405	2.807	0.26
1070	10.0	764.2	5.3000	0.4381	0.1203	0.9386	2.807	0.26
1071	17.3	766.0	5.2870	0.3082	0.1230	0.9641	3.305	0.53
1072	17.3	766.0	5.2870	0.3168	0.1228	0.9624	3.305	0.53
1073	22.3	773.0	5.2390	0.2669	0.1227	0.9718	3.542	0.71
1074	22.3	773.0	5.2390	0.2747	0.1226	0.9703	3.542	0.71
1075	26.5	766.5	5.2840	0.2463	0.1244	0.9764	3.715	0.86
1076	26.5	766.5	5.2840	0.2537	0.1242	0.9749	3.715	0.86

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = - 2°C

SYSTEM: N-HEXANE-HELIUM-LIGHT PARAFFIN OIL

GAS RATE = 165.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
1077	7.0	771.4	5.2500	0.2087	0.1244	0.9836	4.063	0.29
1078	7.0	771.4	5.2500	0.2163	0.1242	0.9820	4.063	0.29
1079	10.0	771.4	5.2500	0.1716	0.1252	0.9909	4.636	0.47
1080	10.0	771.4	5.2500	0.1784	0.1251	0.9896	4.636	0.47
1081	13.0	771.4	5.2500	0.1552	0.1256	0.9942	5.057	0.65
1082	13.0	771.4	5.2500	0.1615	0.1255	0.9930	5.057	0.65
1083	17.3	771.4	5.2500	0.1420	0.1259	0.9969	5.566	0.90
1084	17.3	771.4	5.2500	0.1496	0.1258	0.9953	5.566	0.90
1085	20.0	771.4	5.2500	0.1380	0.1260	0.9977	5.817	1.06
1086	20.0	771.4	5.2500	0.1454	0.1259	0.9962	5.817	1.06
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1087	7.0	771.4	5.2500	0.1840	0.0835	0.9805	3.905	0.27
1088	7.0	771.4	5.2500	0.1910	0.0834	0.9792	3.905	0.27
1089	10.0	771.4	5.2500	0.1511	0.0840	0.9870	4.299	0.43
1090	10.0	771.4	5.2500	0.1572	0.0839	0.9858	4.299	0.43
1091	13.0	771.4	5.2500	0.1380	0.0842	0.9896	4.500	0.60
1092	13.0	771.4	5.2500	0.1454	0.0841	0.9881	4.500	0.60
1093	17.3	771.4	5.2500	0.1217	0.0845	0.9928	4.850	0.83
1094	17.3	771.4	5.2500	0.1283	0.0844	0.9915	4.850	0.83
1095	18.5	771.4	5.2500	0.1164	0.0845	0.9938	4.996	0.90
1096	18.5	771.4	5.2500	0.1228	0.0844	0.9926	4.996	0.90
1097	20.0	771.4	5.2500	0.1152	0.0846	0.9941	5.033	0.98
1098	20.0	771.4	5.2500	0.1215	0.0845	0.9928	5.033	0.98
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
1099	7.0	771.4	5.2500	0.1774	0.0628	0.9779	3.783	0.25
1100	7.0	771.4	5.2500	0.1843	0.0627	0.9766	3.783	0.25

1101	10.0	771.4	5.2500	0.1420	0.0632	0.9848	4.140	0.40
1102	10.0	771.4	5.2500	0.1496	0.0631	0.9833	4.140	0.40
1103	13.0	771.4	5.2500	0.1298	0.0633	0.9872	4.306	0.55
1104	13.0	771.4	5.2500	0.1369	0.0632	0.9858	4.306	0.55
1105	17.3	771.4	5.2500	0.1095	0.0636	0.9911	4.664	0.77
1106	17.3	771.4	5.2500	0.1155	0.0635	0.9900	4.664	0.77
1107	20.0	771.4	5.2500	0.1038	0.0636	0.9923	4.793	0.91
1108	20.0	771.4	5.2500	0.1096	0.0636	0.9911	4.793	0.91
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
1109	5.0	771.4	5.2500	0.3181	0.1861	0.9739	3.613	0.12
1110	5.0	771.4	5.2500	0.3269	0.1857	0.9721	3.613	0.12
1111	7.0	771.4	5.2500	0.2793	0.1874	0.9819	3.966	0.21
1112	7.0	771.4	5.2500	0.2874	0.1872	0.9802	3.966	0.21
1113	10.0	771.4	5.2500	0.2299	0.1892	0.9920	4.742	0.34
1114	10.0	771.4	5.2500	0.2368	0.1889	0.9905	4.742	0.34
1115	13.0	771.4	5.2500	0.2144	0.1897	0.9951	5.184	0.47
1116	13.0	771.4	5.2500	0.2221	0.1895	0.9935	5.184	0.47
1117	17.5	771.4	5.2500	0.2046	0.1901	0.9971	5.641	0.67
1118	17.5	771.4	5.2500	0.2121	0.1898	0.9956	5.641	0.67
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1119	5.0	771.4	5.2500	0.2669	0.1257	0.9724	3.564	0.11
1120	5.0	771.4	5.2500	0.2747	0.1255	0.9709	3.564	0.11
1121	7.0	771.4	5.2500	0.2463	0.1261	0.9765	3.722	0.20
1122	7.0	771.4	5.2500	0.2537	0.1260	0.9751	3.722	0.20
1123	10.0	771.4	5.2500	0.2005	0.1272	0.9857	4.199	0.32
1124	10.0	771.4	5.2500	0.2079	0.1271	0.9842	4.199	0.32
1125	15.5	771.4	5.2500	0.1537	0.1283	0.9950	5.195	0.55
1126	15.5	771.4	5.2500	0.1599	0.1282	0.9938	5.195	0.55
1127	17.4	771.4	5.2500	0.1420	0.1286	0.9974	5.716	0.63
1128	17.4	771.4	5.2500	0.1496	0.1284	0.9959	5.716	0.63
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
1129	7.0	771.4	5.2500	0.2323	0.0950	0.9734	3.600	0.19
1130	7.0	771.4	5.2500	0.2393	0.0949	0.9720	3.600	0.19
1131	10.0	771.4	5.2500	0.2005	0.0956	0.9797	3.860	0.30
1132	10.0	771.4	5.2500	0.2079	0.0954	0.9782	3.860	0.30
1133	17.4	771.4	5.2500	0.1323	0.0968	0.9931	4.886	0.60
1134	17.4	771.4	5.2500	0.1394	0.0967	0.9917	4.886	0.60
1135	20.8	771.4	5.2500	0.1249	0.0969	0.9946	5.105	0.73
1136	20.8	771.4	5.2500	0.1317	0.0968	0.9932	5.105	0.73
1137	20.8	771.4	5.2500	0.1152	0.0971	0.9965	5.501	0.73
1138	20.8	771.4	5.2500	0.1215	0.0970	0.9952	5.501	0.73
1139	25.5	771.4	5.2500	0.1170	0.0971	0.9961	5.412	0.92
1140	25.5	771.4	5.2500	0.1235	0.0970	0.9949	5.412	0.92
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
1141	7.0	771.4	5.2500	0.3453	0.2404	0.9791	3.821	0.16
1142	7.0	771.4	5.2500	0.3547	0.2400	0.9771	3.821	0.16
1143	10.0	771.4	5.2500	0.2793	0.2434	0.9928	4.833	0.26
1144	10.0	771.4	5.2500	0.2874	0.2431	0.9912	4.833	0.26
GAS RATE = 326.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1145	5.0	771.4	5.2500	0.3255	0.1615	0.9678	3.408	0.08
1146	5.0	771.4	5.2500	0.3345	0.1612	0.9660	3.408	0.08
1147	7.0	771.4	5.2500	0.2669	0.1633	0.9796	3.857	0.15
1148	7.0	771.4	5.2500	0.2747	0.1631	0.9781	3.857	0.15
1149	10.0	771.4	5.2500	0.2381	0.1642	0.9855	4.184	0.25
1150	10.0	771.4	5.2500	0.2452	0.1640	0.9840	4.184	0.25
1151	11.0	771.4	5.2500	0.2037	0.1653	0.9924	4.793	0.29

1152	11.0	771.4	5.2500	0.2113	0.1651	0.9909	4.793	0.29
1153	13.5	771.4	5.2500	0.1972	0.1655	0.9938	4.971	0.37
1154	13.5	771.4	5.2500	0.2045	0.1653	0.9923	4.971	0.37
1155	17.4	771.4	5.2500	0.1799	0.1660	0.9973	5.698	0.50
1156	17.4	771.4	5.2500	0.1868	0.1658	0.9959	5.698	0.50
1157	17.5	771.4	5.2500	0.1832	0.1659	0.9966	5.512	0.51
1158	17.5	771.4	5.2500	0.1902	0.1657	0.9952	5.512	0.51

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

1159	5.0	771.4	5.2500	0.2711	0.1227	0.9711	3.516	0.08
1160	5.0	771.4	5.2500	0.2789	0.1225	0.9695	3.516	0.08
1161	7.0	771.4	5.2500	0.2381	0.1234	0.9776	3.769	0.14
1162	7.0	771.4	5.2500	0.2452	0.1233	0.9762	3.769	0.14
1163	10.0	771.4	5.2500	0.2169	0.1239	0.9819	3.968	0.24
1164	10.0	771.4	5.2500	0.2247	0.1237	0.9803	3.968	0.24
1165	14.0	771.4	5.2500	0.1716	0.1250	0.9909	4.630	0.37
1166	14.0	771.4	5.2500	0.1784	0.1248	0.9896	4.630	0.37
1167	17.4	771.4	5.2500	0.1573	0.1253	0.9938	4.985	0.48
1168	17.4	771.4	5.2500	0.1636	0.1252	0.9925	4.985	0.48
1169	25.5	771.4	5.2500	0.1491	0.1255	0.9954	5.266	0.75
1170	25.5	771.4	5.2500	0.1551	0.1254	0.9942	5.266	0.75

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2°C

SYSTEM: N-HEXANE-HELIUM-HEAVY PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1171	7.0	771.4	5.2500	0.5573	0.1162	0.9141	2.446	0.27
1172	7.0	771.4	5.2500	0.5643	0.1161	0.9127	2.446	0.27
1173	10.0	771.4	5.2500	0.4368	0.1191	0.9381	2.766	0.44
1174	10.0	771.4	5.2500	0.4465	0.1188	0.9361	2.766	0.44
1175	13.0	771.4	5.2500	0.3872	0.1202	0.9480	2.939	0.61
1176	13.0	771.4	5.2500	0.3961	0.1200	0.9462	2.939	0.61
1177	17.4	771.4	5.2500	0.3453	0.1212	0.9563	3.110	0.86
1178	17.4	771.4	5.2500	0.3547	0.1210	0.9544	3.110	0.86
1179	20.8	771.4	5.2500	0.3082	0.1221	0.9637	3.293	1.05
1180	20.8	771.4	5.2500	0.3168	0.1219	0.9620	3.293	1.05
1181	25.5	771.4	5.2500	0.2876	0.1226	0.9678	3.412	1.32
1182	25.5	771.4	5.2500	0.2958	0.1224	0.9662	3.412	1.32

GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

1183	7.0	771.4	5.2500	0.4789	0.0789	0.9228	2.549	0.25
1184	7.0	771.4	5.2500	0.4884	0.0787	0.9208	2.549	0.25
1185	10.0	771.4	5.2500	0.4037	0.0801	0.9374	2.757	0.40
1186	10.0	771.4	5.2500	0.4129	0.0799	0.9356	2.757	0.40
1187	13.0	771.4	5.2500	0.3495	0.0809	0.9480	2.940	0.56
1188	13.0	771.4	5.2500	0.3589	0.0808	0.9462	2.940	0.56
1189	17.4	771.4	5.2500	0.3222	0.0813	0.9534	3.048	0.79
1190	17.4	771.4	5.2500	0.3311	0.0812	0.9516	3.048	0.79
1191	20.8	771.4	5.2500	0.2876	0.0819	0.9602	3.204	0.97
1192	20.8	771.4	5.2500	0.2958	0.0817	0.9586	3.204	0.97
1193	25.5	771.4	5.2500	0.2999	0.0817	0.9578	3.145	1.21
1194	25.5	771.4	5.2500	0.3084	0.0815	0.9561	3.145	1.21

GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

1195	7.0	771.4	5.2500	0.3938	0.0602	0.9357	2.731	0.23
1196	7.0	771.4	5.2500	0.4029	0.0601	0.9340	2.731	0.23
1197	10.0	771.4	5.2500	0.3412	0.0608	0.9460	2.902	0.37
1198	10.0	771.4	5.2500	0.3505	0.0607	0.9442	2.902	0.37

1199	13.0	771.4	5.2500	0.3082	0.0612	0.9524	3.028	0.52
1200	13.0	771.4	5.2500	0.3168	0.0611	0.9507	3.028	0.52
1201	17.4	771.4	5.2500	0.2711	0.0617	0.9596	3.191	0.73
1202	17.4	771.4	5.2500	0.2789	0.0616	0.9581	3.191	0.73
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1203	7.0	771.4	5.2500	0.7485	0.1707	0.8862	2.171	0.19
1204	7.0	771.4	5.2500	0.7515	0.1706	0.8856	2.171	0.19
1205	10.0	771.4	5.2500	0.6255	0.1751	0.9112	2.414	0.31
1206	10.0	771.4	5.2500	0.6328	0.1748	0.9098	2.414	0.31
1207	13.0	771.4	5.2500	0.5548	0.1776	0.9256	2.589	0.44
1208	13.0	771.4	5.2500	0.5618	0.1774	0.9242	2.589	0.44
1209	17.4	771.4	5.2500	0.5087	0.1793	0.9350	2.717	0.63
1210	17.4	771.4	5.2500	0.5196	0.1789	0.9328	2.717	0.63
1211	25.5	771.4	5.2500	0.4244	0.1823	0.9522	3.021	0.97
1212	25.5	771.4	5.2500	0.4339	0.1819	0.9503	3.021	0.97
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1213	5.0	771.4	5.2500	0.7067	0.1151	0.8848	2.158	0.09
1214	5.0	771.4	5.2500	0.7099	0.1151	0.8841	2.158	0.09
1215	7.0	771.4	5.2500	0.5964	0.1178	0.9067	2.365	0.17
1216	7.0	771.4	5.2500	0.6036	0.1176	0.9053	2.365	0.17
1217	10.0	771.4	5.2500	0.5631	0.1186	0.9134	2.438	0.30
1218	10.0	771.4	5.2500	0.5702	0.1184	0.9120	2.438	0.30
1219	13.0	771.4	5.2500	0.4947	0.1202	0.9270	2.603	0.42
1220	13.0	771.4	5.2500	0.5053	0.1200	0.9249	2.603	0.42
1221	17.4	771.4	5.2500	0.4575	0.1211	0.9344	2.709	0.59
1222	17.4	771.4	5.2500	0.4675	0.1209	0.9324	2.709	0.59
1223	25.5	771.4	5.2500	0.4037	0.1224	0.9451	2.886	0.92
1224	25.5	771.4	5.2500	0.4129	0.1222	0.9433	2.886	0.92
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1225	5.0	771.4	5.2500	0.6293	0.0879	0.8951	2.248	0.09
1226	5.0	771.4	5.2500	0.6367	0.0877	0.8937	2.248	0.09
1227	7.0	771.4	5.2500	0.5440	0.0894	0.9119	2.422	0.17
1228	7.0	771.4	5.2500	0.5510	0.0893	0.9105	2.422	0.17
1229	10.0	771.4	5.2500	0.4947	0.0903	0.9216	2.533	0.28
1230	10.0	771.4	5.2500	0.5053	0.0901	0.9195	2.533	0.28
1231	13.0	771.4	5.2500	0.4285	0.0915	0.9347	2.714	0.39
1232	13.0	771.4	5.2500	0.4381	0.0913	0.9328	2.714	0.39
1233	17.4	771.4	5.2500	0.3955	0.0921	0.9412	2.818	0.56
1234	17.4	771.4	5.2500	0.4045	0.0919	0.9394	2.818	0.56
1235	25.5	771.4	5.2500	0.3577	0.0928	0.9486	2.951	0.87
1236	25.5	771.4	5.2500	0.3673	0.0926	0.9467	2.951	0.87
GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1237	7.0	771.4	5.2500	0.8430	0.2173	0.8757	2.083	0.14
1238	7.0	771.4	5.2500	0.8453	0.2172	0.8752	2.083	0.14
1239	10.0	771.4	5.2500	0.7635	0.2210	0.8921	2.224	0.24
1240	10.0	771.4	5.2500	0.7665	0.2209	0.8915	2.224	0.24
1241	17.4	771.4	5.2500	0.5897	0.2291	0.9282	2.623	0.49
1242	17.4	771.4	5.2500	0.5969	0.2288	0.9267	2.623	0.49
1243	25.5	771.4	5.2500	0.5216	0.2323	0.9423	2.841	0.77
1244	25.5	771.4	5.2500	0.5284	0.2319	0.9409	2.841	0.77
GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1245	7.0	771.4	5.2500	0.7360	0.1488	0.8849	2.159	0.13
1246	7.0	771.4	5.2500	0.7390	0.1487	0.8843	2.159	0.13
1247	10.0	771.4	5.2500	0.6338	0.1520	0.9055	2.351	0.23
1248	10.0	771.4	5.2500	0.6412	0.1517	0.9040	2.351	0.23
1249	17.4	771.4	5.2500	0.5029	0.1560	0.9319	2.671	0.47

1250	17.4	771.4	5.2500	0.5137	0.1557	0.9297	2.671	0.47
1251	25.5	771.4	5.2500	0.4533	0.1576	0.9419	2.829	0.74
1252	25.5	771.4	5.2500	0.4633	0.1573	0.9399	2.829	0.74

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

1253	7.0	771.4	5.2500	0.6713	0.1133	0.8914	2.213	0.12
1254	7.0	771.4	5.2500	0.6787	0.1131	0.8899	2.213	0.12

1255	10.0	771.4	5.2500	0.5756	0.1156	0.9104	2.405	0.22
1256	10.0	771.4	5.2500	0.5827	0.1154	0.9090	2.405	0.22

1257	17.4	771.4	5.2500	0.4616	0.1182	0.9331	2.690	0.45
1258	17.4	771.4	5.2500	0.4717	0.1180	0.9311	2.690	0.45

1259	25.5	771.4	5.2500	0.4161	0.1193	0.9421	2.834	0.70
1260	25.5	771.4	5.2500	0.4255	0.1191	0.9403	2.834	0.70

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2° C

SYSTEM: N-HEXANE-FREON-14-LIGHT PARAFFIN OIL

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1261	5.0	771.4	5.2500	0.9071	0.1650	0.8541	1.911	0.14
1262	5.0	771.4	5.2500	0.9262	0.1643	0.8502	1.911	0.14

1263	7.0	771.4	5.2500	0.7074	0.1722	0.8946	2.225	0.25
1264	7.0	771.4	5.2500	0.7342	0.1712	0.8891	2.225	0.25

1265	10.0	771.4	5.2500	0.6010	0.1760	0.9162	2.443	0.41
1266	10.0	771.4	5.2500	0.6324	0.1749	0.9099	2.443	0.41

1267	13.0	771.4	5.2500	0.5242	0.1787	0.9319	2.637	0.57
1268	13.0	771.4	5.2500	0.5591	0.1775	0.9248	2.637	0.57

1269	15.0	771.4	5.2500	0.4123	0.1827	0.9547	3.011	0.68
1270	15.0	771.4	5.2500	0.4526	0.1813	0.9465	3.011	0.68

1271	17.4	771.4	5.2500	0.4047	0.1830	0.9563	3.042	0.80
1272	17.4	771.4	5.2500	0.4453	0.1815	0.9480	3.042	0.80

1273	20.7	771.4	5.2500	0.3534	0.1848	0.9667	3.285	0.98
1274	20.7	771.4	5.2500	0.3966	0.1833	0.9579	3.285	0.98

1275	25.5	771.4	5.2500	0.3020	0.1866	0.9772	3.609	1.24
1276	25.5	771.4	5.2500	0.3480	0.1850	0.9678	3.609	1.24

ABSORBER DIAMETER = 0.793 CM

SATURATOR TEMPERATURE = -2° C

SYSTEM: N-HEXANE-FREON-14-HEAVY PARAFFIN OIL

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1277	5.0	771.4	5.2500	1.0851	0.1586	0.8180	1.697	0.12
1278	5.0	771.4	5.2500	1.0982	0.1581	0.8154	1.697	0.12

1279	7.0	771.4	5.2500	0.9920	0.1619	0.8369	1.803	0.22
1280	7.0	771.4	5.2500	1.0080	0.1614	0.8336	1.803	0.22

1281	13.0	771.4	5.2500	0.8392	0.1674	0.8678	2.007	0.53
1282	13.0	771.4	5.2500	0.8608	0.1667	0.8635	2.007	0.53

1283	15.0	771.4	5.2500	0.7466	0.1708	0.8866	2.155	0.64
1284	15.0	771.4	5.2500	0.7718	0.1699	0.8815	2.155	0.64

1285	17.4	771.4	5.2500	0.7542	0.1705	0.8851	2.142	0.76
1286	17.4	771.4	5.2500	0.7791	0.1696	0.8800	2.142	0.76

1287	25.5	771.4	5.2500	0.6521	0.1741	0.9058	2.332	1.18
1288	25.5	771.4	5.2500	0.6812	0.1731	0.8999	2.332	1.18

ABSORBER DIAMETER = 0.594 CM

SATURATOR TEMPERATURE = -2° C

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1289	5.0	771.4	5.2500	0.3988	0.1200	0.9457	2.896	0.13

1290	5.0	771.4	5.2500	0.4079	0.1197	0.9438	2.896	0.13
1291	7.8	771.4	5.2500	0.2917	0.1225	0.9670	3.387	0.25
1292	7.8	771.4	5.2500	0.3000	0.1223	0.9653	3.387	0.25
1293	11.0	771.4	5.2500	0.2406	0.1236	0.9772	3.750	0.39
1294	11.0	771.4	5.2500	0.2478	0.1235	0.9758	3.750	0.39
1295	14.0	771.4	5.2500	0.2005	0.1246	0.9852	4.165	0.52
1296	14.0	771.4	5.2500	0.2079	0.1244	0.9837	4.165	0.52
1297	20.9	771.4	5.2500	0.1593	0.1255	0.9934	4.934	0.83
1298	20.9	771.4	5.2500	0.1657	0.1254	0.9921	4.934	0.83
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1299	5.0	771.4	5.2500	0.3872	0.0803	0.9406	2.810	0.12
1300	5.0	771.4	5.2500	0.3961	0.0802	0.9389	2.810	0.12
1301	7.8	771.4	5.2500	0.2062	0.0831	0.9762	3.707	0.23
1302	7.8	771.4	5.2500	0.2138	0.0830	0.9747	3.707	0.23
1303	11.0	771.4	5.2500	0.1634	0.0838	0.9846	4.133	0.36
1304	11.0	771.4	5.2500	0.1699	0.0837	0.9833	4.133	0.36
1305	14.0	771.4	5.2500	0.1217	0.0845	0.9928	4.850	0.48
1306	14.0	771.4	5.2500	0.1283	0.0844	0.9915	4.850	0.48
1307	17.5	771.4	5.2500	0.1054	0.0847	0.9960	5.393	0.63
1308	17.5	771.4	5.2500	0.1113	0.0846	0.9948	5.393	0.63
1309	20.8	771.4	5.2500	0.0989	0.0848	0.9973	5.736	0.76
1310	20.8	771.4	5.2500	0.1044	0.0847	0.9962	5.736	0.76
1311	25.0	771.4	5.2500	0.0916	0.0849	0.9987	6.363	0.93
1312	25.0	771.4	5.2500	0.0968	0.0848	0.9977	6.363	0.93
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
1313	5.0	771.4	5.2500	0.3789	0.0604	0.9386	2.777	0.11
1314	5.0	771.4	5.2500	0.3877	0.0603	0.9369	2.777	0.11
1315	7.8	771.4	5.2500	0.2087	0.0624	0.9718	3.543	0.21
1316	7.8	771.4	5.2500	0.2163	0.0623	0.9703	3.543	0.21
1317	11.0	771.4	5.2500	0.1298	0.0633	0.9872	4.306	0.34
1318	11.0	771.4	5.2500	0.1369	0.0632	0.9858	4.306	0.34
1319	14.0	771.4	5.2500	0.1021	0.0636	0.9926	4.833	0.45
1320	14.0	771.4	5.2500	0.1079	0.0636	0.9915	4.833	0.45
1321	20.9	771.4	5.2500	0.0786	0.0639	0.9972	5.733	0.71
1322	20.9	771.4	5.2500	0.0831	0.0639	0.9963	5.733	0.71
1323	25.0	771.4	5.2500	0.0729	0.0640	0.9983	6.171	0.87
1324	25.0	771.4	5.2500	0.0771	0.0639	0.9975	6.171	0.87
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
1325	5.0	771.4	5.2500	0.5152	0.1790	0.9337	2.697	0.08
1326	5.0	771.4	5.2500	0.5261	0.1787	0.9315	2.697	0.08
1327	7.8	771.4	5.2500	0.3955	0.1833	0.9581	3.152	0.17
1328	7.8	771.4	5.2500	0.4045	0.1830	0.9563	3.152	0.17
1329	11.0	771.4	5.2500	0.3453	0.1851	0.9684	3.424	0.28
1330	11.0	771.4	5.2500	0.3547	0.1848	0.9665	3.424	0.28
1331	14.0	771.4	5.2500	0.3024	0.1866	0.9771	3.741	0.38
1332	14.0	771.4	5.2500	0.3109	0.1863	0.9754	3.741	0.38
1333	17.8	771.4	5.2500	0.2711	0.1877	0.9835	4.060	0.50
1334	17.8	771.4	5.2500	0.2789	0.1875	0.9819	4.060	0.50
1335	20.9	771.4	5.2500	0.2505	0.1885	0.9878	4.344	0.60
1336	20.9	771.4	5.2500	0.2579	0.1882	0.9862	4.344	0.60
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1337	7.8	771.4	5.2500	0.3082	0.1247	0.9642	3.306	0.16
1338	7.8	771.4	5.2500	0.3168	0.1245	0.9625	3.306	0.16
1339	11.0	771.4	5.2500	0.2587	0.1258	0.9741	3.624	0.26
1340	11.0	771.4	5.2500	0.2663	0.1257	0.9726	3.624	0.26
1341	14.0	771.4	5.2500	0.2075	0.1271	0.9843	4.108	0.36
1342	14.0	771.4	5.2500	0.2150	0.1269	0.9828	4.108	0.36

1343	20.9	771.4	5.2500	0.1922	0.1274	0.9874	4.316	0.57
1344	20.9	771.4	5.2500	0.1995	0.1273	0.9859	4.316	0.57
1345	25.0	771.4	5.2500	0.1716	0.1279	0.9915	4.690	0.69
1346	25.0	771.4	5.2500	0.1784	0.1278	0.9901	4.690	0.69

GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

1347	7.8	771.4	5.2500	0.2463	0.0948	0.9706	3.503	0.15
1348	7.8	771.4	5.2500	0.2537	0.0946	0.9692	3.503	0.15
1349	11.0	771.4	5.2500	0.2005	0.0956	0.9797	3.860	0.25
1350	11.0	771.4	5.2500	0.2079	0.0954	0.9782	3.860	0.25
1351	14.0	771.4	5.2500	0.1774	0.0960	0.9842	4.107	0.34
1352	14.0	771.4	5.2500	0.1843	0.0959	0.9828	4.107	0.34
1353	20.9	771.4	5.2500	0.1511	0.0965	0.9894	4.493	0.54
1354	20.9	771.4	5.2500	0.1572	0.0964	0.9882	4.493	0.54

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1355	5.0	771.4	5.2500	0.8321	0.2183	0.8780	2.102	0.06
1356	5.0	771.4	5.2500	0.8345	0.2182	0.8775	2.102	0.06
1357	7.8	771.4	5.2500	0.5548	0.2312	0.9355	2.730	0.13
1358	7.8	771.4	5.2500	0.5618	0.2309	0.9341	2.730	0.13
1359	10.0	771.4	5.2500	0.4723	0.2351	0.9527	3.029	0.19
1360	10.0	771.4	5.2500	0.4827	0.2346	0.9505	3.029	0.19
1361	14.0	771.4	5.2500	0.3872	0.2390	0.9704	3.490	0.29
1362	14.0	771.4	5.2500	0.3961	0.2386	0.9686	3.490	0.29

1363	17.0	771.4	5.2500	0.3371	0.2413	0.9809	3.909	0.37
1364	17.0	771.4	5.2500	0.3463	0.2409	0.9790	3.909	0.37

1365	20.9	771.4	5.2500	0.2999	0.2430	0.9886	4.405	0.47
1366	20.9	771.4	5.2500	0.3084	0.2426	0.9869	4.405	0.47

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

1367	5.0	771.4	5.2500	0.6505	0.1518	0.9022	2.317	0.06
1368	5.0	771.4	5.2500	0.6579	0.1515	0.9007	2.317	0.06
1369	7.8	771.4	5.2500	0.4806	0.1571	0.9365	2.740	0.12
1370	7.8	771.4	5.2500	0.4911	0.1567	0.9344	2.740	0.12
1371	10.0	771.4	5.2500	0.3789	0.1602	0.9570	3.127	0.18
1372	10.0	771.4	5.2500	0.3877	0.1600	0.9553	3.127	0.18
1373	14.0	771.4	5.2500	0.2917	0.1629	0.9747	3.644	0.28
1374	14.0	771.4	5.2500	0.3000	0.1627	0.9730	3.644	0.28
1375	20.9	771.4	5.2500	0.2381	0.1646	0.9855	4.189	0.45
1376	20.9	771.4	5.2500	0.2452	0.1644	0.9841	4.189	0.45
1377	25.0	771.4	5.2500	0.2128	0.1654	0.9907	4.597	0.55
1378	25.0	771.4	5.2500	0.2205	0.1651	0.9891	4.597	0.55

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

1379	2.5	771.4	5.2500	0.8062	0.1571	0.9365	2.740	0.12
1380	2.5	771.4	5.2500	0.8088	0.1567	0.9344	2.740	0.12
1381	7.8	771.4	5.2500	0.4095	0.1197	0.9435	2.858	0.12
1382	7.8	771.4	5.2500	0.4188	0.1195	0.9417	2.858	0.12
1383	10.0	771.4	5.2500	0.3288	0.1216	0.9596	3.187	0.17
1384	10.0	771.4	5.2500	0.3379	0.1214	0.9578	3.187	0.17
1385	14.0	771.4	5.2500	0.2463	0.1235	0.9760	3.702	0.27
1386	14.0	771.4	5.2500	0.2537	0.1233	0.9746	3.702	0.27
1387	20.9	771.4	5.2500	0.1963	0.1247	0.9860	4.220	0.43
1388	20.9	771.4	5.2500	0.2037	0.1245	0.9846	4.220	0.43

ABSORBER DIAMETER = 0.594 CM

SATURATOR TEMPERATURE = -2° C

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1389	5.0	771.4	5.2500	0.7414	0.1119	0.8775	2.097	0.11

1390	5.0	771.4	5.2500	0.7444	0.1118	0.8769	2.097	0.11
1391	7.8	771.4	5.2500	0.6172	0.1148	0.9022	2.317	0.23
1392	7.8	771.4	5.2500	0.6245	0.1147	0.9007	2.317	0.23
1393	11.0	771.4	5.2500	0.5756	0.1158	0.9104	2.405	0.37
1394	11.0	771.4	5.2500	0.5827	0.1156	0.9090	2.405	0.37
1395	14.0	771.4	5.2500	0.5341	0.1168	0.9187	2.501	0.50
1396	14.0	771.4	5.2500	0.5409	0.1166	0.9173	2.501	0.50
1397	20.8	771.4	5.2500	0.4781	0.1181	0.9298	2.642	0.79
1398	20.8	771.4	5.2500	0.4885	0.1179	0.9278	2.642	0.79
1399	25.0	771.4	5.2500	0.4517	0.1187	0.9351	2.720	0.97
1400	25.0	771.4	5.2500	0.4617	0.1185	0.9331	2.720	0.97
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1401	7.8	771.4	5.2500	0.5029	0.0785	0.9179	2.487	0.21
1402	7.8	771.4	5.2500	0.5137	0.0783	0.9158	2.487	0.21
1403	11.0	771.4	5.2500	0.4699	0.0790	0.9244	2.569	0.34
1404	11.0	771.4	5.2500	0.4801	0.0789	0.9224	2.569	0.34
1405	14.0	771.4	5.2500	0.4450	0.0794	0.9293	2.636	0.46
1406	14.0	771.4	5.2500	0.4549	0.0793	0.9273	2.636	0.46
1407	20.8	771.4	5.2500	0.4037	0.0801	0.9374	2.757	0.73
1408	20.8	771.4	5.2500	0.4129	0.0799	0.9356	2.757	0.73
GAS RATE = 165.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
1409	7.8	771.4	5.2500	0.4161	0.0600	0.9314	2.666	0.20
1410	7.8	771.4	5.2500	0.4255	0.0598	0.9295	2.666	0.20
1411	11.0	771.4	5.2500	0.3872	0.0603	0.9370	2.751	0.32
1412	11.0	771.4	5.2500	0.3961	0.0602	0.9353	2.751	0.32
1413	14.0	771.4	5.2500	0.3660	0.0605	0.9411	2.817	0.43
1414	14.0	771.4	5.2500	0.3757	0.0604	0.9393	2.817	0.43
1415	17.5	771.4	5.2500	0.3453	0.0608	0.9452	2.887	0.55
1416	17.5	771.4	5.2500	0.3547	0.0607	0.9433	2.887	0.55
1417	20.8	771.4	5.2500	0.3288	0.0610	0.9484	2.947	0.68
1418	20.8	771.4	5.2500	0.3379	0.0609	0.9466	2.947	0.68
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 30.0 CC/MIN				
1419	7.8	771.4	5.2500	0.8698	0.1663	0.8616	1.976	0.15
1420	7.8	771.4	5.2500	0.8719	0.1663	0.8612	1.976	0.15
1421	14.0	771.4	5.2500	0.7276	0.1714	0.8905	2.209	0.35
1422	14.0	771.4	5.2500	0.7307	0.1713	0.8899	2.209	0.35
1423	20.9	771.4	5.2500	0.6621	0.1738	0.9038	2.334	0.57
1424	20.9	771.4	5.2500	0.6695	0.1735	0.9023	2.334	0.57
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 45.0 CC/MIN				
1425	5.0	771.4	5.2500	0.9209	0.1100	0.8422	1.846	0.06
1426	5.0	771.4	5.2500	0.9225	0.1099	0.8419	1.846	0.06
1427	7.8	771.4	5.2500	0.7410	0.1143	0.8780	2.101	0.15
1428	7.8	771.4	5.2500	0.7440	0.1142	0.8774	2.101	0.15
1429	14.0	771.4	5.2500	0.5756	0.1183	0.9109	2.410	0.33
1430	14.0	771.4	5.2500	0.5827	0.1181	0.9095	2.410	0.33
1431	20.9	771.4	5.2500	0.5399	0.1191	0.9180	2.493	0.54
1432	20.9	771.4	5.2500	0.5468	0.1190	0.9166	2.493	0.54
1433	25.0	771.4	5.2500	0.5112	0.1198	0.9237	2.559	0.66
1434	25.0	771.4	5.2500	0.5221	0.1196	0.9215	2.559	0.66
GAS RATE = 245.0 CC/MIN				LIQUID RATE = 60.0 CC/MIN				
1435	5.0	771.4	5.2500	0.6817	0.0869	0.8848	2.158	0.06
1436	5.0	771.4	5.2500	0.6850	0.0869	0.8842	2.158	0.06
1437	7.8	771.4	5.2500	0.5673	0.0890	0.9073	2.371	0.14
1438	7.8	771.4	5.2500	0.5744	0.0889	0.9059	2.371	0.14
1439	11.0	771.4	5.2500	0.4798	0.0906	0.9246	2.571	0.23
1440	11.0	771.4	5.2500	0.4902	0.0904	0.9225	2.571	0.23

1441	14.0	771.4	5.2500	0.4327	0.0914	0.9339	2.702	0.32
1442	14.0	771.4	5.2500	0.4423	0.0912	0.9319	2.702	0.32
1443	19.0	771.4	5.2500	0.3652	0.0926	0.9472	2.923	0.46
1444	19.0	771.4	5.2500	0.3748	0.0925	0.9452	2.923	0.46
1445	20.9	771.4	5.2500	0.3748	0.0925	0.9453	2.890	0.51
1446	20.9	771.4	5.2500	0.3835	0.0923	0.9435	2.890	0.51
1447	25.0	771.4	5.2500	0.3495	0.0929	0.9503	2.982	0.63
1448	25.0	771.4	5.2500	0.3589	0.0927	0.9484	2.982	0.63

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1449	5.0	771.4	5.2500	1.5138	0.1862	0.7378	1.342	0.04
1450	5.0	771.4	5.2500	1.5045	0.1867	0.7397	1.342	0.04
1451	7.8	771.4	5.2500	1.1844	0.2018	0.8054	1.638	0.11
1452	7.8	771.4	5.2500	1.1823	0.2019	0.8058	1.638	0.11
1453	14.0	771.4	5.2500	0.8489	0.2175	0.8746	2.074	0.27
1454	14.0	771.4	5.2500	0.8511	0.2174	0.8741	2.074	0.27
1455	20.9	771.4	5.2500	0.7351	0.2229	0.8981	2.281	0.44
1456	20.9	771.4	5.2500	0.7382	0.2227	0.8975	2.281	0.44

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

1457	5.0	771.4	5.2500	1.2256	0.1337	0.7866	1.546	0.04
1458	5.0	771.4	5.2500	1.2227	0.1338	0.7872	1.546	0.04
1459	7.8	771.4	5.2500	0.9745	0.1416	0.8370	1.813	0.11
1460	7.8	771.4	5.2500	0.9755	0.1416	0.8368	1.813	0.11
1461	14.0	771.4	5.2500	0.7025	0.1502	0.8917	2.220	0.26
1462	14.0	771.4	5.2500	0.7058	0.1500	0.8910	2.220	0.26
1463	20.9	771.4	5.2500	0.6380	0.1522	0.9047	2.343	0.42
1464	20.9	771.4	5.2500	0.6453	0.1519	0.9032	2.343	0.42

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

1465	5.0	771.4	5.2500	0.9997	0.1058	0.8262	1.750	0.04
1466	5.0	771.4	5.2500	1.0003	0.1058	0.8261	1.750	0.04
1467	7.8	771.4	5.2500	0.8279	0.1099	0.8603	1.967	0.10
1468	7.8	771.4	5.2500	0.8304	0.1098	0.8598	1.967	0.10
1469	10.0	771.4	5.2500	0.6950	0.1130	0.8867	2.175	0.15
1470	10.0	771.4	5.2500	0.6983	0.1129	0.8860	2.175	0.15
1471	14.0	771.4	5.2500	0.5673	0.1160	0.9121	2.424	0.25
1472	14.0	771.4	5.2500	0.5744	0.1158	0.9107	2.424	0.25
1473	20.9	771.4	5.2500	0.5153	0.1172	0.9224	2.543	0.41
1474	20.9	771.4	5.2500	0.5263	0.1170	0.9203	2.543	0.41

ABSORBER DIAMETER = 1.000 CM

SATURATOR TEMPERATURE = -2°C

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1475	5.0	771.4	5.2500	0.2752	0.1228	0.9703	3.490	0.28
1476	5.0	771.4	5.2500	0.2832	0.1227	0.9687	3.490	0.28
1477	7.6	771.4	5.2500	0.2128	0.1243	0.9827	4.016	0.51
1478	7.6	771.4	5.2500	0.2205	0.1241	0.9812	4.016	0.51
1479	11.0	771.4	5.2500	0.1569	0.1256	0.9939	5.006	0.82
1480	11.0	771.4	5.2500	0.1631	0.1254	0.9926	5.006	0.82

GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

1481	5.0	771.4	5.2500	0.2046	0.0832	0.9765	3.720	0.25
1482	5.0	771.4	5.2500	0.2121	0.0830	0.9750	3.720	0.25
1483	7.6	771.4	5.2500	0.1601	0.0839	0.9852	4.175	0.47
1484	7.6	771.4	5.2500	0.1665	0.0838	0.9840	4.175	0.47
1485	11.0	771.4	5.2500	0.1217	0.0845	0.9928	4.850	0.75
1486	11.0	771.4	5.2500	0.1283	0.0844	0.9915	4.850	0.75
1487	15.5	771.4	5.2500	0.0948	0.0849	0.9981	6.034	1.13

1488	15.5	771.4	5.2500	0.1002	0.0848	0.9970	6.034	1.13
1489	21.8	771.4	5.2500	0.0851	0.0850	1.0000	9.191	1.66
1490	21.8	771.4	5.2500	0.0899	0.0849	0.9990	9.191	1.66
GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1491	5.8	771.4	5.2500	0.1881	0.0626	0.9758	3.694	0.29
1492	5.8	771.4	5.2500	0.1952	0.0625	0.9744	3.694	0.29
1493	7.6	771.4	5.2500	0.1552	0.0630	0.9822	3.997	0.44
1494	7.6	771.4	5.2500	0.1615	0.0629	0.9810	3.997	0.44
1495	11.0	771.4	5.2500	0.1176	0.0635	0.9896	4.505	0.70
1496	11.0	771.4	5.2500	0.1241	0.0634	0.9883	4.505	0.70
1497	15.5	771.4	5.2500	0.0891	0.0638	0.9951	5.229	1.05
1498	15.5	771.4	5.2500	0.0942	0.0637	0.9941	5.229	1.05
1499	18.5	771.4	5.2500	0.0759	0.0639	0.9977	5.915	1.28
1500	18.5	771.4	5.2500	0.0803	0.0639	0.9968	5.915	1.28
1501	21.8	771.4	5.2500	0.0688	0.0640	0.9991	6.678	1.53
1502	21.8	771.4	5.2500	0.0728	0.0640	0.9983	6.678	1.53
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1503	5.0	771.4	5.2500	0.3913	0.1835	0.9590	3.172	0.19
1504	5.0	771.4	5.2500	0.4003	0.1831	0.9571	3.172	0.19
1505	5.7	771.4	5.2500	0.3453	0.1851	0.9684	3.424	0.24
1506	5.7	771.4	5.2500	0.3547	0.1848	0.9665	3.424	0.24
1507	7.6	771.4	5.2500	0.2917	0.1870	0.9793	3.839	0.37
1508	7.6	771.4	5.2500	0.3000	0.1867	0.9776	3.839	0.37
1509	12.0	771.4	5.2500	0.2299	0.1892	0.9920	4.742	0.67
1510	12.0	771.4	5.2500	0.2368	0.1889	0.9905	4.742	0.67
1511	15.5	771.4	5.2500	0.2128	0.1898	0.9955	5.244	0.91
1512	15.5	771.4	5.2500	0.2205	0.1895	0.9939	5.244	0.91
1513	20.0	771.4	5.2500	0.2037	0.1901	0.9973	5.691	1.21
1514	20.0	771.4	5.2500	0.2113	0.1899	0.9958	5.691	1.21
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1515	5.7	771.4	5.2500	0.2752	0.1255	0.9708	3.506	0.22
1516	5.7	771.4	5.2500	0.2832	0.1253	0.9692	3.506	0.22
1517	7.6	771.4	5.2500	0.2422	0.1262	0.9774	3.757	0.35
1518	7.6	771.4	5.2500	0.2495	0.1261	0.9759	3.757	0.35
1519	12.5	771.4	5.2500	0.2046	0.1271	0.9849	4.145	0.66
1520	12.5	771.4	5.2500	0.2121	0.1270	0.9834	4.145	0.66
1521	15.5	771.4	5.2500	0.1781	0.1278	0.9902	4.558	0.86
1522	15.5	771.4	5.2500	0.1849	0.1276	0.9888	4.558	0.86
1523	18.0	771.4	5.2500	0.1618	0.1282	0.9934	4.936	1.02
1524	18.0	771.4	5.2500	0.1682	0.1280	0.9921	4.936	1.02
1525	21.8	771.4	5.2500	0.1511	0.1284	0.9956	5.297	1.26
1526	21.8	771.4	5.2500	0.1572	0.1283	0.9943	5.297	1.26
1527	25.0	771.4	5.2500	0.1693	0.1280	0.9919	4.744	1.47
1528	25.0	771.4	5.2500	0.1759	0.1278	0.9906	4.744	1.47
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1529	5.0	771.4	5.2500	0.3206	0.0934	0.9560	3.103	0.17
1530	5.0	771.4	5.2500	0.3294	0.0933	0.9542	3.103	0.17
1531	7.6	771.4	5.2500	0.2422	0.0948	0.9714	3.530	0.33
1532	7.6	771.4	5.2500	0.2495	0.0947	0.9700	3.530	0.33
1533	15.5	771.4	5.2500	0.1782	0.0960	0.9840	4.097	0.81
1534	15.5	771.4	5.2500	0.1851	0.0959	0.9827	4.097	0.81
1535	21.8	771.4	5.2500	0.1404	0.0967	0.9915	4.688	1.19
1536	21.8	771.4	5.2500	0.1479	0.0965	0.9900	4.688	1.19
1537	25.5	771.4	5.2500	0.1375	0.0967	0.9921	4.755	1.42
1538	25.5	771.4	5.2500	0.1449	0.0966	0.9906	4.755	1.42
GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1539	5.0	771.4	5.2500	0.9133	0.2145	0.8612	1.974	0.14

1540	5.0	771.4	5.2500	0.9150	0.2145	0.8609	1.974	0.14
1541	7.6	771.4	5.2500	0.4798	0.2347	0.9511	2.997	0.29
1542	7.6	771.4	5.2500	0.4902	0.2342	0.9490	2.997	0.29
1543	11.0	771.4	5.2500	0.3619	0.2402	0.9757	3.678	0.47
1544	11.0	771.4	5.2500	0.3715	0.2397	0.9737	3.678	0.47
1545	15.5	771.4	5.2500	0.2711	0.2443	0.9947	5.099	0.72
1546	15.5	771.4	5.2500	0.2789	0.2440	0.9930	5.099	0.72
GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1547	5.0	771.4	5.2500	0.6463	0.1519	0.9030	2.326	0.13
1548	5.0	771.4	5.2500	0.6537	0.1517	0.9015	2.326	0.13
1549	7.6	771.4	5.2500	0.4136	0.1592	0.9500	2.977	0.27
1550	7.6	771.4	5.2500	0.4230	0.1589	0.9481	2.977	0.27
1551	15.5	771.4	5.2500	0.2422	0.1645	0.9847	4.135	0.69
1552	15.5	771.4	5.2500	0.2495	0.1642	0.9832	4.135	0.69
1553	21.8	771.4	5.2500	0.1972	0.1659	0.9938	4.982	1.01
1554	21.8	771.4	5.2500	0.2045	0.1656	0.9924	4.982	1.01
GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1555	5.0	771.4	5.2500	0.5540	0.1163	0.9147	2.454	0.13
1556	5.0	771.4	5.2500	0.5610	0.1162	0.9133	2.454	0.13
1557	7.6	771.4	5.2500	0.3748	0.1205	0.9504	2.987	0.26
1558	7.6	771.4	5.2500	0.3835	0.1203	0.9487	2.987	0.26
1559	15.5	771.4	5.2500	0.2087	0.1244	0.9836	4.063	0.66
1560	15.5	771.4	5.2500	0.2163	0.1242	0.9820	4.063	0.66
1561	21.8	771.4	5.2500	0.1716	0.1252	0.9909	4.636	0.97
1562	21.8	771.4	5.2500	0.1784	0.1251	0.9896	4.636	0.97

ABSORBER DIAMETER = 1.000 CM

SATURATOR TEMPERATURE = -2°C

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1563	7.6	771.4	5.2500	0.6630	0.1138	0.8931	2.229	0.48
1564	7.6	771.4	5.2500	0.6704	0.1136	0.8916	2.229	0.48
1565	11.0	771.4	5.2500	0.5548	0.1163	0.9146	2.452	0.77
1566	11.0	771.4	5.2500	0.5618	0.1161	0.9132	2.452	0.77
1567	15.5	771.4	5.2500	0.4864	0.1179	0.9282	2.619	1.16
1568	15.5	771.4	5.2500	0.4969	0.1177	0.9261	2.619	1.16
1569	21.8	771.4	5.2500	0.3660	0.1207	0.9522	3.021	1.71
1570	21.8	771.4	5.2500	0.3757	0.1205	0.9503	3.021	1.71
1571	27.5	771.4	5.2500	0.3041	0.1222	0.9645	3.316	2.20
1572	27.5	771.4	5.2500	0.3126	0.1220	0.9628	3.316	2.20
GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1573	5.0	771.4	5.2500	0.7753	0.0742	0.8646	1.997	0.22
1574	5.0	771.4	5.2500	0.7781	0.0742	0.8640	1.997	0.22
1575	7.6	771.4	5.2500	0.6272	0.0765	0.8936	2.234	0.44
1576	7.6	771.4	5.2500	0.6345	0.0764	0.8921	2.234	0.44
1577	11.0	771.4	5.2500	0.5341	0.0780	0.9118	2.421	0.71
1578	11.0	771.4	5.2500	0.5409	0.0779	0.9105	2.421	0.71
1579	15.5	771.4	5.2500	0.4450	0.0794	0.9293	2.636	1.07
1580	15.5	771.4	5.2500	0.4549	0.0793	0.9273	2.636	1.07
1581	21.8	771.4	5.2500	0.3495	0.0809	0.9480	2.940	1.57
1582	21.8	771.4	5.2500	0.3589	0.0808	0.9462	2.940	1.57
1583	25.0	771.4	5.2500	0.3467	0.0809	0.9486	2.950	1.83
1584	25.0	771.4	5.2500	0.3560	0.0808	0.9468	2.950	1.83
GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1585	7.6	771.4	5.2500	0.6255	0.0575	0.8906	2.206	0.41
1586	7.6	771.4	5.2500	0.6328	0.0574	0.8892	2.206	0.41

1587	11.0	771.4	5.2500	0.5104	0.0588	0.9130	2.430	0.66
1588	11.0	771.4	5.2500	0.5213	0.0587	0.9109	2.430	0.66
1589	15.5	771.4	5.2500	0.4327	0.0598	0.9282	2.620	0.99
1590	15.5	771.4	5.2500	0.4423	0.0596	0.9263	2.620	0.99
AV 1591	21.8	771.4	5.2500	0.3164	0.0611	0.9508	2.995	1.46
HCI 1592	21.8	771.4	5.2500	0.3252	0.0610	0.9491	2.995	1.46
1593	25.0	771.4	5.2500	0.3280	0.0610	0.9485	2.950	1.69
1594	25.0	771.4	5.2500	0.3370	0.0609	0.9468	2.950	1.69
GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1595	5.0	771.4	5.2500	1.6143	0.1393	0.7114	1.247	0.17
1596	5.0	771.4	5.2500	1.6023	0.1397	0.7138	1.247	0.17
1597	7.6	771.4	5.2500	1.0920	0.1583	0.8166	1.697	0.34
1598	7.6	771.4	5.2500	1.0914	0.1583	0.8168	1.697	0.34
1599	12.5	771.4	5.2500	0.7485	0.1707	0.8862	2.171	0.66
1600	12.5	771.4	5.2500	0.7515	0.1706	0.8856	2.171	0.66
1601	15.5	771.4	5.2500	0.5839	0.1766	0.9197	2.513	0.85
1602	15.5	771.4	5.2500	0.5911	0.1763	0.9183	2.513	0.85
1603	21.8	771.4	5.2500	0.4409	0.1817	0.9489	2.954	1.27
1604	21.8	771.4	5.2500	0.4507	0.1813	0.9468	2.954	1.27
GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1605	5.0	771.4	5.2500	1.3721	0.0990	0.7529	1.400	0.15
1606	5.0	771.4	5.2500	1.3663	0.0992	0.7540	1.400	0.15
1607	7.6	771.4	5.2500	0.9913	0.1083	0.8283	1.761	0.32
1608	7.6	771.4	5.2500	0.9921	0.1082	0.8281	1.761	0.32
1609	12.0	771.4	5.2500	0.6950	0.1154	0.8871	2.179	0.59
1610	12.0	771.4	5.2500	0.6983	0.1153	0.8865	2.179	0.59
1611	21.8	771.4	5.2500	0.3872	0.1228	0.9484	2.948	1.19
1612	21.8	771.4	5.2500	0.3961	0.1226	0.9466	2.948	1.19
GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1613	5.0	771.4	5.2500	1.3527	0.0747	0.7531	1.401	0.15
1614	5.0	771.4	5.2500	1.3473	0.0748	0.7541	1.401	0.15
1615	7.6	771.4	5.2500	0.9745	0.0816	0.8272	1.755	0.30
1616	7.6	771.4	5.2500	0.9755	0.0816	0.8270	1.755	0.30
1617	15.5	771.4	5.2500	0.5357	0.0896	0.9135	2.440	0.76
1618	15.5	771.4	5.2500	0.5426	0.0894	0.9122	2.440	0.76
1619	21.8	771.4	5.2500	0.3371	0.0931	0.9527	3.032	1.13
1620	21.8	771.4	5.2500	0.3463	0.0930	0.9509	3.032	1.13
GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
1621	5.0	771.4	5.2500	1.6388	0.1803	0.7123	1.250	0.11
1622	5.0	771.4	5.2500	1.6262	0.1809	0.7149	1.250	0.11
1623	7.6	771.4	5.2500	1.2012	0.2010	0.8019	1.620	0.26
1624	7.6	771.4	5.2500	1.1988	0.2011	0.8024	1.620	0.26
1625	15.5	771.4	5.2500	0.7000	0.2245	0.9054	2.354	0.67
1626	15.5	771.4	5.2500	0.7033	0.2243	0.9047	2.354	0.67
1627	21.8	771.4	5.2500	0.5153	0.2331	0.9437	2.858	1.00
1628	21.8	771.4	5.2500	0.5263	0.2326	0.9415	2.858	1.00
GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN								
1629	7.6	771.4	5.2500	1.1760	0.1353	0.7965	1.593	0.24
1630	7.6	771.4	5.2500	1.1740	0.1353	0.7969	1.593	0.24
1631	15.5	771.4	5.2500	0.6900	0.1505	0.8942	2.243	0.64
1632	15.5	771.4	5.2500	0.6933	0.1504	0.8935	2.243	0.64
1633	21.8	771.4	5.2500	0.4947	0.1566	0.9336	2.697	0.96
1634	21.8	771.4	5.2500	0.5053	0.1563	0.9315	2.697	0.96
GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN								
1635	5.0	771.4	5.2500	1.5028	0.0938	0.7267	1.301	0.11
AV 1636	5.0	771.4	5.2500	1.4939	0.0940	0.7285	1.301	0.11

1637	7.6	771.4	5.2500	1.1592	0.1020	0.7946	1.584	0.23
1638	7.6	771.4	5.2500	1.1575	0.1021	0.7950	1.584	0.23
1639	15.5	771.4	5.2500	0.6917	0.1131	0.8874	2.181	0.61
1640	15.5	771.4	5.2500	0.6950	0.1130	0.8867	2.181	0.61
1641	21.8	771.4	5.2500	0.4740	0.1182	0.9307	2.654	0.92
1642	21.8	771.4	5.2500	0.4843	0.1180	0.9286	2.654	0.92

APPENDIX 2

SAMPLE CALCULATION AND CALCULATED RESULTS

2-A. Sample Calculation

A-1. Introduction

In determining the general flow characteristics of the unstable two phase slug flows, the following quantities were evaluated, the hold up ratio, the slug rise velocity, the slug separation distance, the slug shape and size. These quantities are defined and calculated in the following manners.

1-a. Hold Up Ratio

$$\text{Gas phase void fraction } \alpha = \frac{\Delta V}{A_p H} \quad (2-1)$$

$$\text{Hold up ratio } \gamma = \frac{(A_p H \Delta V) / \Delta V V}{Q_L / G} = \frac{G Q_L \alpha}{Q_L} \quad (2-2)$$

where ΔV is the volume occupied by the gas phase in the absorber of length H and cross-sectional area A_p . G and Q_L are the initial gas and liquid flow rates in cc/min.

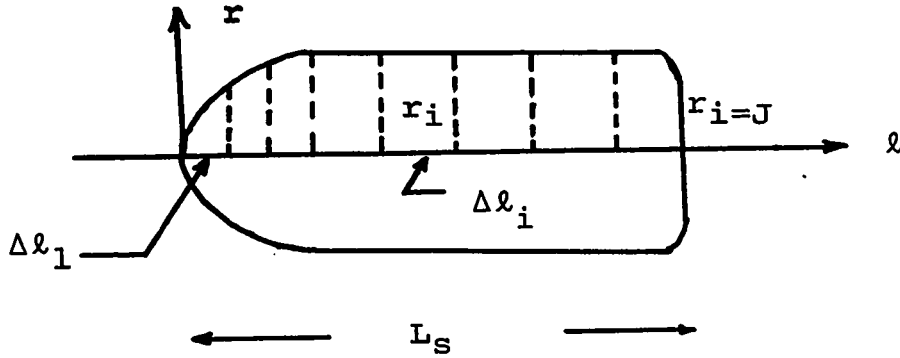
1-b. Mean Slug Frequencies $\bar{F}$ in rise zone

$$\bar{F} = \left(\sum_j^{n_f} F_j \right) / n_f \quad (\text{slugs/sec}) \quad (2-3)$$

where F_j is the point slug frequencies and n_f is the number of locations at which F_j was measured.

1-c. Slug Surface Area and Volume

For any slug it can be divided into sections as shown below :



Hence, from the numerical calculation, slug surface area

$$A_s \approx \sum_i^J \pi(r_i + r_{i+1}) \{ \Delta l_i^2 + (r_i - r_{i+1})^2 \}^{\frac{1}{2}} + \frac{\pi}{4} (2r_J)^2 \quad (2-4)$$

and slug volume

$$V_s \approx \sum_i^J (\Delta l_i / 3.0) (r_i^2 + r_i r_{i+1} + r_{i+1}^2) \quad (2-5)$$

Then mean slug surface area $\bar{A}_s = \frac{\bar{n}}{\sum_j} (A_s)_j / \bar{n}$

mean slug volume $\bar{V}_s = \frac{\bar{n}}{\sum_j} (V_s)_j / \bar{n} \quad (2-6)$

where $\bar{n}$ is the number of slug measured. $\bar{A}_s$ and $\bar{V}_s$ could be also evaluated from the independently measured mean slug frequencies as

$$\bar{V}_s = \frac{G_s}{\bar{F}} \quad (2-7)$$

where G_s is gas flow rate in cc/sec.

Since $\bar{L}_s = \bar{V}_s \times \frac{1.0}{(V_s/L_s)} \quad (2-8)$

$$\bar{A}_s = \bar{L}_s \times \left(\frac{A_s}{L_s} \right)$$

where $\bar{L}_s$ is the mean slug length while (A_s/L_s) and (V_s/L_s) are the slug surface area and volume to slug length ratios respectively which can be evaluated from equations (2-4) and (2-5).

A-2. Sample Calculation of Mass Transfer Run NO.563, Table 1-10

Observed Readings

Absorber length = 10.0 cm
 Absorber diameter = 0.793 cm
 Potentiometer reading = 7.13 MV
 Experimental temperature = 24.5°C
 Saturator temperature = -2°C
 Flowmeter reading = 21
 Manometer pressure = 764.2 mm of Hg
 Atmospheric pressure = 759.8 mm of Hg

Slug Size

Mean slug frequency = 9.50 slugs/sec (figure 17)
 Mean slug length = 2.21 cm (equation 2-8)
 Mean slug surface area = 4.35 cm² (Table 1-1)
 Mean slug surface volume = 0.567 cm³ (Table 1-1)
 Mean slug surface area to volume ratio = 7.43 cm⁻¹ (equation V-44)
 Point slug frequency (top of absorber) = 9.0 slugs/sec (Table 2-4)
 Point slug length = 2.40 cm (Table 2-4)
 Point slug surface area = 4.61 cm² (Table 1-1)
 Point slug surface volume = 0.61 cm³ (Table 1-1)
 Point slug surface area to volume ratio = 7.43 cm⁻¹ (equation V-44)

Time of Rise

Slug rise velocity = 25.88 cm/sec (equation V-450)
 Actual height of rise = 10.0 - 1.37 - 1.50 = 7.13 cm
 Time of rise = 7.13/25.88 = 0.269 sec

Total Efficiency

Concentration of n-hexane in exit gas = 0.01069 m.f.
 Concentration of n-hexane in inlet gas mixture saturated at -2°C = 0.053 m.f.
 Cup mixing outlet liquid concentration $x = 0.0105$ m.f.
 Equilibrium gas phase composition $y_{off}^* = mx = 0.002093$ m.f.
 Total efficiency $E_{OT} = (y_{on} - y_{off}) / (y_{on} - y_{off}^*) = 0.831$
 and $-\ln(1 - E_{OT}) = 1.778$

Mass Transfer Coefficients

$$K_{OG}A_e = (\text{slope} \times G_m) / (P \times F)$$

$$\overline{K_{OG}A_e} = G_m / (P \times \overline{F}) \{-\ln(1-E_{OT}) + \ln(1-E_E)\}$$

$$K_{OG}a = \text{slope} \times \frac{1}{(A_S/V_S)} \times \frac{1}{22414}$$

$$\overline{K_{OG}a} = \{-\ln(1-E_{OT}) + \ln(1-E_E)\} \times \frac{1}{(\overline{A_S}/\overline{V_S})} \times \frac{1}{22414}$$

$$\text{Slope} = 1.395$$

$$G_m = 0.000242 \text{ (g-mole/sec)}$$

$$P = 1 \text{ atm}$$

$$F = 9.0 \text{ slugs /sec}$$

$$\overline{F} = 9.5 \text{ slugs/sec}$$

$$E_E = 0.7436$$

$$(\overline{A_S}/\overline{V_S}) = 7.43 \text{ cm}^{-1}$$

$$(A_S/V_S) = 7.43 \text{ cm}^{-1}$$

$$\therefore K_{OG}A_e = 0.373 \times 10^{-4} \text{ g-mole/sec atm}$$

$$\overline{K_{OG}A_e} = 0.3915 \times 10^{-4} \text{ g-mole/sec atm}$$

$$K_{OG}a = 0.0838 \times 10^{-4} \text{ g-mole/cm}^2\text{sec atm}$$

$$\overline{K_{OG}a} = 0.0929 \times 10^{-4} \text{ g-mole/cm}^2\text{sec atm}$$

Effective Mass Transfer Area

$$\overline{a} = (\overline{K_{OG}a}) / (K_{OG})_{\text{theoretical}}$$

$$\text{Theoretical } K_{OG} = 0.3801 \times 10^{-4} \text{ g-mole/cm}^2\text{sec atm}$$

$$\overline{a} = 0.237 \text{ cm}^2/\text{cm}^2$$

A-3. Variation of Equilibrium Gas Phase Concentration y_{off}^* With Absorber Length

Due to the high formation end effect mass transfer encountered in this study, y_{off}^* values calculated from equa-

tion $y_{\text{Off}}^* = mx$ with x being the cup mixing hexane composition in the outlet could be approximated constant. Variation of y_{Off}^* with absorber length for $y_{\text{On}} \approx 0.073$ and at the highest gas rate and lowest liquid rate are shown in Table 2-1.

Table 2-1

Variation of y_{Off}^* With Absorber Length

$y_{\text{On}} \approx 0.073$ m.f.

$G = 326$ cc/min

$Q_L = 30$ cc/min

System : n-Hexane-Nitrogen-Light Paraffin Oil

H cm	x m.f.	y_{Off}^* m.f.
5.7	0.0162	0.00322
7.5	0.0165	0.00329
10.0	0.0167	0.00332
14.0	0.0167	0.00332
17.4	0.0168	0.00334
25.0	0.0171	0.00339

2-B. Calculated Results

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Table 2-2

COMPARISON OF INTERFACIAL VELOCITIES FROM EQUATION (II-6)
AND EQUATION (II-7)

NO.	D_p	G	Q_L	U_s	l	r_i	U_i (II-6)	U_i (II-7)
HEAVY PARAFFIN OIL								
1	0.793	245.0	30.0	20.58	0.141	0.225	-14.73	-17.98
2	0.793	245.0	30.0	20.58	0.203	0.253	-18.34	-19.55
3	0.793	245.0	30.0	20.58	0.313	0.294	-23.09	-24.48
4	0.793	245.0	30.0	20.58	0.500	0.295	-27.47	-27.68
5	0.793	245.0	30.0	20.58	0.800	0.295	-27.80	-28.07
6	0.793	245.0	30.0	20.58	1.060	0.295	-27.80	-28.07
7	0.793	326.0	30.0	27.60	0.141	0.225	-25.64	-22.70
8	0.793	326.0	30.0	27.60	0.203	0.253	-25.64	-22.70
9	0.793	326.0	30.0	27.60	0.313	0.278	-32.19	-35.44
10	0.793	326.0	30.0	27.60	0.500	0.295	-38.67	-41.07
11	0.793	326.0	30.0	27.60	0.800	0.295	-38.67	-41.07
12	0.793	326.0	30.0	27.60	1.060	0.295	-38.67	-41.07

Table 2-3

LIQUID FILM VELOCITY PROFILE S FROM EQUATION (II-6)

NO.	U_s	l	R_i	U_i
HEAVY PARAFFIN OIL				
ABSORBER DIAMETER = 0.793 CM				
G = 326.0 CC/MIN Q_L = 30.0 CC/MIN				
1	24.710	0.063	0.156	31.728
2	24.710	0.063	0.216	27.291
3	24.710	0.063	0.276	12.896
4	24.710	0.063	0.336	-4.672
5	24.710	0.063	0.396	-0.000
6	24.710	0.156	0.234	-1.539
7	24.710	0.156	0.275	0.436
8	24.710	0.156	0.315	5.059
9	24.710	0.156	0.356	7.869
10	24.710	0.156	0.396	0.000
11	24.710	0.218	0.257	-1.563
12	24.710	0.218	0.292	-0.514
13	24.710	0.218	0.327	1.853
14	24.710	0.218	0.362	3.336
15	24.710	0.218	0.396	0.0
16	24.710	0.406	0.290	-7.693
17	24.710	0.406	0.317	-7.020
18	24.710	0.406	0.343	-5.161
19	24.710	0.406	0.370	-2.561
20	24.710	0.406	0.396	0.001

OTTAWA ERMATIQUE	21	27.500	0.800	0.295	14.568	-42.068
	22	27.500	0.800	0.321	13.631	-41.131
	23	27.500	0.800	0.346	10.795	-38.295
	24	27.500	0.800	0.371	6.152	-33.652

Table 2-4

K_{OGA_e} and K_{OGA_e} Values for $H < 25$ cm

NO H Slope F L_s K_{OGA_e} NTU F L_s K_{OGA_e}
x10⁴ x10⁴

Absorber Diameter = 0.793 cm

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

APPROXIMATE YON = 0.023 M.F.

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

1	5.7	1.548	38.00	0.38	0.0491	0.408	52.0	0.31	0.0383
2	10.0	1.215	30.00	0.44	0.0488	0.868	33.0	0.41	0.0589
3	15.0	0.948	21.60	0.56	0.0529	1.178	23.2	0.53	0.0699
4	17.4	0.850	18.20	0.64	0.0563	1.314	20.4	0.59	0.0748
5	20.0	0.760	15.40	0.74	0.0594	1.490	18.2	0.64	0.0813

GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

6	5.7	0.989	30.50	0.44	0.0391	0.229	31.0	0.43	0.0391
7	10.0	0.800	19.80	0.60	0.0486	0.481	22.4	0.55	0.0522
8	17.4	0.581	12.80	0.86	0.0546	0.805	15.4	0.74	0.0660
9	20.0	0.525	11.60	0.93	0.0545	0.952	14.0	0.80	0.0734
10	25.0	0.438	10.30	1.04	0.0512	0.993	12.2	0.89	0.0687

GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

11	15.0	0.879	12.80	0.86	0.0827	0.589	15.4	0.74	0.0617
12	17.4	0.964	11.60	0.93	0.1000	0.602	14.0	0.80	0.0585

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

13	5.7	1.537	24.00	0.71	0.1182	0.269	26.0	0.66	0.1147
14	10.0	1.210	16.80	0.95	0.1329	0.509	20.0	0.82	0.1243
15	15.0	0.947	12.00	1.28	0.1456	0.870	16.0	1.00	0.1608
16	17.4	0.850	10.80	1.41	0.1452	1.031	14.6	1.08	0.1758
17	25.0	0.625	9.20	1.63	0.1253	1.163	12.1	1.27	0.1591

GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

18	5.7	1.484	22.00	0.76	0.1244	0.190	23.0	0.73	0.0973
19	10.0	1.475	16.40	0.97	0.1659	0.612	17.4	0.93	0.1818
20	15.0	1.464	12.20	1.26	0.2214	0.811	14.0	1.12	0.1816
21	17.4	1.459	11.30	1.35	0.2383	1.063	13.3	1.17	0.2107
22	20.0	1.454	10.60	1.44	0.2531	1.197	12.8	1.21	0.2102

GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

23	5.7	2.082	25.40	0.68	0.1513	0.294	28.0	0.63	0.1305
24	10.0	1.990	20.20	0.82	0.1817	0.740	21.6	0.77	0.1871
25	15.0	1.889	16.20	0.98	0.2152	1.081	17.4	0.93	0.2055
26	17.4	1.844	14.60	1.08	0.2330	1.371	16.3	0.98	0.2340
27	20.0	1.796	13.40	1.16	0.2473	1.510	15.0	1.05	0.2390

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

28	5.7	3.217	17.20	1.20	0.4504	0.476	18.2	1.14	0.5039
29	10.0	2.158	13.00	1.55	0.3997	0.934	15.0	1.36	0.5058

30	15.0	1.473	10.40	1.90	0.3412	1.264	12.0	1.66	0.5120
31	17.4	1.253	9.60	2.05	0.3143	1.446	11.2	1.77	0.5249
32	24.0	0.855	8.40	2.32	0.2452	1.681	9.8	2.01	0.4838

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
33	5.7	2.925	16.60	1.24	0.4243	0.398	18.5	1.13	0.4337
34	10.0	2.171	14.80	1.37	0.3533	0.803	15.3	1.33	0.4457
35	15.0	1.611	13.00	1.55	0.2985	1.171	13.0	1.55	0.4580
36	17.4	1.415	12.40	1.61	0.2748	1.305	12.4	1.61	0.4476
37	20.0	1.243	11.80	1.69	0.2537	1.432	11.9	1.68	0.4364

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
38	5.7	2.823	18.00	1.15	0.3778	0.368	18.4	1.13	0.4207
39	10.0	2.092	13.80	1.46	0.3650	0.743	14.4	1.41	0.4581
40	15.0	1.550	11.40	1.74	0.3274	1.080	11.9	1.68	0.4820
41	17.4	1.362	10.60	1.87	0.3094	1.203	11.0	1.80	0.4867
42	20.0	1.194	10.20	1.93	0.2820	1.322	10.4	1.90	0.4815

APPROXIMATE YON = 0.052 M.F.

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
43	5.7	3.743	38.00	0.38	0.1186	1.127	52.0	0.31	0.1057
44	7.5	3.174	34.20	0.40	0.1118	1.490	44.0	0.34	0.1106
45	10.0	2.579	30.00	0.44	0.1035	2.002	33.0	0.41	0.1359
46	12.0	2.215	26.00	0.49	0.1026	2.380	29.0	0.45	0.1470
47	17.4	1.545	18.20	0.64	0.1022	2.985	20.4	0.59	0.1700
48	20.0	1.326	15.40	0.74	0.1037	3.373	18.2	0.64	0.1841
49	25.0	1.018	11.20	0.96	0.1095	3.606	15.2	0.74	0.1844

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
50	5.7	1.873	30.50	0.44	0.0739	0.476	31.0	0.43	0.0813
51	10.0	1.473	20.00	0.60	0.0887	0.900	22.4	0.55	0.0978
52	14.0	1.206	15.20	0.74	0.0956	1.300	18.0	0.65	0.1170
53	17.4	1.033	12.80	0.86	0.0971	1.465	15.4	0.74	0.1200

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
54	14.0	1.281	15.20	0.74	0.1015	1.280	18.0	0.65	0.1243
55	17.4	1.095	12.80	0.86	0.1030	1.446	15.4	0.74	0.1279

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
56	5.7	5.114	23.20	0.73	0.4067	1.008	25.6	0.67	0.4372
57	10.0	3.581	16.80	0.95	0.3933	1.892	20.0	0.82	0.4620
58	14.0	2.700	12.60	1.23	0.3954	2.541	16.5	0.97	0.4947
59	18.0	2.109	10.60	1.44	0.3670	2.982	14.4	1.09	0.4956

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
60	5.7	3.599	22.00	0.76	0.3018	0.593	22.4	0.75	0.3113
61	10.0	2.868	16.40	0.97	0.3227	1.240	17.4	0.93	0.3685
62	14.0	2.372	12.80	1.21	0.3420	1.749	14.4	1.09	0.4132
63	18.5	1.954	11.00	1.39	0.3277	2.199	13.0	1.19	0.4156
64	20.0	1.839	10.60	1.44	0.3201	2.479	12.8	1.21	0.4354
65	25.0	1.521	10.10	1.50	0.2778	2.624	12.4	1.25	0.3709

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
66	5.7	3.672	25.40	0.68	0.2667	0.613	27.8	0.63	0.2735
67	10.0	3.010	20.20	0.82	0.2749	1.185	21.6	0.77	0.2995
68	14.0	2.544	16.80	0.95	0.2793	1.671	18.0	0.90	0.3334
69	17.4	2.227	14.60	1.08	0.2815	2.123	16.4	0.97	0.3602

70	20.0	2.024	13.40	1.16	0.2786	2.347	15.2	1.04	0.3666
71	25.0	1.703	11.80	1.30	0.2663	2.680	14.2	1.11	0.3492

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
72	5.7	4.561	17.20	1.20	0.6372	0.538	18.4	1.13	0.5606
73	10.0	4.186	13.20	1.52	0.7620	1.382	15.0	1.36	0.7466
74	14.0	3.875	10.80	1.83	0.8622	2.085	12.6	1.59	0.8707
75	17.4	3.638	9.60	2.05	0.9107	2.434	11.2	1.77	0.8817
76	20.0	3.472	9.00	2.17	0.9269	2.796	10.5	1.88	0.9194
77	25.0	3.182	8.40	2.32	0.9102	3.556	9.8	2.01	0.9737

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
78	5.7	5.874	16.60	1.24	0.8503	0.860	18.4	1.13	0.9374
79	10.0	3.854	14.80	1.37	0.6257	1.575	15.3	1.33	0.8727
80	14.0	2.778	13.40	1.50	0.4981	2.162	13.4	1.50	0.8883
81	17.4	2.184	12.40	1.61	0.4232	2.489	12.4	1.61	0.8520
82	20.0	1.849	11.80	1.69	0.3766	2.619	11.9	1.68	0.7950
83	25.0	1.390	11.00	1.80	0.3036	2.949	11.5	1.73	0.7198

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
84	5.7	6.660	17.80	1.16	0.8992	1.051	18.4	1.13	1.1959
85	10.0	3.547	13.80	1.46	0.6176	1.770	14.5	1.40	1.0811
86	14.0	2.259	11.70	1.70	0.4640	2.222	12.2	1.64	1.0470
87	17.4	1.648	10.60	1.87	0.3736	2.491	11.0	1.80	1.0036
88	20.0	1.333	10.20	1.93	0.3142	2.643	10.6	1.87	0.9405
89	25.0	0.937	9.90	1.99	0.2274	2.779	10.1	1.95	0.8066

APPROXIMATE YON = 0.072 M.F.

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
90	5.7	1.189	38.00	0.38	0.0377	0.166	52.0	0.31	0.0156
91	10.0	2.177	30.00	0.44	0.0874	0.875	33.0	0.41	0.0594
92	14.0	4.816	22.60	0.54	0.2566	1.619	24.8	0.51	0.0974
93	16.5	9.962	19.50	0.61	0.6152	2.393	23.5	0.53	0.1256
94	17.4	14.042	18.20	0.64	0.9291	3.656	20.4	0.59	0.2082

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
95	5.7	2.063	30.50	0.44	0.0814	0.430	31.0	0.43	0.0735
96	10.0	2.361	20.00	0.60	0.1422	1.076	22.4	0.55	0.1169
97	14.0	2.700	15.20	0.74	0.2139	1.623	18.0	0.65	0.1460
98	17.4	3.049	12.80	0.86	0.2868	2.281	15.4	0.74	0.1868

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
99	14.0	2.119	15.20	0.74	0.1679	1.462	18.0	0.65	0.1421
100	17.4	2.117	12.80	0.86	0.1991	1.876	15.4	0.74	0.1659

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
101	5.4	6.231	23.80	0.71	0.4830	1.179	26.0	0.66	0.5525
102	7.5	4.819	20.60	0.80	0.4316	1.739	23.0	0.73	0.5472
103	11.5	3.190	15.00	1.05	0.3924	2.493	18.6	0.87	0.5477
104	14.0	2.560	12.60	1.23	0.3748	2.928	16.5	0.97	0.5701
105	17.4	1.964	10.80	1.41	0.3354	3.217	14.6	1.08	0.5484

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
106	5.7	3.983	22.00	0.76	0.3340	0.625	22.4	0.75	0.3281
107	17.4	2.635	16.40	0.97	0.2965	2.356	18.0	0.90	0.3450
108	10.0	3.387	12.80	1.21	0.4882	1.477	14.5	1.08	0.5267

109	14.0	2.946	11.40	1.34	0.4768	1.968	13.3	1.17	0.5033
110	20.0	2.430	10.60	1.44	0.4229	2.830	12.8	1.21	0.4971
111	25.0	2.097	10.10	1.50	0.3830	3.226	12.4	1.25	0.4560

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
112	5.7	3.812	25.40	0.68	0.2769	0.406	27.8	0.63	0.1813
113	10.0	3.343	20.20	0.82	0.3054	1.265	21.6	0.77	0.3199
114	14.0	2.981	16.80	0.95	0.3274	1.866	18.0	0.90	0.3724
115	17.4	2.718	14.70	1.07	0.3411	2.474	16.4	0.97	0.4198
116	20.0	2.539	13.40	1.16	0.3496	2.785	15.2	1.04	0.4350
117	25.0	2.242	11.80	1.30	0.3505	2.784	14.2	1.11	0.3628

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
118	5.7	5.902	17.20	1.20	0.8265	0.634	18.4	1.13	0.6635
119	10.0	4.656	15.00	1.36	0.7476	1.631	17.0	1.21	0.7776
120	7.5	5.328	13.20	1.52	0.9721	1.269	15.0	1.36	1.0351
121	14.0	3.823	10.80	1.83	0.8525	2.395	12.6	1.59	1.0022
122	17.4	3.278	9.60	2.05	0.8225	3.237	11.2	1.77	1.1750
123	25.0	2.415	8.50	2.30	0.6841	3.536			

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
124	5.7	5.827	16.60	1.24	0.8454	0.766	18.4	1.13	0.8395
125	10.0	4.556	14.80	1.37	0.7414	1.620	15.3	1.33	0.8978
126	14.0	3.716	13.40	1.50	0.6679	2.254	13.4	1.50	0.9279
127	17.4	3.172	12.40	1.61	0.6160	2.679	12.4	1.61	0.9190
128	25.0	2.317	11.00	1.80	0.5072	3.478	11.6	1.72	0.8435

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
129	5.7	3.337	17.80	1.16	0.4516	0.239	18.4	1.13	0.2736
130	10.0	3.179	13.80	1.46	0.5548	1.102	14.5	1.40	0.6731
131	14.0	3.042	11.70	1.70	0.6262	1.421	12.2	1.64	0.6709
132	17.4	2.932	10.60	1.87	0.6662	1.556	11.0	1.80	0.6283
133	20.0	2.852	10.20	1.93	0.6735	2.087	10.4	1.90	0.7584
134	25.0	2.708	9.90	1.99	0.6587	2.480	10.1	1.95	0.7214

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

APPROXIMATE YCN = 0.024 M.F.

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
135	5.7	0.780	23.00	0.58	0.0408	0.188	24.6	0.56	0.0413
136	10.0	0.610	16.60	0.75	0.0443	0.399	16.6	0.75	0.0574
137	17.4	0.425	9.70	1.18	0.0527	0.624	10.2	1.13	0.0748
138	22.4	0.344	7.30	1.52	0.0567	0.760	7.8	1.44	0.0895

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
139	5.7	1.106	13.20	0.91	0.1009	0.226	13.8	0.88	0.0960
140	10.0	0.767	10.00	1.15	0.0924	0.571	11.2	1.04	0.1323
141	17.4	0.463	7.60	1.47	0.0734	0.747	9.6	1.19	0.1033
142	22.4	0.350	7.60	1.47	0.0554	0.897	9.1	1.25	0.0984

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
143	5.7	1.686	32.60	0.46	0.0623	0.429	36.0	0.43	0.0754
144	10.0	0.972	25.00	0.55	0.0468	0.735	26.0	0.53	0.0793
145	17.4	0.487	15.30	0.80	0.0383	1.017	16.7	0.75	0.0873

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
146	5.7	1.106	16.00	1.08	0.1275	0.160	16.4	1.06	0.1251
147	10.0	0.847	12.00	1.39	0.1303	0.403	12.0	1.39	0.1778

148	17.4	0.575	7.20	2.22	0.1473	0.603	7.2	2.22	0.2206
149	22.4	0.459	5.50	2.86	0.1540	0.748	5.9	2.68	0.2494

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
150	5.7	1.148	10.80	1.53	0.1961	0.165	11.0	1.50	0.2033
151	10.0	0.966	8.40	1.92	0.2121	0.373	9.7	1.69	0.2160
152	17.4	0.740	6.40	2.48	0.2134	0.647	8.3	1.95	0.2177
153	22.4	0.630	6.40	2.48	0.1815	0.805	8.0	2.01	0.2097

GAS RATE =		245.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
154	5.7	0.965	15.60	1.10	0.1141	0.117	22.0	0.83	0.0766
155	10.0	0.615	12.40	1.35	0.0915	0.311	16.2	1.07	0.1137
156	17.4	0.339	8.20	1.97	0.0762	0.466	10.2	1.61	0.1347
157	22.4	0.246	7.40	2.16	0.0613	0.475	8.7	1.86	0.1202

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
158	5.7	1.822	12.20	1.78	0.3598	0.214	12.6	1.72	0.3976
159	10.0	1.330	9.20	2.31	0.3481	0.457	9.6	2.22	0.4247
160	17.4	0.851	5.70	3.63	0.3596	0.789	5.8	3.57	0.5896
161	22.4	0.660	4.30	4.77	0.3699	0.911	4.5	4.56	0.6513

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
162	5.7	1.783	9.60	2.22	0.4474	0.200	10.4	2.06	0.4712
163	10.0	1.283	8.40	2.51	0.3679	0.399	8.4	2.51	0.4441
164	13.5	1.017	7.50	2.80	0.3267	0.618	7.8	2.69	0.4929
165	17.4	0.808	7.00	2.98	0.2780	0.737	7.3	2.87	0.4577
166	22.4	0.622	6.70	3.11	0.2236	0.831	7.0	2.98	0.3993

GAS RATE =		326.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
167	5.7	1.655	13.00	1.67	0.3066	0.173	16.2	1.37	0.2728
168	8.0	1.451	11.10	1.94	0.3149	0.275	14.8	1.49	0.2544
169	10.0	1.304	9.60	2.22	0.3271	0.358	13.1	1.66	0.2665
170	13.0	1.122	8.00	2.63	0.3377	0.563	11.0	1.95	0.3494
171	17.4	0.916	6.70	3.11	0.3294	0.722	9.1	2.33	0.3757
172	22.4	0.745	5.80	3.57	0.3092	0.793	8.1	2.60	0.3440

APPROXIMATE YON = 0.053 M.F.

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		30.0 CC/MIN			
173	5.7	1.352	23.00	0.58	0.0708	0.326	24.6	0.56	0.0716
174	10.0	0.981	16.60	0.75	0.0711	0.720	16.6	0.75	0.1037
175	14.2	0.749	12.20	0.97	0.0739	0.881	12.6	0.94	0.1084
176	17.4	0.623	9.70	1.18	0.0773	1.051	10.2	1.13	0.1259
177	22.6	0.477	7.30	1.52	0.0787	1.236	7.8	1.44	0.1441

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		45.0 CC/MIN			
178	5.7	1.177	13.20	0.91	0.1074	0.269	13.8	0.88	0.1143
179	10.0	0.946	10.00	1.15	0.1139	0.532	11.3	1.04	0.1223
180	17.4	0.682	7.60	1.47	0.1080	0.901	9.6	1.19	0.1246
181	22.6	0.557	7.60	1.47	0.0883	1.084	9.0	1.26	0.1190

GAS RATE =		165.0 CC/MIN		LIQUID RATE =		60.0 CC/MIN			
182	5.7	1.538	32.60	0.46	0.0568	0.344	36.0	0.43	0.0604
183	10.0	1.055	25.00	0.55	0.0508	0.667	26.0	0.53	0.0720
184	17.4	0.630	15.20	0.81	0.0499	0.980	16.7	0.75	0.0842
185	22.6	0.468	11.80	1.00	0.0478	1.150	13.0	0.92	0.0944

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN									
186	5.7	1.295	16.40	1.06	0.1456	0.197	16.4	1.06	0.1544
187	10.0	1.067	12.00	1.39	0.1641	0.447	12.0	1.39	0.1973
188	17.4	0.795	7.20	2.22	0.2038	0.760	7.2	2.22	0.2781
189	22.6	0.662	5.40	2.91	0.2262	0.946	5.8	2.72	0.3178

GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN									
190	5.7	1.333	10.80	1.53	0.2276	0.185	11.0	1.50	0.2289
191	10.0	1.081	8.40	1.92	0.2374	0.448	9.7	1.69	0.2590
192	17.4	0.789	6.40	2.48	0.2274	0.720	8.3	1.95	0.2422
193	22.6	0.649	6.40	2.48	0.1871	0.906	8.0	2.01	0.2338

GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN									
194	5.7	1.171	15.60	1.10	0.1385	0.143	22.4	0.81	0.0918
195	10.0	1.023	11.40	1.46	0.1655	0.386	16.2	1.07	0.1412
196	17.4	0.826	8.20	1.97	0.1858	0.629	10.2	1.61	0.1818
197	22.6	0.720	5.70	2.77	0.2329	0.824	8.7	1.86	0.2064

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN									
198	5.7	1.662	12.20	1.78	0.3273	0.188	12.6	1.72	0.3463
199	10.0	1.395	9.00	2.35	0.3724	0.417	9.5	2.24	0.3915
200	15.0	1.158	6.60	3.16	0.4218	0.675	6.7	3.11	0.5232
201	17.4	1.066	5.70	3.63	0.4493	0.815	5.8	3.57	0.6075
202	22.8	0.894	4.40	4.66	0.4882	0.975	4.4	4.66	0.6964

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN									
203	5.7	1.417	9.60	2.22	0.3546	0.101	10.4	2.06	0.2371
204	10.0	1.190	8.40	2.51	0.3405	0.429	8.4	2.51	0.4759
205	17.4	0.910	7.00	2.98	0.3125	0.605	7.2	2.91	0.3802
206	22.6	0.769	6.70	3.11	0.2758	0.807	7.0	2.98	0.3830

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN									
207	5.7	2.476	13.00	1.67	0.4577	0.282	17.2	1.30	0.4173
208	10.0	1.524	11.60	1.86	0.3156	0.578	13.1	1.66	0.4296
209	17.4	0.811	6.70	3.11	0.2909	0.869	9.1	2.33	0.4514
210	22.6	0.573	5.70	3.63	0.2414	0.994	8.0	2.63	0.4314

APPROXIMATE YON = 0.073 M.F.

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN									
211	5.7	1.602	23.00	0.58	0.0839	0.382	24.6	0.56	0.0838
212	10.0	1.289	16.60	0.75	0.0935	0.792	16.6	0.75	0.1140
213	17.4	0.930	9.70	1.18	0.1155	1.314	10.2	1.13	0.1574
214	20.9	0.811	7.90	1.42	0.1236	1.590	8.2	1.37	0.1925
215	25.0	0.698	6.70	1.65	0.1255	1.678	7.4	1.51	0.1845

GAS RATE = 165.0 CC/MIN LIQUID RATE = 45.0 CC/MIN									
216	5.7	1.653	13.20	0.91	0.1508	0.354	13.8	0.88	0.1506
217	10.0	1.348	10.00	1.15	0.1623	0.714	11.3	1.04	0.1641
218	17.4	0.990	7.60	1.47	0.1569	1.318	9.6	1.19	0.1822
219	20.3	0.888	7.40	1.51	0.1445	1.519	9.2	1.24	0.1840
220	25.0	0.753	8.00	1.40	0.1134	1.583	9.0	1.26	0.1555

GAS RATE = 165.0 CC/MIN LIQUID RATE = 60.0 CC/MIN									
221	5.7	1.696	32.60	0.46	0.0626	0.356	36.0	0.43	0.0625
222	10.0	1.400	25.00	0.55	0.0674	0.697	26.0	0.53	0.0752

223	12.5	1.263	21.60	0.61	0.0704	0.923	21.7	0.61	0.0902
224	17.4	1.046	15.20	0.81	0.0829	1.208	16.7	0.75	0.1037
225	20.9	0.924	12.60	0.94	0.0883	1.419	14.0	0.87	0.1180
226	25.0	0.806	10.80	1.08	0.0899	1.597	11.6	1.01	0.1314

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

227	5.7	1.594	16.20	1.07	0.1816	0.241	16.4	1.06	0.1890
228	10.0	1.316	12.00	1.39	0.2024	0.502	12.1	1.38	0.2196
229	13.5	1.141	9.20	1.77	0.2287	0.796	9.6	1.70	0.2972
230	17.4	0.983	7.20	2.22	0.2520	0.925	7.3	2.19	0.3340
231	20.9	0.868	5.90	2.68	0.2715	1.148	6.2	2.55	0.3945
232	25.0	0.758	5.10	3.07	0.2741	1.217	5.6	2.81	0.3779

GAS RATE = 245.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

233	5.7	1.313	10.80	1.53	0.2243	0.182	11.0	1.50	0.2244
234	10.0	1.194	8.40	1.92	0.2623	0.431	9.7	1.69	0.2492
235	17.4	1.025	6.40	2.48	0.2955	0.778	8.3	1.95	0.2616
236	20.9	0.957	6.20	2.55	0.2848	0.975	8.0	2.01	0.2750
237	25.0	0.886	6.60	2.41	0.2476	1.107	8.0	2.01	0.2549

GAS RATE = 245.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

238	5.7	1.274	15.60	1.10	0.1507	0.158	22.0	0.83	0.1030
239	10.0	1.131	11.40	1.46	0.1830	0.415	16.2	1.07	0.1518
240	17.4	0.935	8.20	1.97	0.2104	0.694	10.2	1.61	0.2005
241	20.9	0.860	7.60	2.11	0.2087	0.856	9.0	1.81	0.2266

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

242	5.7	2.083	12.20	1.78	0.4102	0.220	12.6	1.72	0.4056
243	10.0	1.558	9.20	2.31	0.4068	0.558	9.5	2.24	0.5236
244	13.0	1.301	7.60	2.76	0.4113	0.722	7.6	2.76	0.5919
245	17.4	1.025	5.70	3.63	0.4323	0.867	5.7	3.63	0.6578
246	20.9	0.864	4.60	4.47	0.4515	1.038	4.8	4.29	0.7521

GAS RATE = 326.0 CC/MIN LIQUID RATE = 45.0 CC/MIN

247	5.7	1.558	9.70	2.19	0.3860	0.140	10.4	2.06	0.3285
248	10.0	1.369	8.40	2.51	0.3916	0.429	8.4	2.51	0.4758
249	17.4	1.116	7.00	2.98	0.3830	0.703	7.2	2.91	0.4421
250	20.9	1.020	6.80	3.07	0.3604	0.879	7.0	2.98	0.4572

GAS RATE = 326.0 CC/MIN LIQUID RATE = 60.0 CC/MIN

251	5.0	3.362	14.20	1.55	0.5689	0.214	18.0	1.25	0.4088
252	5.7	3.057	13.00	1.67	0.5650	0.401	17.2	1.30	0.5919
253	10.0	1.850	9.60	2.22	0.4631	0.706	13.1	1.66	0.5247
254	13.5	1.328	7.90	2.66	0.4038	0.906	10.8	1.99	0.5439
255	17.4	0.969	6.70	3.11	0.3476	1.105	9.1	2.33	0.5739
256	20.9	0.758	6.00	3.46	0.3037	1.142	8.2	2.57	0.5296

Table 2-5

K_{OGa} and $\overline{K_{OGa}}$ Values for $H < 25$ cm

NO	G	Q_L	H	EE	NTU	Slope	$\overline{A_s}/\overline{V_s}$	K_{OGa} x10 ⁴	$\overline{K_{OGa}}$ x10 ⁴
SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL									
ABSORBER DIAMETER = 0.793 CM									
APPROXIMATE YCN = 0.0234 M.F.									
1	165.0	30.0	5.69	0.9519	0.408	1.548	13.804	0.0500	0.0534
2	165.0	30.0	10.00	0.9519	0.868	1.215	10.971	0.0494	0.0657
3	165.0	30.0	15.00	0.9519	1.178	0.948	9.538	0.0444	0.0630

4	165.0	30.0	17.40	0.9519	1.314	0.850	9.193	0.0413	0.0615
5	165.0	30.0	20.00	0.9519	1.490	0.760	8.955	0.0379	0.0613
6	165.0	45.0	5.69	0.9583	0.229	0.989	12.006	0.0268	0.0374
7	165.0	45.0	10.00	0.9583	0.481	0.800	10.049	0.0355	0.0431
8	165.0	45.0	15.00	0.9583	0.709	0.641	9.059	0.0315	0.0433
9	165.0	45.0	17.40	0.9583	0.805	0.581	8.822	0.0294	0.0427
10	165.0	45.0	20.00	0.9583	0.952	0.525	8.657	0.0270	0.0440
11	165.0	45.0	25.00	0.9583	0.993	0.438	8.493	0.0230	0.0366
12	165.0	60.0	5.69	0.9654	0.111	0.639	16.112	0.0177	0.0146
13	165.0	60.0	10.00	0.9654	0.306	0.736	12.780	0.0257	0.0233
14	165.0	60.0	15.00	0.9654	0.589	0.879	10.845	0.0362	0.0325
15	165.0	60.0	17.40	0.9654	0.602	0.964	10.322	0.0417	0.0294
16	245.0	30.0	5.69	0.9128	0.269	1.537	9.484	0.0723	0.0760
17	245.0	30.0	10.00	0.9128	0.509	1.210	8.663	0.0623	0.0694
18	245.0	30.0	15.00	0.9128	0.870	0.947	8.247	0.0512	0.0755
19	245.0	30.0	17.40	0.9128	1.031	0.850	8.147	0.0465	0.0762
20	245.0	30.0	25.00	0.9128	1.163	0.625	8.009	0.0348	0.0581
21	245.0	45.0	5.69	0.9130	0.190	1.484	9.078	0.0729	0.0596
22	245.0	45.0	10.00	0.9130	0.612	1.475	8.486	0.0775	0.0902
23	245.0	45.0	15.00	0.9130	0.811	1.464	8.186	0.0798	0.0751
24	245.0	45.0	17.40	0.9130	1.063	1.459	8.114	0.0802	0.0835
25	245.0	45.0	20.00	0.9130	1.197	1.454	8.064	0.0804	0.0807
26	245.0	60.0	5.69	0.9077	0.294	2.082	9.630	0.0965	0.0917
27	245.0	60.0	10.00	0.9077	0.740	1.990	9.000	0.0986	0.1086
28	245.0	60.0	15.00	0.9077	1.081	1.889	8.633	0.0976	0.1002
29	245.0	60.0	17.40	0.9077	1.371	1.844	8.534	0.0964	0.1081
30	245.0	60.0	20.00	0.9077	1.510	1.796	8.460	0.0947	0.1025
31	326.0	30.0	5.69	0.8295	0.476	3.217	8.142	0.1763	0.2087
32	326.0	30.0	10.00	0.8295	0.934	2.158	7.763	0.1240	0.1810
33	326.0	30.0	15.00	0.8295	1.264	1.473	7.571	0.0868	0.1503
34	326.0	30.0	17.43	0.8295	1.446	1.253	7.525	0.0743	0.1447
35	326.0	30.0	24.00	0.8295	1.681	0.855	7.466	0.0511	0.1176
36	326.0	45.0	5.69	0.8548	0.398	2.925	8.149	0.1601	0.1824
37	326.0	45.0	10.00	0.8548	0.803	2.171	7.869	0.1231	0.1606
38	326.0	45.0	15.00	0.8548	1.171	1.611	7.726	0.0930	0.1427
39	326.0	45.0	17.43	0.8548	1.305	1.415	7.692	0.0821	0.1337
40	326.0	45.0	20.00	0.8548	1.432	1.243	7.669	0.0723	0.1255
41	326.0	60.0	5.69	0.8759	0.368	2.823	8.063	0.1562	0.1778
42	326.0	60.0	10.00	0.8759	0.743	2.092	7.840	0.1190	0.1558
43	326.0	60.0	15.00	0.8759	1.080	1.550	7.711	0.0897	0.1378
44	326.0	60.0	17.40	0.8759	1.203	1.362	7.676	0.0792	0.1292
45	326.0	60.0	20.00	0.8759	1.322	1.194	7.649	0.0696	0.1213

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL
 ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0525 M.F.

46	165.0	30.0	5.69	0.9240	1.127	3.743	13.804	0.1210	0.1475
47	165.0	30.0	7.50	0.9240	1.490	3.174	12.346	0.1147	0.1460
48	165.0	30.0	10.00	0.9240	2.002	2.579	10.971	0.1049	0.1514
49	165.0	30.0	12.00	0.9240	2.380	2.215	10.241	0.0965	0.1542
50	165.0	30.0	15.00	0.9240	2.748	1.799	9.538	0.0842	0.1469
51	165.0	30.0	17.40	0.9240	2.985	1.545	9.193	0.0750	0.1398
52	165.0	30.0	20.00	0.9240	3.373	1.326	8.955	0.0661	0.1387
53	165.0	30.0	25.00	0.9240	3.606	1.018	8.718	0.0521	0.1191
54	165.0	45.0	5.69	0.9591	0.476	1.873	12.006	0.0696	0.0778
55	165.0	45.0	10.00	0.9591	0.901	1.473	10.049	0.0654	0.0808
56	165.0	45.0	14.00	0.9591	1.300	1.206	9.193	0.0585	0.0849
57	165.0	45.0	15.00	0.9591	1.326	1.151	9.059	0.0567	0.0811

58	165.0	45.0	17.40	0.9591	1.465	1.033	8.822	0.0522	0.0776
59	165.0	60.0	5.69	0.9566	0.471	1.996	16.112	0.0553	0.0620
60	165.0	60.0	10.00	0.9566	0.889	1.566	12.780	0.0547	0.0677
61	165.0	60.0	14.00	0.9566	1.280	1.281	11.126	0.0514	0.0745
62	165.0	60.0	15.00	0.9566	1.308	1.222	10.845	0.0502	0.0721
63	165.0	60.0	17.40	0.9566	1.446	1.095	10.322	0.0473	0.0707
64	245.0	30.0	5.69	0.8294	1.008	5.114	9.484	0.2406	0.2854
65	245.0	30.0	10.00	0.8294	1.892	3.581	8.663	0.1844	0.2579
66	245.0	30.0	14.00	0.8294	2.541	2.700	8.303	0.1451	0.2377
67	245.0	30.0	15.00	0.8294	2.649	2.531	8.247	0.1369	0.2299
68	245.0	30.0	18.00	0.8294	2.582	2.109	8.128	0.1158	0.2123
69	245.0	45.0	5.69	0.9006	0.593	3.599	9.078	0.1769	0.1858
70	245.0	45.0	10.00	0.9006	1.240	2.868	8.486	0.1508	0.1827
71	245.0	45.0	14.00	0.9006	1.749	2.372	8.227	0.1287	0.1749
72	245.0	45.0	15.00	0.9006	1.857	2.268	8.186	0.1236	0.1719
73	245.0	45.0	18.50	0.9006	2.199	1.954	8.090	0.1078	0.1615
74	245.0	45.0	20.00	0.9006	2.479	1.839	8.064	0.1017	0.1671
75	245.0	45.0	25.00	0.9006	2.624	1.521	8.015	0.0846	0.1388
76	245.0	60.0	5.69	0.9027	0.613	3.672	9.630	0.1701	0.1909
77	245.0	60.0	10.00	0.9027	1.185	3.010	9.000	0.1492	0.1738
78	245.0	60.0	14.00	0.9027	1.671	2.544	8.686	0.1306	0.1671
79	245.0	60.0	15.00	0.9027	1.820	2.444	8.633	0.1263	0.1687
80	245.0	60.0	17.40	0.9027	2.123	2.227	8.534	0.1164	0.1674
81	245.0	60.0	20.00	0.9027	2.347	2.024	8.460	0.1067	0.1593
82	245.0	60.0	25.00	0.9027	2.680	1.703	8.379	0.0907	0.1431
83	326.0	30.0	5.69	0.8605	0.538	4.561	8.152	0.2496	0.2349
84	326.0	30.0	9.98	0.8605	1.382	4.186	7.771	0.2403	0.2676
W 85	326.0	30.0	14.00	0.8605	2.085	3.875	7.603	0.2274	0.2679
86	326.0	30.0	15.00	0.8605	2.137	3.803	7.577	0.2239	0.2534
87	326.0	30.0	17.40	0.8605	2.434	3.638	7.531	0.2155	0.2435
88	326.0	30.0	20.00	0.8605	2.796	3.472	7.499	0.2066	0.2390
89	326.0	30.0	25.00	0.8605	3.556	3.182	7.467	0.1901	0.2373
90	326.0	45.0	5.69	0.8072	0.860	5.874	8.156	0.3213	0.3927
91	326.0	45.0	9.98	0.8072	1.575	3.854	7.874	0.2183	0.3148
92	326.0	45.0	14.00	0.8072	2.162	2.778	7.750	0.1599	0.2852
93	326.0	45.0	15.00	0.8072	2.231	2.580	7.730	0.1489	0.2713
94	326.0	45.0	17.40	0.8072	2.489	2.184	7.696	0.1266	0.2549
95	326.0	45.0	20.00	0.8072	2.619	1.849	7.672	0.1075	0.2289
96	326.0	45.0	25.00	0.8072	2.949	1.390	7.649	0.0811	0.2009
97	326.0	60.0	5.69	0.7826	1.051	6.660	8.074	0.3680	0.5060
98	326.0	60.0	9.99	0.7826	1.770	3.547	7.850	0.2016	0.3708
99	326.0	60.0	14.00	0.7826	2.222	2.259	7.737	0.1303	0.3065
100	326.0	60.0	15.00	0.7826	2.303	2.048	7.719	0.1184	0.2929
101	326.0	60.0	17.40	0.7826	2.491	1.648	7.683	0.0957	0.2668
102	326.0	60.0	20.00	0.7826	2.643	1.333	7.657	0.0777	0.2417
103	326.0	60.0	25.00	0.7826	2.779	0.937	7.628	0.0548	0.1983

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0716 M.F.

104	165.0	30.0	5.69	0.9768	0.166	1.189	13.804	0.0384	0.0218
105	165.0	30.0	10.00	0.9768	0.875	2.177	10.971	0.0885	0.0662
106	165.0	30.0	14.00	0.9768	1.619	4.816	9.731	0.2208	0.0920
107	165.0	30.0	15.00	0.9768	1.951	6.246	9.538	0.2922	0.1043
108	165.0	30.0	16.50	0.9768	2.393	9.962	9.305	0.4776	0.1175
109	165.0	30.0	17.40	0.9768	3.656		9.193	0.6815	0.1711

110	165.0	45.0	5.69	0.9646	0.430	2.063	12.006	0.0767	0.0703
111	165.0	45.0	10.00	0.9646	1.076	2.361	10.049	0.1048	0.0965
112	165.0	45.0	14.00	0.9646	1.623	2.700	9.193	0.1310	0.1059
113	165.0	45.0	15.00	0.9646	1.833	2.796	9.059	0.1377	0.1121
114	165.0	45.0	17.40	0.9646	2.281	3.049	8.822	0.1542	0.1208
115	165.0	60.0	5.69	0.9573	0.448	2.125	16.112	0.0588	0.0589
116	165.0	60.0	10.00	0.9573	0.974	2.122	12.780	0.0741	0.0741
117	165.0	60.0	14.00	0.9573	1.462	2.119	11.126	0.0850	0.0852
118	165.0	60.0	15.00	0.9573	1.584	2.118	10.845	0.0871	0.0873
119	165.0	60.0	17.40	0.9573	1.876	2.117	10.322	0.0915	0.0917
120	245.0	30.0	5.39	0.8541	1.179	6.231	9.568	0.2905	0.3630
121	245.0	30.0	7.50	0.8541	1.739	4.819	9.061	0.2373	0.3359
122	245.0	30.0	11.50	0.8541	2.493	3.190	8.497	0.1675	0.2899
123	245.0	30.0	14.00	0.8541	2.928	2.560	8.303	0.1375	0.2740
124	245.0	30.0	15.00	0.8541	2.989	2.359	8.247	0.1276	0.2594
125	245.0	30.0	17.40	0.8541	3.217	1.964	8.147	0.1075	0.2376
126	245.0	45.0	5.69	0.9056	0.625	3.983	9.078	0.1957	0.1958
127	245.0	45.0	15.00	0.9056	2.124	2.849	8.186	0.1553	0.1966
128	245.0	45.0	17.40	0.9056	2.356	2.635	8.114	0.1449	0.1850
129	245.0	45.0	10.00	0.9056	1.477	3.387	8.486	0.1781	0.2176
130	245.0	45.0	14.00	0.9056	1.968	2.946	8.227	0.1598	0.1968
131	245.0	45.0	20.00	0.9056	2.831	2.430	8.064	0.1244	0.1908
132	245.0	45.0	25.00	0.9056	3.226	2.097	8.015	0.1167	0.1706
133	245.0	60.0	5.69	0.9285	0.406	3.812	9.630	0.1766	0.1266
134	245.0	60.0	10.00	0.9285	1.265	3.343	9.000	0.1657	0.1856
135	245.0	60.0	14.00	0.9285	1.866	2.981	8.686	0.1531	0.1866
136	245.0	60.0	15.00	0.9285	1.958	2.900	8.633	0.1498	0.1815
137	245.0	60.0	17.40	0.9285	2.474	2.718	8.534	0.1421	0.1951
138	245.0	60.0	20.00	0.9285	2.785	2.539	8.460	0.1339	0.1890
139	245.0	60.0	25.00	0.9285	2.784	2.242	8.379	0.1194	0.1487
140	326.0	30.0	5.69	0.8782	0.634	5.902	8.153	0.3230	0.2774
141	326.0	30.0	10.00	0.8782	1.631	4.656	7.770	0.2674	0.3151
142	326.0	30.0	7.49	0.8782	1.269	5.328	7.957	0.2987	0.3615
143	326.0	30.0	14.00	0.8782	2.395	3.823	7.603	0.2243	0.3077
144	326.0	30.0	15.00	0.8782	2.537	3.649	7.577	0.2149	0.3008
145	326.0	30.0	17.40	0.8782	3.237	3.278	7.531	0.1942	0.3237
146	326.0	30.0	25.00	0.8782	3.537	2.415	7.467	0.1443	0.2360
147	326.0	45.0	5.69	0.8433	0.766	5.827	8.156	0.3187	0.3508
148	326.0	45.0	10.00	0.8433	1.620	4.556	7.873	0.2582	0.3232
149	326.0	45.0	14.00	0.8433	2.254	3.716	7.750	0.2139	0.2972
150	326.0	45.0	15.00	0.8433	2.383	3.542	7.730	0.2044	0.2897
151	326.0	45.0	17.40	0.8433	2.679	3.172	7.696	0.1839	0.2743
152	326.0	45.0	25.00	0.8433	3.478	2.317	7.649	0.1351	0.2370
153	326.0	60.0	5.69	0.9215	0.239	3.337	8.075	0.1844	0.1155
154	326.0	60.0	10.00	0.9215	1.102	3.179	7.849	0.1807	0.2303
155	326.0	60.0	14.00	0.9215	1.421	3.042	7.737	0.1754	0.1960
156	326.0	60.0	15.00	0.9215	1.467	3.009	7.719	0.1739	0.1865
157	326.0	60.0	17.40	0.9215	1.556	2.932	7.683	0.1703	0.1666
158	326.0	60.0	20.00	0.9215	2.087	2.852	7.657	0.1662	0.1908
159	326.0	60.0	25.00	0.9215	2.480	2.708	7.628	0.1584	0.1770

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0237 M.F.

160	165.0	30.0	5.69	0.8751	0.188	0.780	12.223	0.0285	0.0308
161	165.0	30.0	10.00	0.8751	0.399	0.610	9.924	0.0274	0.0356
162	165.0	30.0	15.00	0.8751	0.563	0.474	8.760	0.0242	0.0346

163	165.0	30.0	17.40	0.8751	0.624	0.425	8.480	0.0224	0.0333
164	165.0	30.0	22.40	0.8751	0.760	0.344	8.173	0.0188	0.0317
165	165.0	45.0	5.69	0.8898	0.226	1.106	9.145	0.0539	0.0537
166	165.0	45.0	10.00	0.8898	0.571	0.767	8.411	0.0407	0.0653
167	165.0	45.0	15.00	0.8898	0.701	0.538	8.039	0.0299	0.0509
168	165.0	45.0	17.40	0.8898	0.747	0.463	7.950	0.0260	0.0462
169	165.0	45.0	22.40	0.8898	0.897	0.350	7.852	0.0199	0.0423
170	165.0	60.0	5.69	0.8755	0.429	1.686	13.145	0.0572	0.0765
171	165.0	60.0	10.00	0.8755	0.735	0.972	11.104	0.0391	0.0688
172	165.0	60.0	15.00	0.8755	0.946	0.594	9.919	0.0267	0.0602
173	165.0	60.0	17.40	0.8755	1.018	0.487	9.599	0.0226	0.0563
174	245.0	30.0	5.69	0.7817	0.160	1.106	8.771	0.0562	0.0566
175	245.0	30.0	10.00	0.7817	0.403	0.847	8.105	0.0466	0.0637
176	245.0	30.0	15.00	0.7817	0.551	0.647	7.767	0.0372	0.0540
177	245.0	30.0	17.40	0.7817	0.603	0.575	7.686	0.0334	0.0500
178	245.0	30.0	22.40	0.7817	0.748	0.459	7.597	0.0270	0.0468
179	245.0	45.0	5.69	0.7964	0.165	1.148	7.973	0.0642	0.0678
180	245.0	45.0	10.00	0.7964	0.373	0.966	7.751	0.0556	0.0654
181	245.0	45.0	15.00	0.7964	0.567	0.804	7.639	0.0469	0.0599
182	245.0	45.0	17.40	0.7964	0.647	0.740	7.612	0.0434	0.0574
183	245.0	45.0	22.40	0.7964	0.805	0.630	7.582	0.0370	0.0535
184	245.0	60.0	5.69	0.8396	0.117	0.965	8.862	0.0486	0.0460
185	245.0	60.0	10.00	0.8396	0.311	0.615	8.476	0.0324	0.0526
186	245.0	60.0	15.00	0.8396	0.397	0.403	8.251	0.0218	0.0410
187	245.0	60.0	17.40	0.8396	0.466	0.339	8.190	0.0185	0.0406
188	245.0	60.0	22.40	0.8396	0.475	0.246	8.116	0.0135	0.0311
189	326.0	30.0	5.69	0.6987	0.214	1.822	7.740	0.1051	0.1199
190	326.0	30.0	10.00	0.6987	0.457	1.330	7.429	0.0799	0.1017
191	326.0	30.0	15.00	0.6987	0.689	0.973	7.272	0.0597	0.0913
192	326.0	30.0	17.40	0.6987	0.789	0.851	7.235	0.0525	0.0876
193	326.0	30.0	22.40	0.6987	0.911	0.660	7.193	0.0410	0.0755
194	326.0	45.0	5.69	0.7496	0.200	1.783	7.564	0.1052	0.1200
195	326.0	45.0	10.00	0.7496	0.399	1.283	7.458	0.0768	0.0927
196	326.0	45.0	13.50	0.7496	0.618	1.017	7.416	0.0612	0.0960
197	326.0	45.0	15.00	0.7496	0.640	0.928	7.404	0.0559	0.0872
198	326.0	45.0	17.40	0.7496	0.737	0.808	7.391	0.0488	0.0837
199	326.0	45.0	22.40	0.7496	0.831	0.622	7.377	0.0376	0.0702
200	326.0	60.0	5.69	0.7572	0.173	1.655	7.636	0.0967	0.1072
201	326.0	60.0	8.00	0.7572	0.275	1.451	7.551	0.0858	0.0924
202	326.0	60.0	10.00	0.7572	0.358	1.304	7.498	0.0776	0.0862
203	326.0	60.0	13.00	0.7572	0.563	1.122	7.443	0.0672	0.0956
204	326.0	60.0	15.00	0.7572	0.597	1.021	7.418	0.0614	0.0848
205	326.0	60.0	17.40	0.7572	0.722	0.916	7.396	0.0553	0.0856
206	326.0	60.0	22.40	0.7572	0.793	0.745	7.370	0.0451	0.0700

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0527 M.F.

207	165.0	30.0	5.69	0.8219	0.326	1.352	12.223	0.0494	0.0534
208	165.0	30.0	10.00	0.8219	0.720	0.981	9.924	0.0441	0.0643
209	165.0	30.0	14.20	0.8219	0.881	0.749	8.883	0.0376	0.0570
210	165.0	30.0	15.00	0.8219	0.946	0.714	8.760	0.0364	0.0581
211	165.0	30.0	17.40	0.8219	1.051	0.623	8.480	0.0328	0.0561
212	165.0	30.0	22.60	0.8219	1.236	0.477	8.165	0.0261	0.0510
213	165.0	45.0	5.69	0.8490	0.269	1.177	9.145	0.0574	0.0639
214	165.0	45.0	10.00	0.8490	0.532	0.946	8.411	0.0502	0.0609
215	165.0	45.0	15.00	0.8490	0.792	0.754	8.039	0.0418	0.0576

216	165.0	45.0	17.40	0.8490	0.901	0.682	7.950	0.0382	0.0557
217	165.0	45.0	22.60	0.8490	1.084	0.557	7.850	0.0317	0.0506
218	165.0	60.0	5.69	0.8441	0.344	1.538	13.145	0.0522	0.0613
219	165.0	60.0	10.00	0.8441	0.667	1.055	11.104	0.0424	0.0624
220	165.0	60.0	15.00	0.8441	0.899	0.734	9.919	0.0330	0.0572
221	165.0	60.0	17.40	0.8441	0.980	0.630	9.599	0.0293	0.0543
222	165.0	60.0	22.60	0.8441	1.150	0.468	9.198	0.0227	0.0494
223	245.0	30.0	5.69	0.8016	0.197	1.295	8.771	0.0658	0.0698
224	245.0	30.0	10.00	0.8016	0.447	1.067	8.105	0.0587	0.0706
225	245.0	30.0	15.00	0.8016	0.670	0.871	7.767	0.0500	0.0657
226	245.0	30.0	17.40	0.8016	0.760	0.795	7.686	0.0462	0.0630
227	245.0	30.0	22.60	0.8016	0.946	0.662	7.595	0.0389	0.0587
228	245.0	45.0	5.69	0.8120	0.185	1.333	7.973	0.0746	0.0764
229	245.0	45.0	10.00	0.8120	0.448	1.081	7.751	0.0622	0.0784
230	245.0	45.0	15.00	0.8120	0.645	0.869	7.639	0.0508	0.0681
231	245.0	45.0	17.40	0.8120	0.720	0.789	7.612	0.0462	0.0639
232	245.0	45.0	22.60	0.8120	0.906	0.649	7.581	0.0382	0.0597
233	245.0	60.0	5.69	0.8279	0.143	1.171	8.862	0.0590	0.0561
234	245.0	60.0	10.00	0.8279	0.386	1.023	8.476	0.0538	0.0652
235	245.0	60.0	15.00	0.8279	0.560	0.883	8.251	0.0477	0.0578
236	245.0	60.0	17.40	0.8279	0.629	0.826	8.190	0.0450	0.0547
237	245.0	60.0	22.60	0.8279	0.824	0.720	8.114	0.0396	0.0535
238	326.0	30.0	5.69	0.7436	0.188	1.662	7.739	0.0958	0.1047
239	326.0	30.0	10.00	0.7436	0.417	1.395	7.429	0.0838	0.0929
240	326.0	30.0	15.00	0.7436	0.675	1.158	7.272	0.0711	0.0895
241	326.0	30.0	17.40	0.7436	0.815	1.066	7.235	0.0657	0.0904
242	326.0	30.0	22.80	0.7436	0.975	0.894	7.191	0.0555	0.0791
243	326.0	45.0	5.69	0.7701	0.101	1.417	7.564	0.0836	0.0605
244	326.0	45.0	10.00	0.7701	0.429	1.190	7.458	0.0712	0.0995
245	326.0	45.0	15.00	0.7701	0.555	0.989	7.404	0.0596	0.0756
246	326.0	45.0	17.40	0.7701	0.605	0.910	7.391	0.0550	0.0688
247	326.0	45.0	22.60	0.7701	0.807	0.769	7.377	0.0465	0.0675
248	326.0	60.0	5.70	0.7328	0.282	2.476	7.636	0.1447	0.1745
249	326.0	60.0	10.00	0.7328	0.578	1.524	7.498	0.0907	0.1394
250	326.0	60.0	15.00	0.7328	0.793	0.974	7.418	0.0586	0.1127
251	326.0	60.0	17.40	0.7328	0.869	0.811	7.396	0.0489	0.1031
252	326.0	60.0	22.60	0.7328	0.994	0.573	7.369	0.0347	0.0869

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YQN = 0.0730 M.F.

253	165.0	30.0	5.69	0.7851	0.382	1.602	12.223	0.0585	0.0625
254	165.0	30.0	10.00	0.7851	0.792	1.289	9.924	0.0579	0.0707
255	165.0	30.0	15.00	0.7851	1.171	1.028	8.760	0.0524	0.0719
256	165.0	30.0	17.40	0.7851	1.314	0.930	8.480	0.0489	0.0701
257	165.0	30.0	20.90	0.7851	1.590	0.811	8.238	0.0439	0.0710
258	165.0	30.0	25.00	0.7851	1.678	0.698	8.094	0.0385	0.0625
259	165.0	45.0	5.69	0.8136	0.354	1.653	9.145	0.0807	0.0842
260	165.0	45.0	10.00	0.8136	0.714	1.348	8.411	0.0715	0.0817
261	165.0	45.0	15.00	0.8136	1.120	1.089	8.039	0.0604	0.0814
262	165.0	45.0	17.40	0.8136	1.318	0.990	7.950	0.0556	0.0815
263	165.0	45.0	20.30	0.8136	1.519	0.888	7.883	0.0503	0.0795
264	165.0	45.0	25.00	0.8136	1.583	0.753	7.827	0.0429	0.0662
265	165.0	60.0	5.69	0.8204	0.356	1.696	13.145	0.0575	0.0634
266	165.0	60.0	10.00	0.8204	0.697	1.400	11.104	0.0563	0.0652
267	165.0	60.0	12.50	0.8204	0.923	1.263	10.402	0.0542	0.0697
268	165.0	60.0	15.00	0.8204	1.070	1.145	9.919	0.0515	0.0681

269	165.0	60.0	17.40	0.8204	1.208	1.046	9.599	0.0486	0.0668
270	165.0	60.0	20.90	0.8204	1.419	0.924	9.296	0.0443	0.0658
271	165.0	60.0	25.00	0.8204	1.597	0.806	9.095	0.0395	0.0621
272	245.0	30.0	5.69	0.7768	0.241	1.594	8.771	0.0811	0.0854
273	245.0	30.0	10.00	0.7768	0.502	1.316	8.105	0.0725	0.0793
274	245.0	30.0	13.50	0.7768	0.796	1.141	7.839	0.0649	0.0880
275	245.0	30.0	15.00	0.7768	0.826	1.076	7.767	0.0618	0.0809
276	245.0	30.0	17.40	0.7768	0.925	0.983	7.686	0.0571	0.0767
277	245.0	30.0	20.90	0.7768	1.148	0.868	7.616	0.0509	0.0777
278	245.0	30.0	25.00	0.7768	1.217	0.758	7.574	0.0446	0.0676
279	245.0	45.0	5.69	0.8104	0.182	1.313	7.973	0.0735	0.0748
280	245.0	45.0	10.00	0.8104	0.431	1.194	7.751	0.0687	0.0754
281	245.0	45.0	15.00	0.8104	0.681	1.076	7.639	0.0628	0.0719
282	245.0	45.0	17.40	0.8104	0.778	1.025	7.612	0.0601	0.0690
283	245.0	45.0	20.90	0.8104	0.975	0.957	7.588	0.0563	0.0701
284	245.0	45.0	25.00	0.8104	1.107	0.886	7.575	0.0522	0.0651
285	245.0	60.0	5.69	0.8327	0.158	1.274	8.862	0.0641	0.0618
286	245.0	60.0	10.00	0.8327	0.415	1.131	8.476	0.0595	0.0702
287	245.0	60.0	15.00	0.8327	0.616	0.993	8.251	0.0537	0.0636
288	245.0	60.0	17.40	0.8327	0.694	0.935	8.190	0.0509	0.0604
289	245.0	60.0	20.90	0.8327	0.856	0.860	8.133	0.0472	0.0606
290	326.0	30.0	5.69	0.7474	0.220	2.083	7.739	0.1201	0.1226
291	326.0	30.0	10.00	0.7474	0.558	1.558	7.429	0.0935	0.1243
292	326.0	30.0	13.00	0.7474	0.722	1.301	7.319	0.0793	0.1141
293	326.0	30.0	15.00	0.7474	0.798	1.163	7.272	0.0714	0.1058
294	326.0	30.0	17.40	0.7474	0.867	1.025	7.235	0.0632	0.0962
295	326.0	30.0	20.90	0.7474	1.038	0.864	7.202	0.0535	0.0931
296	326.0	45.0	5.69	0.7737	0.140	1.558	7.564	0.0919	0.0839
297	326.0	45.0	10.00	0.7737	0.429	1.369	7.458	0.0819	0.0995
298	326.0	45.0	15.00	0.7737	0.628	1.190	7.404	0.0717	0.0856
299	326.0	45.0	17.40	0.7737	0.703	1.116	7.391	0.0673	0.0800
300	326.0	45.0	20.90	0.7737	0.879	1.020	7.380	0.0616	0.0805
301	326.0	60.0	4.99	0.7230	0.214	3.362	7.668	0.1956	0.1782
302	326.0	60.0	5.70	0.7230	0.401	3.057	7.636	0.1786	0.2475
303	326.0	60.0	10.00	0.7230	0.706	1.850	7.498	0.1101	0.1702
304	326.0	60.0	13.50	0.7230	0.906	1.328	7.436	0.0797	0.1467
305	326.0	60.0	15.00	0.7230	0.973	1.169	7.418	0.0703	0.1382
306	326.0	60.0	17.40	0.7230	1.105	0.969	7.396	0.0585	0.1311
307	326.0	60.0	20.90	0.7230	1.142	0.758	7.376	0.0459	0.1093

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN

OIL MIXTURE (RATIO 2 : 1)

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0525 M.F.

308	165.0	30.0	5.69	0.8080	0.600	2.146	12.831	0.0746	0.0894
309	165.0	30.0	10.00	0.8080	1.104	1.494	10.352	0.0644	0.0917
310	165.0	30.0	15.00	0.8080	1.524	1.051	9.098	0.0515	0.0879
311	165.0	30.0	17.30	0.8080	1.677	0.911	8.807	0.0461	0.0848
312	165.0	30.0	22.30	0.8080	1.933	0.689	8.470	0.0363	0.0764
313	165.0	45.0	5.69	0.9232	0.255	1.036	9.997	0.0462	0.0530
314	165.0	45.0	10.00	0.9232	0.467	0.813	8.953	0.0405	0.0487
315	165.0	45.0	14.00	0.9232	0.685	0.665	8.496	0.0349	0.0499
316	165.0	45.0	15.00	0.9232	0.709	0.634	8.425	0.0336	0.0480
317	165.0	45.0	17.30	0.9232	0.800	0.571	8.302	0.0307	0.0466
318	165.0	45.0	22.30	0.9232	0.943	0.463	8.160	0.0253	0.0420
319	165.0	60.0	5.69	0.8590	1.022	2.309	14.078	0.0732	0.1627
320	165.0	60.0	10.00	0.8590	1.294	0.815	11.644	0.0312	0.1207

321	165.0	60.0	15.00	0.8590	1.530	0.377	10.231	0.0164	0.0921
322	165.0	60.0	17.30	0.8590	1.566	0.286	9.862	0.0130	0.0829
323	165.0	60.0	22.30	0.8590	1.638	0.175	9.389	0.0083	0.0685
324	245.0	30.0	5.69	0.8457	0.285	1.800	9.060	0.0887	0.0917
325	245.0	30.0	10.00	0.8457	0.701	1.204	8.341	0.0644	0.1038
326	245.0	30.0	15.00	0.8457	0.877	0.821	7.977	0.0459	0.0813
327	245.0	30.0	17.30	0.8457	0.931	0.703	7.893	0.0398	0.0737
328	245.0	30.0	22.30	0.8457	1.114	0.521	7.795	0.0298	0.0667
329	245.0	45.0	5.69	0.8608	0.122	1.452	8.336	0.0777	0.0452
330	245.0	45.0	10.00	0.8608	0.590	1.068	8.020	0.0594	0.0961
331	245.0	45.0	15.00	0.8608	0.693	0.787	7.860	0.0447	0.0691
332	245.0	45.0	17.30	0.8608	0.831	0.693	7.823	0.0395	0.0703
333	245.0	45.0	22.30	0.8608	0.854	0.540	7.780	0.0310	0.0543
334	245.0	60.0	5.69	0.8838	0.303	1.771	9.125	0.0866	0.1082
335	245.0	60.0	10.00	0.8838	0.554	1.113	8.665	0.0573	0.0883
336	245.0	60.0	15.00	0.8838	0.755	0.723	8.397	0.0384	0.0744
337	245.0	60.0	17.30	0.8838	0.830	0.609	8.327	0.0326	0.0696
338	245.0	60.0	22.30	0.8838	0.929	0.439	8.237	0.0238	0.0589
339	326.0	30.0	5.69	0.6505	0.681	4.102	7.894	0.2318	0.3432
340	326.0	30.0	10.00	0.6505	1.184	1.784	7.562	0.1053	0.2487
341	326.0	30.0	15.00	0.6505	1.408	0.916	7.394	0.0553	0.1781
342	326.0	30.0	17.30	0.6505	1.466	0.717	7.355	0.0435	0.1567
343	326.0	30.0	22.30	0.6505	1.599	0.459	7.310	0.0280	0.1278
344	326.0	45.0	5.69	0.7770	0.284	2.607	7.753	0.1500	0.1522
345	326.0	45.0	10.00	0.7770	0.679	1.771	7.604	0.1039	0.1483
346	326.0	45.0	15.00	0.7770	0.948	1.221	7.528	0.0723	0.1232
347	326.0	45.0	17.30	0.7770	1.123	1.050	7.510	0.0624	0.1230
348	326.0	45.0	22.30	0.7770	1.168	0.784	7.490	0.0467	0.0954
349	326.0	60.0	5.69	0.8398	0.029	1.843	7.799	0.1054	0.0164
350	326.0	60.0	9.98	0.8398	0.633	1.471	7.635	0.0860	0.1439
351	326.0	60.0	15.00	0.8398	0.696	1.164	7.539	0.0689	0.0941
352	326.0	60.0	17.27	0.8398	0.864	1.055	7.514	0.0627	0.0988
353	326.0	60.0	22.27	0.8398	0.888	0.865	7.482	0.0515	0.0758
354	326.0	60.0	24.00	0.8398	0.998	0.810	7.476	0.0484	0.0783

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN
OIL MIXTURE (RATIO 1 : 1)

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0525 M.F.

355	165.0	30.0	5.69	0.9000	0.438	1.523	13.139	0.0517	0.0626
356	165.0	30.0	10.00	0.9000	0.768	1.026	10.556	0.0433	0.0618
357	165.0	30.0	14.00	0.9000	1.055	0.754	9.426	0.0357	0.0631
358	165.0	30.0	15.00	0.9000	1.085	0.703	9.249	0.0339	0.0609
359	165.0	30.0	17.30	0.9000	1.228	0.603	8.946	0.0301	0.0605
360	165.0	30.0	22.30	0.9000	1.330	0.449	8.594	0.0233	0.0513
361	165.0	45.0	5.69	0.9140	0.396	1.614	10.527	0.0684	0.0766
362	165.0	45.0	10.00	0.9140	0.744	1.303	9.260	0.0628	0.0741
363	165.0	45.0	14.00	0.9140	1.101	1.089	8.706	0.0558	0.0774
364	165.0	45.0	15.00	0.9140	1.132	1.043	8.619	0.0540	0.0741
365	165.0	45.0	17.30	0.9140	1.265	0.949	8.470	0.0500	0.0715
366	165.0	45.0	22.30	0.9140	1.532	0.784	8.298	0.0421	0.0665
367	165.0	60.0	5.69	0.8777	0.546	2.280	14.647	0.0695	0.0819
368	165.0	60.0	10.00	0.8777	1.064	1.518	11.966	0.0566	0.0885
369	165.0	60.0	15.00	0.8777	1.380	1.031	10.409	0.0442	0.0808
370	165.0	60.0	17.30	0.8777	1.480	0.882	10.002	0.0393	0.0765
371	165.0	60.0	22.30	0.8777	1.729	0.652	9.481	0.0307	0.0709
372	245.0	30.0	5.69	0.8337	0.420	2.456	9.198	0.1191	0.1293
373	245.0	30.0	10.00	0.8337	0.928	1.725	8.449	0.0911	0.1350

374	245.0	30.0	15.00	0.8337	1.237	1.222	8.070	0.0676	0.1121
375	245.0	30.0	17.30	0.8337	1.332	1.062	7.982	0.0593	0.1031
376	245.0	30.0	22.30	0.8337	1.599	0.806	7.880	0.0457	0.0938
377	245.0	45.0	5.69	0.7844	0.587	3.210	8.543	0.1676	0.2057
378	245.0	45.0	10.00	0.7844	1.132	1.962	8.160	0.1073	0.1786
379	245.0	45.0	15.00	0.7844	1.460	1.249	7.966	0.0699	0.1420
380	245.0	45.0	17.30	0.7844	1.560	1.045	7.921	0.0589	0.1289
381	245.0	45.0	22.30	0.7844	1.791	0.745	7.869	0.0422	0.1114
382	245.0	60.0	5.69	0.9177	0.027	0.861	9.273	0.0414	0.0091
383	245.0	60.0	10.00	0.9177	0.390	0.891	8.766	0.0454	0.0605
384	245.0	60.0	15.00	0.9177	0.482	0.928	8.471	0.0489	0.0465
385	245.0	60.0	17.30	0.9177	0.579	0.946	8.394	0.0503	0.0477
386	245.0	60.0	22.30	0.9177	0.869	0.987	8.295	0.0531	0.0541
387	245.0	60.0	25.00	0.9177	0.802	1.010	8.266	0.0545	0.0442
388	326.0	30.0	5.69	0.7823	0.387	2.890	7.973	0.1617	0.1857
389	326.0	30.0	10.00	0.7823	0.765	2.184	7.627	0.1277	0.1563
390	326.0	30.0	14.00	0.7823	1.131	1.736	7.476	0.1036	0.1520
391	326.0	30.0	15.00	0.7823	1.176	1.646	7.452	0.0985	0.1456
392	326.0	30.0	17.30	0.7823	1.331	1.463	7.412	0.0881	0.1396
393	326.0	30.0	22.30	0.7823	1.562	1.157	7.365	0.0701	0.1227
394	326.0	45.0	5.69	0.7415	0.621	4.159	7.864	0.2359	0.3163
395	326.0	45.0	10.00	0.7415	1.101	2.177	7.683	0.1264	0.2335
396	326.0	45.0	15.00	0.7415	1.427	1.247	7.591	0.0733	0.1815
397	326.0	45.0	17.30	0.7415	1.562	1.009	7.569	0.0595	0.1678
398	326.0	45.0	22.30	0.7415	1.661	0.680	7.545	0.0402	0.1332
399	326.0	60.0	5.69	0.7183	0.626	4.527	7.873	0.2566	0.3323
400	326.0	60.0	10.00	0.7183	1.169	2.506	7.694	0.1453	0.2586
401	326.0	60.0	15.00	0.7183	1.505	1.489	7.589	0.0875	0.1998
402	326.0	60.0	17.30	0.7183	1.606	1.218	7.562	0.0719	0.1803
403	326.0	60.0	22.30	0.7183	1.802	0.836	7.527	0.0495	0.1513

SYSTEM: N-HEXANE-NITROGEN-HEAVY AND LIGHT PARAFFIN
OIL MIXTURE (RATIO 1:2)

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YCN = 0.0525 M.F.

404	165.0	30.0	5.69	0.9400	0.155	0.951	13.335	0.0318	0.0215
405	165.0	30.0	10.00	0.9400	0.430	0.978	10.680	0.0409	0.0339
406	165.0	30.0	13.50	0.9400	0.899	1.002	9.622	0.0464	0.0546
407	165.0	30.0	15.00	0.9400	0.838	1.012	9.337	0.0483	0.0463
408	165.0	30.0	17.30	0.9400	1.048	1.027	9.025	0.0508	0.0509
409	165.0	30.0	22.30	0.9400	1.457	1.063	8.664	0.0547	0.0555
410	165.0	30.0	25.00	0.9400	1.358	1.083	8.569	0.0564	0.0461
411	165.0	45.0	5.69	0.9567	0.208	1.162	10.915	0.0475	0.0382
412	165.0	45.0	10.00	0.9567	0.563	1.088	9.473	0.0512	0.0544
413	165.0	45.0	15.00	0.9567	0.887	1.011	8.744	0.0516	0.0569
414	165.0	45.0	17.30	0.9567	1.008	0.978	8.574	0.0509	0.0559
415	165.0	45.0	18.00	0.9567	1.225	0.968	8.535	0.0506	0.0653
416	165.0	45.0	22.30	0.9567	1.353	0.912	8.378	0.0486	0.0578
417	165.0	45.0	25.00	0.9567	1.357	0.879	8.327	0.0471	0.0515
418	165.0	60.0	5.69	0.9549	0.254	1.297	15.051	0.0384	0.0367
419	165.0	60.0	10.00	0.9549	0.610	1.193	12.190	0.0436	0.0494
420	165.0	60.0	15.00	0.9549	0.907	1.087	10.529	0.0460	0.0522
421	165.0	60.0	17.30	0.9549	1.003	1.042	10.095	0.0461	0.0511
422	165.0	60.0	20.00	0.9549	1.270	0.994	9.744	0.0455	0.0569
423	165.0	60.0	22.30	0.9549	1.330	0.955	9.539	0.0447	0.0539
424	165.0	60.0	25.00	0.9549	1.450	0.913	9.374	0.0435	0.0528
425	245.0	30.0	5.69	0.8800	0.407	2.534	9.281	0.1218	0.1219
426	245.0	30.0	10.00	0.8800	1.010	1.443	8.512	0.0757	0.1428

427	245.0	30.0	13.00	0.8800	1.201	1.053	8.238	0.0570	0.1258
428	245.0	30.0	15.00	0.8800	1.217	0.874	8.122	0.0480	0.1087
429	245.0	30.0	17.30	0.8800	1.268	0.720	8.032	0.0400	0.0969
430	245.0	30.0	18.00	0.8800	1.373	0.681	8.011	0.0379	0.1005
431	245.0	30.0	22.30	0.8800	1.413	0.499	7.927	0.0281	0.0819
432	245.0	45.0	5.69	0.9297	0.081	0.958	8.686	0.0492	0.0274
433	245.0	45.0	10.00	0.9297	0.357	0.868	8.250	0.0469	0.0551
434	245.0	45.0	13.00	0.9297	0.498	0.813	8.095	0.0448	0.0562
435	245.0	45.0	15.00	0.9297	0.522	0.778	8.029	0.0433	0.0499
436	245.0	45.0	17.30	0.9297	0.664	0.742	7.978	0.0415	0.0541
437	245.0	45.0	22.30	0.9297	0.680	0.671	7.918	0.0378	0.0418
438	245.0	45.0	22.50	0.9297	0.789	0.668	7.917	0.0376	0.0480
439	245.0	60.0	4.99	0.9273	0.080	1.482	9.497	0.0696	0.0331
440	245.0	60.0	5.69	0.9273	0.295	1.443	9.371	0.0687	0.0980
441	245.0	60.0	10.00	0.9273	0.517	1.233	8.830	0.0623	0.0788
442	245.0	60.0	15.00	0.9273	0.719	1.041	8.515	0.0546	0.0685
443	245.0	60.0	17.30	0.9273	0.788	0.968	8.433	0.0512	0.0641
444	245.0	60.0	22.30	0.9273	1.023	0.833	8.328	0.0446	0.0631
445	326.0	30.0	5.69	0.8086	0.434	3.210	8.020	0.1786	0.2024
446	326.0	30.0	10.00	0.8086	0.900	2.367	7.665	0.1378	0.1808
447	326.0	30.0	15.00	0.8086	1.305	1.747	7.485	0.1042	0.1595
448	326.0	30.0	17.30	0.8086	1.457	1.541	7.443	0.0924	0.1509
449	326.0	30.0	22.30	0.8086	1.723	1.202	7.394	0.0725	0.1339
450	326.0	45.0	5.69	0.7151	0.839	5.305	7.939	0.2981	0.4135
451	326.0	45.0	10.00	0.7151	1.507	2.601	7.732	0.1501	0.3139
452	326.0	45.0	15.00	0.7151	1.834	1.431	7.628	0.0837	0.2301
453	326.0	45.0	17.30	0.7151	1.923	1.143	7.603	0.0671	0.2040
454	326.0	45.0	22.30	0.7151	2.129	0.755	7.575	0.0445	0.1689
455	326.0	60.0	5.69	0.7189	0.839	5.762	7.925	0.3244	0.4324
456	326.0	60.0	10.00	0.7189	1.538	3.031	7.734	0.1749	0.3344
457	326.0	60.0	15.00	0.7189	1.925	1.742	7.623	0.1020	0.2524
458	326.0	60.0	17.30	0.7189	2.036	1.411	7.594	0.0829	0.2258
459	326.0	60.0	22.30	0.7189	2.273	0.952	7.556	0.0562	0.1888

SYSTEM: N-HEXANE-HELIUM-LIGHT PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0525 M.F.

460	165.0	30.0	6.99	0.9329	1.361	3.537	12.678	0.1245	0.1613
461	165.0	30.0	10.00	0.9329	1.932	2.725	10.945	0.1111	0.1652
462	165.0	30.0	13.00	0.9329	2.351	2.164	9.937	0.0971	0.1609
463	165.0	30.0	15.00	0.9329	2.600	1.881	9.512	0.0882	0.1572
464	165.0	30.0	17.35	0.9329	2.846	1.614	9.173	0.0785	0.1511
465	165.0	45.0	7.00	0.9672	0.489	1.823	11.221	0.0725	0.0711
466	165.0	45.0	10.00	0.9672	0.882	1.711	10.027	0.0761	0.0895
467	165.0	45.0	13.05	0.9672	1.082	1.606	9.322	0.0769	0.0854
468	165.0	45.0	15.00	0.9672	1.265	1.545	9.037	0.0763	0.0875
469	165.0	45.0	17.35	0.9672	1.430	1.475	8.803	0.0748	0.0860
470	165.0	45.0	18.55	0.9672	1.576	1.441	8.717	0.0738	0.0887
471	165.0	60.0	7.00	0.9640	0.458	1.814	14.840	0.0545	0.0544
472	165.0	60.0	10.00	0.9640	0.814	1.689	12.757	0.0591	0.0702
473	165.0	60.0	13.05	0.9640	0.980	1.575	11.411	0.0616	0.0683
474	165.0	60.0	15.00	0.9640	1.162	1.508	10.822	0.0622	0.0725
475	165.0	60.0	17.35	0.9640	1.338	1.433	10.308	0.0620	0.0743
476	245.0	30.0	4.99	0.9297	0.958	6.541	9.663	0.3020	0.3757
477	245.0	30.0	7.00	0.9297	1.310	5.244	9.139	0.2560	0.3108
478	245.0	30.0	10.00	0.9297	2.084	3.920	8.637	0.2025	0.3190

479	245.0	30.0	13.00	0.9297	2.519	3.041	8.344	0.1626	0.2871
480	245.0	30.0	15.00	0.9297	2.727	2.610	8.221	0.1416	0.2658
481	245.0	30.0	17.50	0.9297	2.963	2.189	8.118	0.1203	0.2443
482	245.0	45.0	4.99	0.9625	0.279	2.525	9.203	0.1224	0.1216
483	245.0	45.0	7.00	0.9625	0.437	2.882	8.826	0.1457	0.1139
484	245.0	45.0	10.00	0.9625	0.913	3.577	8.464	0.1885	0.1511
485	245.0	45.0	15.50	0.9625	1.905	5.714	8.146	0.3130	0.1910
486	245.0	45.0	17.40	0.9625	2.406	6.919	8.092	0.3814	0.2123
487	245.0	60.0	7.00	0.9673	0.180	1.457	9.372	0.0693	0.0467
488	245.0	60.0	10.00	0.9673	0.440	1.882	8.977	0.0935	0.0725
489	245.0	60.0	15.00	0.9673	0.898	3.153	8.610	0.1634	0.0935
490	245.0	60.0	17.40	0.9673	1.462	4.277	8.511	0.2242	0.1296
491	245.0	60.0	20.80	0.9673	1.679	7.275	8.420	0.3855	0.1228
492	245.0	60.0	20.80	0.9673	2.070	7.275	8.420	0.3855	0.1513
493	326.0	45.0	4.99	0.9548	0.311	4.818	8.204	0.2620	0.2027
494	326.0	45.0	7.00	0.9548	0.760	4.884	8.024	0.2715	0.2779
495	326.0	45.0	10.00	0.9548	1.087	4.984	7.851	0.2832	0.2426
496	326.0	45.0	11.00	0.9548	1.693	5.018	7.811	0.2866	0.3346
497	326.0	45.0	13.50	0.9548	1.870	5.105	7.738	0.2943	0.2879
498	326.0	45.0	15.00	0.9548	2.105	5.158	7.708	0.2985	0.2862
499	326.0	45.0	17.40	0.9548	2.580	5.245	7.674	0.3049	0.2955
500	326.0	45.0	17.50	0.9548	2.400	5.248	7.673	0.3052	0.2731
501	326.0	60.0	4.99	0.9584	0.336	4.107	8.104	0.2261	0.2316
502	326.0	60.0	7.00	0.9584	0.589	3.729	7.967	0.2088	0.2268
503	326.0	60.0	10.00	0.9584	0.788	3.254	7.826	0.1855	0.1843
504	326.0	60.0	14.00	0.9584	1.448	2.750	7.715	0.1590	0.2235
505	326.0	60.0	15.00	0.9584	1.428	2.642	7.696	0.1532	0.2032
506	326.0	60.0	17.40	0.9584	1.802	2.408	7.660	0.1402	0.2159
507	326.0	60.0	25.50	0.9584	2.079	1.812	7.603	0.1063	0.1625

SYSTEM: N-HEXANE-HELIUM-HEAVY PARAFFIN OIL
 ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YCN = 0.0525 M.F.

508	165.0	30.0	6.99	0.8614	0.470	1.536	11.321	0.0605	0.0681
509	165.0	30.0	10.00	0.8614	0.790	1.236	9.912	0.0556	0.0800
510	165.0	30.0	13.00	0.8614	0.963	1.016	9.093	0.0498	0.0766
511	165.0	30.0	15.00	0.8614	1.051	0.900	8.747	0.0459	0.0733
512	165.0	30.0	17.40	0.8614	1.133	0.786	8.467	0.0414	0.0687
513	165.0	30.0	20.80	0.8614	1.317	0.658	8.230	0.0357	0.0670
514	165.0	45.0	6.99	0.8932	0.312	1.177	8.850	0.0593	0.0628
515	165.0	45.0	10.00	0.8932	0.520	1.006	8.398	0.0534	0.0675
516	165.0	45.0	13.00	0.8932	0.703	0.870	8.135	0.0477	0.0679
517	165.0	45.0	15.00	0.8932	0.747	0.794	8.024	0.0441	0.0617
518	165.0	45.0	17.40	0.8932	0.811	0.715	7.935	0.0402	0.0570
519	165.0	45.0	20.80	0.8932	0.967	0.622	7.859	0.0353	0.0560
520	165.0	60.0	7.00	0.8985	0.443	1.372	12.375	0.0495	0.0689
521	165.0	60.0	10.00	0.8985	0.614	0.987	11.093	0.0397	0.0652
522	165.0	60.0	13.00	0.8985	0.739	0.744	10.277	0.0323	0.0611
523	245.0	30.0	7.00	0.8434	0.317	1.644	8.499	0.0863	0.0909
524	245.0	30.0	10.00	0.8434	0.560	1.375	8.091	0.0758	0.0996
525	245.0	30.0	13.00	0.8434	0.735	1.168	7.853	0.0664	0.0957
526	245.0	30.0	15.00	0.8434	0.793	1.055	7.753	0.0607	0.0876
527	245.0	30.0	17.40	0.8434	0.863	0.939	7.671	0.0546	0.0806
528	245.0	30.0	25.50	0.8434	1.167	0.663	7.556	0.0392	0.0714
529	245.0	45.0	4.99	0.8665	0.145	1.706	8.013	0.0950	0.0868
530	245.0	45.0	7.00	0.8665	0.351	1.413	7.871	0.0801	0.1152
531	245.0	45.0	10.00	0.8665	0.425	1.098	7.734	0.0633	0.0837

532	245.0	45.0	13.00	0.8665	0.589	0.878	7.655	0.0512	0.0834
533	245.0	45.0	15.00	0.8665	0.635	0.766	7.621	0.0448	0.0756
534	245.0	45.0	17.40	0.8665	0.696	0.658	7.594	0.0386	0.0696
535	245.0	45.0	25.50	0.8665	0.873	0.423	7.555	0.0250	0.0566
536	245.0	60.0	4.99	0.8667	0.233	2.271	8.937	0.1134	0.1321
537	245.0	60.0	7.00	0.8667	0.406	1.724	8.702	0.0884	0.1274
538	245.0	60.0	10.00	0.8667	0.518	1.211	8.459	0.0639	0.0986
539	245.0	60.0	13.00	0.8667	0.698	0.898	8.305	0.0482	0.0962
540	245.0	60.0	15.00	0.8667	0.734	0.752	8.234	0.0407	0.0855
541	245.0	60.0	17.40	0.8667	0.803	0.619	8.173	0.0338	0.0788
542	245.0	60.0	25.50	0.8667	0.935	0.360	8.074	0.0199	0.0600
543	326.0	30.0	7.00	0.8263	0.333	1.998	7.603	0.1172	0.1419
544	326.0	30.0	10.00	0.8263	0.474	1.643	7.413	0.0989	0.1182
545	326.0	30.0	15.00	0.8263	0.751	1.231	7.256	0.0757	0.1117
546	326.0	30.0	17.40	0.8263	0.873	1.086	7.218	0.0671	0.1087
547	326.0	30.0	25.50	0.8263	1.091	0.749	7.165	0.0466	0.0875
548	326.0	45.0	7.00	0.8124	0.486	2.599	7.504	0.1545	0.2198
549	326.0	45.0	10.00	0.8124	0.678	1.756	7.439	0.1053	0.1765
550	326.0	45.0	15.00	0.8124	0.914	1.044	7.385	0.0631	0.1397
551	326.0	45.0	17.40	0.8124	0.997	0.848	7.372	0.0513	0.1273
552	326.0	45.0	25.50	0.8124	1.155	0.476	7.353	0.0289	0.0945
553	326.0	60.0	7.00	0.8223	0.485	2.632	7.568	0.1552	0.2277
554	326.0	60.0	10.00	0.8223	0.677	1.722	7.481	0.1027	0.1831
555	326.0	60.0	15.00	0.8223	0.890	0.991	7.401	0.0597	0.1418
556	326.0	60.0	17.40	0.8223	0.962	0.796	7.379	0.0481	0.1281
557	326.0	60.0	25.50	0.8223	1.106	0.436	7.344	0.0265	0.0947

SYSTEM: N-HEXANE-FREON-14-LIGHT PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0525 M.F.

558	245.0	30.0	4.99	0.8138	0.230	1.958	9.663	0.0904	0.0753
559	245.0	30.0	7.00	0.8138	0.543	1.851	9.139	0.0903	0.1073
560	245.0	30.0	10.00	0.8138	0.761	1.706	8.637	0.0881	0.0970
561	245.0	30.0	13.00	0.8138	0.955	1.578	8.344	0.0844	0.0906
562	245.0	30.0	15.00	0.8138	1.327	1.500	8.221	0.0814	0.1076
563	245.0	30.0	17.40	0.8138	1.358	1.414	8.121	0.0777	0.0938
564	245.0	30.0	20.70	0.8138	1.597	1.308	8.038	0.0726	0.0914
565	245.0	30.0	25.50	0.8138	1.913	1.173	7.979	0.0656	0.0875

SYSTEM: N-HEXANE-FREON-14-HEAVY PARAFFIN OIL

ABSORBER DIAMETER = 0.793 CM

APPROXIMATE YON = 0.0525 M.F.

566	245.0	30.0	4.99	0.7963	0.106	0.951	8.919	0.0476	0.0444
567	245.0	30.0	7.00	0.7963	0.212	0.851	8.494	0.0447	0.0503
568	245.0	30.0	13.00	0.7963	0.416	0.631	7.848	0.0359	0.0448
569	245.0	30.0	15.00	0.7963	0.564	0.576	7.748	0.0332	0.0515
570	245.0	30.0	17.40	0.7963	0.551	0.519	7.667	0.0302	0.0425
571	245.0	30.0	25.50	0.7963	0.741	0.379	7.552	0.0224	0.0375

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

ABSORBER DIAMETER = 0.594 CM

APPROXIMATE YON = 0.0525 M.F.

572	165.0	30.0	5.00	0.9142	0.440	3.479	16.389	0.0947	0.0935
573	165.0	30.0	7.75	0.9142	0.930	3.211	14.067	0.1018	0.1173
574	165.0	30.0	11.00	0.9142	1.294	2.932	12.463	0.1050	0.1165
575	165.0	30.0	14.00	0.9142	1.708	2.706	11.622	0.1039	0.1233
576	165.0	30.0	15.00	0.9142	1.824	2.636	11.428	0.1029	0.1235
577	165.0	30.0	20.90	0.9142	2.474	2.275	10.786	0.0941	0.1216

578	165.0	45.0	5.00	0.8682	0.783	6.589	14.105	0.2084	0.2098
579	165.0	45.0	7.75	0.8682	1.680	5.587	12.501	0.1994	0.2585
580	165.0	45.0	11.00	0.8682	2.106	4.672	11.394	0.1829	0.2250
581	165.0	45.0	14.00	0.8682	2.820	4.013	10.813	0.1656	0.2371
582	165.0	45.0	15.00	0.8682	2.932	3.825	10.679	0.1598	0.2303
583	165.0	45.0	17.50	0.8682	3.359	3.407	10.433	0.1457	0.2260
584	165.0	45.0	20.80	0.8682	3.696	2.953	10.240	0.1287	0.2086
585	165.0	60.0	5.00	0.8147	1.091	8.528	18.546	0.2052	0.2396
586	165.0	60.0	7.75	0.8147	1.856	6.662	15.920	0.1867	0.2418
587	165.0	60.0	11.00	0.8147	2.619	5.151	13.937	0.1649	0.2466
588	165.0	60.0	14.00	0.8147	3.145	4.171	12.794	0.1454	0.2410
589	165.0	60.0	15.00	0.8147	3.297	3.905	12.514	0.1392	0.2382
590	165.0	60.0	20.90	0.8147	4.038	2.755	11.497	0.1069	0.2177
591	245.0	30.0	5.00	0.9086	0.305	4.057	11.576	0.1564	0.1447
592	245.0	30.0	7.75	0.9086	0.759	3.654	10.903	0.1495	0.1825
593	245.0	30.0	11.00	0.9086	1.031	3.250	10.438	0.1389	0.1602
594	245.0	30.0	14.00	0.9086	1.348	2.935	10.193	0.1284	0.1585
595	245.0	30.0	15.00	0.9086	1.444	2.840	10.137	0.1250	0.1571
596	245.0	30.0	17.75	0.9086	1.667	2.601	10.026	0.1157	0.1503
597	245.0	30.0	20.90	0.9086	1.950	2.362	9.951	0.1059	0.1469
598	245.0	45.0	7.75	0.9521	0.268	2.366	10.358	0.1019	0.0718
599	245.0	45.0	11.00	0.9521	0.586	2.400	10.022	0.1068	0.1003
600	245.0	45.0	14.00	0.9521	1.070	2.431	9.846	0.1102	0.1378
601	245.0	45.0	15.00	0.9521	0.909	2.442	9.806	0.1111	0.1081
602	245.0	45.0	20.90	0.9521	1.277	2.507	9.671	0.1156	0.1047
603	245.0	45.0	25.00	0.9521	1.650	2.553	9.634	0.1182	0.1111
604	245.0	60.0	7.75	0.9210	0.965	4.484	10.947	0.1827	0.2578
605	245.0	60.0	11.00	0.9210	1.322	3.222	10.571	0.1360	0.2261
606	245.0	60.0	14.00	0.9210	1.568	2.476	10.355	0.1067	0.2026
607	245.0	60.0	15.00	0.9210	1.637	2.285	10.301	0.0989	0.1955
608	245.0	60.0	20.90	0.9210	1.953	1.503	10.109	0.0663	0.1616
609	326.0	30.0	5.05	0.8292	0.335	6.758	10.119	0.2979	0.2507
610	326.0	30.0	7.75	0.8292	0.963	6.181	9.815	0.2809	0.3388
611	326.0	30.0	10.00	0.8292	1.261	5.755	9.654	0.2660	0.3104
612	326.0	30.0	14.00	0.8292	1.723	5.099	9.488	0.2398	0.2775
613	326.0	30.0	15.00	0.8292	1.913	4.953	9.462	0.2335	0.2836
614	326.0	30.0	17.00	0.8292	2.141	4.678	9.422	0.2215	0.2739
615	326.0	30.0	20.90	0.8292	2.635	4.205	9.376	0.2001	0.2659
616	326.0	45.0	5.05	0.8507	0.416	7.110	9.832	0.3226	0.3349
617	326.0	45.0	7.75	0.8507	0.838	6.114	9.608	0.2839	0.3150
618	326.0	45.0	10.00	0.8507	1.225	5.436	9.488	0.2556	0.3207
619	326.0	45.0	14.00	0.8507	1.742	4.481	9.365	0.2135	0.2972
620	326.0	45.0	15.00	0.8507	1.796	4.281	9.346	0.2044	0.2819
621	326.0	45.0	20.90	0.8507	2.286	3.336	9.282	0.1603	0.2436
622	326.0	45.0	25.00	0.8507	2.693	2.852	9.265	0.1373	0.2343
623	326.0	60.0	5.00	0.8928	0.364	5.927	9.783	0.2703	0.3146
624	326.0	60.0	7.75	0.8928	0.625	5.289	9.607	0.2456	0.2449
625	326.0	60.0	10.00	0.8928	0.954	4.841	9.508	0.2271	0.2600
626	326.0	60.0	14.00	0.8928	1.469	4.173	9.398	0.1981	0.2605
627	326.0	60.0	15.00	0.8928	1.495	4.028	9.379	0.1916	0.2439
628	326.0	60.0	20.90	0.8928	1.986	3.308	9.311	0.1585	0.2201

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

ABSORBER DIAMETER = 0.594 CM

APPROXIMATE YON = 0.0525 M.F.

629	165.0	30.0	5.00	0.8552	0.165	1.469	14.182	0.0462	0.0463
630	165.0	30.0	7.75	0.8552	0.385	1.088	12.297	0.0395	0.0602

631	165.0	30.0	11.00	0.8552	0.473	0.803	10.995	0.0326	0.0513
632	165.0	30.0	14.00	0.8552	0.569	0.628	10.312	0.0272	0.0488
633	165.0	30.0	15.00	0.8552	0.597	0.582	10.154	0.0256	0.0479
634	165.0	30.0	20.80	0.8552	0.710	0.395	9.638	0.0183	0.0410
635	165.0	30.0	25.00	0.8552	0.788	0.310	9.489	0.0146	0.0376
636	165.0	45.0	7.75	0.9014	0.170	0.685	10.343	0.0296	0.0344
637	165.0	45.0	11.00	0.9014	0.252	0.583	9.927	0.0262	0.0329
638	165.0	45.0	14.00	0.9014	0.319	0.507	9.709	0.0233	0.0315
639	165.0	60.0	7.75	0.9175	0.171	0.751	13.456	0.0249	0.0286
640	165.0	60.0	11.00	0.9175	0.256	0.645	12.241	0.0235	0.0292
641	165.0	60.0	14.00	0.9175	0.322	0.566	11.541	0.0219	0.0289
642	165.0	60.0	15.00	0.9175	0.344	0.542	11.369	0.0213	0.0288
643	165.0	60.0	17.50	0.9175	0.392	0.490	11.038	0.0198	0.0282
644	245.0	30.0	7.75	0.7859	0.435	1.765	9.784	0.0805	0.1306
645	245.0	30.0	14.00	0.7859	0.668	0.787	9.208	0.0381	0.0928
646	245.0	30.0	15.00	0.7859	0.691	0.710	9.162	0.0346	0.0885
647	245.0	30.0	20.90	0.7859	0.792	0.421	9.011	0.0209	0.0693
648	245.0	45.0	5.00	0.7804	0.330	4.126	9.648	0.1908	0.2471
649	245.0	45.0	7.75	0.7804	0.585	2.269	9.465	0.1069	0.1921
650	245.0	45.0	14.00	0.7804	0.894	0.901	9.274	0.0433	0.1305
651	245.0	45.0	15.00	0.7804	0.887	0.803	9.258	0.0387	0.1190
652	245.0	45.0	20.90	0.7804	0.977	0.454	9.208	0.0220	0.0885
653	245.0	45.0	25.00	0.7804	1.043	0.330	9.194	0.0160	0.0771
654	245.0	60.0	5.00	0.8664	0.145	2.685	10.401	0.1152	0.1064
655	245.0	60.0	7.75	0.8664	0.358	2.204	10.096	0.0974	0.1162
656	245.0	60.0	11.00	0.8664	0.558	1.785	9.866	0.0807	0.1107
657	245.0	60.0	14.00	0.8664	0.688	1.497	9.734	0.0686	0.1010
658	245.0	60.0	15.00	0.8664	0.720	1.416	9.701	0.0651	0.0973
659	245.0	60.0	19.00	0.8664	0.909	1.150	9.611	0.0534	0.0931
660	245.0	60.0	20.90	0.8664	0.876	1.049	9.583	0.0489	0.0805
661	326.0	30.0	5.00	0.6483	0.297	5.855	9.202	0.2839	0.3466
662	326.0	30.0	7.75	0.6483	0.593	3.709	8.950	0.1849	0.2651
663	326.0	30.0	14.00	0.6483	1.029	1.731	8.684	0.0889	0.1957
664	326.0	30.0	15.00	0.6483	1.057	1.568	8.663	0.0808	0.1842
665	326.0	30.0	20.90	0.6483	1.236	0.950	8.593	0.0493	0.1441
666	326.0	45.0	5.00	0.7113	0.304	6.059	9.206	0.2936	0.3697
667	326.0	45.0	7.75	0.7113	0.571	3.454	9.120	0.1690	0.2620
668	326.0	45.0	14.00	0.7113	0.977	1.425	9.029	0.0704	0.1869
669	326.0	45.0	15.00	0.7113	0.974	1.275	9.022	0.0631	0.1704
670	326.0	45.0	20.90	0.7113	1.101	0.733	8.998	0.0363	0.1281
671	326.0	60.0	5.05	0.7807	0.232	5.128	9.106	0.2512	0.2898
672	326.0	60.0	7.75	0.7807	0.449	3.412	9.000	0.1691	0.2180
673	326.0	60.0	10.00	0.7807	0.658	2.564	8.940	0.1280	0.2124
674	326.0	60.0	14.00	0.7807	0.906	1.677	8.872	0.0843	0.1841
675	326.0	60.0	15.00	0.7807	0.883	1.527	8.861	0.0769	0.1641
676	326.0	60.0	20.90	0.7807	1.025	0.948	8.819	0.0479	0.1271

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

ABSORBER DIAMETER = 1.000 CM

APPROXIMATE YON = 0.0525 M.F.

677	165.0	30.0	5.00	0.9517	0.460	1.896	12.478	0.0578	0.0589
678	165.0	30.0	7.63	0.9517	0.985	2.537	10.235	0.1106	0.0824
679	165.0	30.0	11.00	0.9517	1.971	3.969	8.553	0.2070	0.1238
680	165.0	30.0	15.50	0.9517	4.437	8.988	7.434	0.5394	0.2141
681	165.0	45.0	5.01	0.9620	0.448	1.884	10.745	0.0782	0.0722
682	165.0	45.0	7.65	0.9620	0.902	2.163	9.197	0.1050	0.0912
683	165.0	45.0	11.03	0.9620	1.575	2.635	8.038	0.1461	0.1143

694	165.0	45.0	15.50	0.9620	2.739	3.539	7.271	0.2172	0.1469
685	165.0	60.0	5.71	0.9614	0.439	1.673	14.305	0.0522	0.0455
686	165.0	60.0	7.63	0.9614	0.741	1.795	12.561	0.0637	0.0593
687	165.0	60.0	11.00	0.9614	1.248	2.042	10.489	0.0869	0.0752
688	165.0	60.0	15.50	0.9614	1.970	2.463	8.938	0.1229	0.0929
689	165.0	60.0	18.50	0.9614	2.648	2.819	8.356	0.1505	0.1094
690	245.0	30.0	4.96	0.8845	1.013	4.575	7.678	0.2559	0.3142
691	245.0	30.0	5.67	0.8845	1.265	4.229	7.470	0.2526	0.3216
692	245.0	30.0	7.64	0.8845	1.680	3.448	7.015	0.2193	0.2907
693	245.0	30.0	12.00	0.8845	2.581	2.334	5.432	0.1519	0.2704
694	245.0	30.0	15.50	0.8845	3.075	1.789	6.203	0.1287	0.2462
695	245.0	30.0	20.00	0.8845	3.508	1.329	6.058	0.0979	0.2149
696	245.0	60.0	4.97	0.9433	0.233	1.757	8.000	0.0390	0.0776
697	245.0	60.0	7.64	0.9433	0.660	1.618	7.513	0.0951	0.1194
698	245.0	60.0	15.50	0.9433	1.226	1.293	6.828	0.0845	0.0999
699	245.0	60.0	21.80	0.9433	1.815	1.098	5.642	0.0738	0.1032
700	245.0	60.0	25.50	0.9433	1.882	1.004	6.591	0.0679	0.0907
701	326.0	30.0	5.02	0.7319	0.657	5.194	6.213	0.3730	0.3265
702	326.0	30.0	7.64	0.7319	1.680	5.209	5.915	0.3929	0.4393
703	326.0	30.0	11.00	0.7319	2.361	5.228	5.691	0.4099	0.3911
704	326.0	30.0	15.50	0.7319	3.773	5.254	5.541	0.4230	0.4215
705	326.0	45.0	4.97	0.8363	0.516	3.957	6.491	0.2720	0.2518
706	326.0	45.0	7.64	0.8363	1.168	3.550	6.265	0.2528	0.3017
707	326.0	45.0	15.50	0.8363	2.324	2.658	5.988	0.1981	0.2515
708	326.0	45.0	21.80	0.8363	3.167	2.165	5.928	0.1530	0.2337
709	326.0	60.0	4.97	0.8385	0.631	4.360	6.335	0.3070	0.3423
710	326.0	60.0	7.64	0.8385	1.164	3.537	6.163	0.2561	0.3193
711	326.0	60.0	15.50	0.8385	2.239	2.117	5.920	0.1595	0.2560
712	326.0	60.0	21.80	0.8385	2.910	1.517	5.854	0.1156	0.2194

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

ABSORBER DIAMETER = 1.000 CM

APPROXIMATE YON = 0.0525 M.F.

713	165.0	30.0	7.63	0.8672	0.210	0.512	9.476	0.0241	0.0205
714	165.0	30.0	11.00	0.8672	0.433	0.555	8.111	0.0305	0.0306
715	165.0	30.0	15.50	0.8672	0.601	0.622	7.201	0.0386	0.0315
716	165.0	30.0	21.80	0.8672	1.002	0.738	6.707	0.0491	0.0385
717	165.0	45.0	4.95	0.8332	0.206	0.946	7.607	0.0555	0.0532
718	165.0	45.0	7.63	0.8332	0.443	0.813	7.013	0.0517	0.0634
719	165.0	45.0	11.00	0.8332	0.630	0.682	6.578	0.0463	0.0596
720	165.0	45.0	15.50	0.8332	0.845	0.551	6.288	0.0391	0.0554
721	165.0	45.0	21.80	0.8332	1.149	0.423	6.130	0.0308	0.0526
722	165.0	45.0	25.00	0.8332	1.160	0.374	6.097	0.0274	0.0459
723	165.0	60.0	7.63	0.8781	0.102	0.447	10.512	0.0190	0.0105
724	165.0	60.0	11.00	0.8781	0.326	0.499	9.243	0.0241	0.0237
725	165.0	60.0	15.50	0.8781	0.516	0.586	8.294	0.0315	0.0278
726	165.0	60.0	21.80	0.8781	0.890	0.750	7.692	0.0435	0.0351
727	165.0	60.0	25.00	0.8781	0.846	0.861	7.546	0.0509	0.0292
728	245.0	30.0	5.02	0.5682	0.407	2.418	7.441	0.1453	0.1488
729	245.0	30.0	7.64	0.5682	0.857	2.043	6.917	0.1318	0.1555
730	245.0	30.0	12.50	0.5682	1.331	1.545	6.409	0.1075	0.1427
731	245.0	30.0	15.50	0.5682	1.673	1.323	5.258	0.0943	0.1413
732	245.0	30.0	21.80	0.5682	2.114	0.989	6.114	0.0722	0.1231
733	245.0	45.0	4.97	0.6557	0.334	2.135	6.300	0.1512	0.1557
734	245.0	45.0	7.64	0.6557	0.695	1.869	5.122	0.1352	0.1508
735	245.0	45.0	12.00	0.6557	1.112	1.530	5.964	0.1145	0.1430
736	245.0	45.0	15.00	0.6557	1.388	1.348	5.909	0.1018	0.1368

737	245.0	45.0	21.80	0.6557	1.881	1.038	5.854	0.0791	0.1213
738	245.0	60.0	4.97	0.6899	0.230	1.798	7.405	0.1083	0.0964
739	245.0	60.0	7.64	0.6899	0.584	1.742	7.107	0.1093	0.1231
740	245.0	60.0	15.50	0.6899	1.269	1.591	6.688	0.1051	0.1124
741	245.0	60.0	21.80	0.6399	1.861	1.484	6.574	0.1007	0.1130
742	326.0	30.0	4.98	0.6229	0.275	2.420	6.320	0.1708	0.1679
743	326.0	30.0	7.64	0.6229	0.645	2.165	6.073	0.1590	0.1846
744	326.0	30.0	15.50	0.6229	1.379	1.610	5.769	0.1245	0.1584
745	326.0	30.0	21.80	0.6229	1.882	1.306	5.703	0.1022	0.1453
746	326.0	45.0	7.64	0.6788	0.458	1.770	5.773	0.1368	0.1442
747	326.0	45.0	15.50	0.6788	1.108	1.509	5.669	0.1188	0.1356
748	326.0	45.0	21.80	0.6788	1.561	1.340	5.646	0.1059	0.1282
749	326.0	60.0	4.98	0.6720	0.186	1.886	6.110	0.1378	0.1281
750	326.0	60.0	7.64	0.6720	0.469	1.798	5.005	0.1336	0.1484
751	326.0	60.0	15.50	0.6720	1.066	1.569	5.856	0.1195	0.1320
752	326.0	60.0	21.80	0.6720	1.539	1.416	5.816	0.1086	0.1283

Table 2-6

K_{OGAe} and K_{OGa} Values for H > 25 cm

NO.	H	G	Q _L	Slope	F	L _s	A _s	K _{OGAe} x10 ⁴	K _{OGa} x10 ⁴
SYSTEM : N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL									
Absorber Diameter = 0.793 cm									
APPROXIMATE YON = 0.0230 M.F.									
1	29.3	245.0	30.0	0.1950	5.70	2.76	5.319	0.0623	0.0117
2	33.5	245.0	30.0	0.1950	6.60	2.41	4.657	0.0538	0.0115
3	37.7	245.0	30.0	0.1950	8.20	1.97	3.840	0.0433	0.0113
4	30.7	245.0	45.0	0.1752	8.10	1.99	3.881	0.0394	0.0102
5	35.1	245.0	45.0	0.1752	9.50	1.72	3.378	0.0335	0.0099
6	39.6	245.0	45.0	0.1752	12.00	1.39	2.772	0.0266	0.0096
7	29.7	245.0	60.0	0.2466	7.00	2.28	4.418	0.0542	0.0145
8	34.4	245.0	60.0	0.2466	7.20	2.22	4.308	0.0624	0.0145
9	36.8	245.0	60.0	0.2466	7.50	2.13	4.154	0.0599	0.0144
10	29.8	326.0	30.0	0.3651	4.30	4.76	9.025	0.2058	0.0228
11	35.0	326.0	30.0	0.3651	4.90	4.20	7.977	0.1806	0.0226
12	37.6	326.0	30.0	0.3651	5.50	3.75	7.158	0.1509	0.0225
13	30.9	326.0	45.0	0.2793	6.60	3.15	6.043	0.1025	0.0170
14	33.6	326.0	45.0	0.2793	6.70	3.11	5.959	0.1011	0.0170
15	36.4	326.0	45.0	0.2793	6.80	3.06	5.879	0.0996	0.0169
16	29.1	326.0	60.0	0.2867	5.40	3.82	7.282	0.1287	0.0177
17	34.8	326.0	60.0	0.2857	5.90	3.51	6.704	0.1178	0.0176
18	37.6	326.0	60.0	0.2867	6.40	3.25	5.217	0.1086	0.0175
APPROXIMATE YON = 0.0530 M.F.									
19	29.3	245.0	30.0	0.4343	5.70	2.76	5.319	0.1388	0.0261
20	33.5	245.0	30.0	0.4343	6.50	2.44	4.722	0.1217	0.0258
21	37.7	245.0	30.0	0.4343	8.10	1.99	3.881	0.0977	0.0252
22	30.7	245.0	45.0	0.5298	8.20	1.97	3.840	0.1177	0.0307
23	35.1	245.0	45.0	0.5298	9.50	1.72	3.378	0.1015	0.0301
24	39.6	245.0	45.0	0.5298	11.00	1.50	2.981	0.0877	0.0294
25	29.7	245.0	60.0	0.5929	7.00	2.28	4.418	0.1543	0.0349
26	34.4	245.0	60.0	0.5929	7.20	2.22	4.308	0.1500	0.0348
27	39.1	245.0	60.0	0.5929	7.80	2.06	4.013	0.1385	0.0345
28	29.8	326.0	30.0	0.5495	4.10	4.98	9.442	0.3249	0.0344
29	35.0	326.0	30.0	0.5495	5.00	4.11	7.827	0.2664	0.0340

30	37.6	326.0	30.0	0.5495	5.50	3.75	7.158	0.2422	0.0338
31	30.9	326.0	45.0	0.4732	8.20	2.57	4.955	0.2203	0.0444
32	33.6	326.0	45.0	0.4732	9.00	2.35	4.556	0.1915	0.0420
33	36.3	326.0	45.0	0.4732	10.00	2.13	4.147	0.1602	0.0383
34	32.0	326.0	60.0	0.4066	5.50	3.75	7.158	0.1792	0.0250
35	34.8	326.0	60.0	0.4066	5.90	3.51	6.704	0.1671	0.0249
36	37.6	326.0	60.0	0.4066	6.50	3.20	5.128	0.1515	0.0247
APPROXIMATE YON = 0.0730 M.F.									
37	29.3	245.0	30.0	0.7488	5.70	2.76	5.319	0.2393	0.0450
38	33.5	245.0	30.0	0.7488	6.60	2.41	4.657	0.2067	0.0444
39	37.7	245.0	30.0	0.7488	8.10	1.99	3.881	0.1684	0.0434
40	30.7	245.0	45.0	0.3668	8.10	1.99	3.881	0.0825	0.0213
41	35.1	245.0	45.0	0.3668	9.50	1.72	3.378	0.0703	0.0208
42	39.6	245.0	45.0	0.3668	11.90	1.40	2.791	0.0562	0.0201
43	29.7	245.0	60.0	0.2016	7.00	2.28	4.418	0.0525	0.0119
44	34.4	245.0	60.0	0.2016	7.20	2.22	4.308	0.0510	0.0118
45	39.1	245.0	60.0	0.2016	7.80	2.06	4.013	0.0471	0.0117
46	29.8	326.0	30.0	1.3320	4.30	4.76	9.025	0.3815	0.0432
47	35.0	326.0	30.0	1.3320	5.00	4.11	7.827	0.3250	0.0415
48	37.6	326.0	30.0	1.3320	5.50	3.75	7.158	0.2801	0.0390
49	30.9	326.0	45.0	0.9916	6.60	3.15	6.043	0.3542	0.0503
50	33.6	326.0	45.0	0.9916	6.70	3.11	5.959	0.3588	0.0602
51	39.0	326.0	45.0	0.9916	7.00	2.98	5.724	0.3434	0.0600
52	29.1	326.0	60.0	0.6897	5.40	3.82	7.282	0.3095	0.0425
53	34.8	326.0	60.0	0.6897	5.90	3.51	6.704	0.2834	0.0423
54	37.6	326.0	60.0	0.6897	6.40	3.25	6.217	0.2612	0.0420

Table 2-7

Theoretical K_{OG} Values

NO.	λ	$\langle U_F \rangle$	U_i	$k_L A_F \times 10^4$	$k_G A_F \times 10^4$	$K_{OG} A_F \times 10^4$	A_s	$K_{OG} \times 10^4$
SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL								
DG = 0.0813 CM ² /SEC DI = 0.1150E-05 CM ² /SEC								
ABSORBER DIAMETER = 0.793 CM								
GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
RISE VELOCITY = 16.79 CM/SEC								
1	0.20	-0.44	-17.45	0.0607	0.6845	0.2123	0.517	0.4104
2	0.31	-3.31	-21.75	0.0965	1.0341	0.3319	0.748	0.4440
3	0.41	-5.27	-24.69	0.1187	1.3964	0.4205	0.940	0.4475
4	0.50	-5.93	-25.68	0.1389	1.7730	0.5039	1.119	0.4503
5	0.56	-6.14	-25.99	0.1512	2.0837	0.5601	1.237	0.4528
6	0.81	-6.14	-25.99	0.1928	2.7060	0.7178	1.701	0.4220
7	1.06	-6.14	-25.99	0.2269	3.3283	0.8545	2.165	0.3948
8	1.31	-6.14	-25.99	0.2565	3.9506	0.9780	2.629	0.3721
9	1.56	-6.14	-25.99	0.2831	4.5729	1.0918	3.092	0.3531
10	1.81	-6.14	-25.99	0.3073	5.1953	1.1980	3.556	0.3369
11	2.06	-6.14	-25.99	0.3298	5.8176	1.2981	4.020	0.3229
12	2.56	-6.14	-25.99	0.3707	6.6976	1.4668	4.948	0.2964
13	3.56	-6.14	-25.99	0.4412	7.9423	1.7444	6.803	0.2564
14	5.06	-6.14	-25.99	0.5297	9.4666	2.0909	9.586	0.2181

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN								
RISE VELOCITY = 20.59 CM/SEC								
15	0.20	1.50	-18.34	0.0619	0.6977	0.2162	0.517	0.4180

16	0.31	-1.67	-23.10	0.0987	1.0580	0.3396	0.748	0.4543
17	0.41	-3.85	-26.36	0.1219	1.4323	0.4314	0.940	0.4592
18	0.50	-4.57	-27.45	0.1429	1.8217	0.5180	1.119	0.4629
19	0.56	-4.81	-27.80	0.1556	2.1430	0.5764	1.237	0.4659
20	0.81	-4.81	-27.80	0.1988	2.7866	0.7398	1.701	0.4350
21	1.06	-4.81	-27.80	0.2342	3.4301	0.8815	2.165	0.4072
22	1.31	-4.81	-27.80	0.2649	4.0737	1.0094	2.629	0.3840
23	1.56	-4.81	-27.80	0.2923	4.7173	1.1272	3.092	0.3645
24	1.81	-4.81	-27.80	0.3174	5.3609	1.2372	3.556	0.3479
25	2.06	-4.81	-27.80	0.3407	6.0044	1.3408	4.020	0.3335
26	2.56	-4.81	-27.80	0.3830	6.9146	1.5153	4.948	0.3063
27	3.56	-4.81	-27.80	0.4560	8.2017	1.8026	6.803	0.2650
28	5.06	-4.81	-27.80	0.5476	9.7781	2.1611	9.586	0.2254

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN
RISE VELOCITY = 27.59 CM/SEC

29	0.20	1.30	-25.64	0.0733	0.8263	0.2562	0.517	0.4952
30	0.31	-3.07	-32.19	0.1168	1.2518	0.4018	0.748	0.5374
31	0.41	-6.06	-36.69	0.1440	1.6933	0.5100	0.940	0.5428
32	0.50	-7.07	-38.19	0.1688	2.1526	0.6120	1.119	0.5469
33	0.56	-7.39	-38.67	0.1838	2.5316	0.6808	1.237	0.5504
34	0.81	-7.39	-38.67	0.2347	3.2906	0.8734	1.701	0.5135
35	1.06	-7.39	-38.67	0.2764	4.0496	1.0405	2.165	0.4807
36	1.31	-7.39	-38.67	0.3125	4.8087	1.1912	2.629	0.4532
37	1.56	-7.39	-38.67	0.3449	5.5677	1.3301	3.092	0.4301
38	1.81	-7.39	-38.67	0.3745	6.3268	1.4598	3.556	0.4105
39	2.06	-7.39	-38.67	0.4020	7.0858	1.5819	4.020	0.3935
40	2.56	-7.39	-38.67	0.4518	8.1593	1.7877	4.948	0.3613
41	3.56	-7.39	-38.67	0.5379	9.6774	2.1266	6.803	0.3126
42	5.06	-7.39	-38.67	0.6459	11.5366	2.5493	9.586	0.2659

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL
DG= 0.0813 CM²/SEC DL= 0.3640E-05 CM²/SEC

ABSORBER DIAMETER = 0.793 CM

GAS RATE = 165.0 CC/MIN LIQUID RATE = 30.0 CC/MIN
RISE VELOCITY = 15.88 CM/SEC

43	0.31	-4.66	-22.87	0.1990	1.1474	0.5367	0.822	0.6528
44	0.40	-6.31	-25.34	0.2427	1.5212	0.6800	1.007	0.6752
45	0.53	-7.27	-26.79	0.3003	1.9980	0.8638	1.271	0.6794
46	0.62	-7.27	-26.79	0.3341	2.3892	0.9908	1.443	0.6868
47	0.87	-7.27	-26.79	0.4146	3.0453	1.2432	1.924	0.6460
48	1.12	-7.27	-26.79	0.4819	3.7015	1.4712	2.406	0.6114
49	1.37	-7.27	-26.79	0.5409	4.3576	1.6824	2.888	0.5826
50	1.62	-7.27	-26.79	0.5940	5.0137	1.8807	3.370	0.5581
51	1.87	-7.27	-26.79	0.6427	5.6699	2.0685	3.851	0.5371
52	2.12	-7.27	-26.79	0.6880	6.3260	2.2475	4.333	0.5187
53	2.62	-7.27	-26.79	0.7707	7.2539	2.5384	5.297	0.4792
54	3.62	-7.27	-26.79	0.9139	8.5662	3.0057	7.224	0.4161
55	5.12	-7.27	-26.79	1.0941	10.1734	3.5881	10.114	0.3548

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN
RISE VELOCITY = 21.85 CM/SEC

56	0.31	-5.91	-30.72	0.2305	1.3284	0.6214	0.822	0.7558
57	0.40	-8.14	-34.06	0.2811	1.7618	0.7876	1.007	0.7821
58	0.53	-9.44	-36.02	0.3480	2.3146	1.0008	1.271	0.7872

59	0.62	-9.44	-36.02	0.3872	2.7682	1.1481	1.443	0.7959
60	0.87	-9.44	-36.02	0.4806	3.5290	1.4408	1.924	0.7487
61	1.12	-9.44	-36.02	0.5586	4.2898	1.7052	2.406	0.7087
62	1.37	-9.44	-36.02	0.6270	5.0506	1.9501	2.888	0.6753
63	1.62	-9.44	-36.02	0.6886	5.8114	2.1801	3.370	0.6470
64	1.87	-9.44	-36.02	0.7451	6.5722	2.3979	3.851	0.6226
65	2.12	-9.44	-36.02	0.7977	7.3330	2.6055	4.333	0.6013
66	2.62	-9.44	-36.02	0.8936	8.4089	2.9429	5.297	0.5556
67	3.62	-9.44	-36.02	1.0596	9.9305	3.4847	7.224	0.4824
68	5.12	-9.44	-36.02	1.2685	11.7941	4.1601	10.114	0.4113

GAS RATE = 326.0 CC/MIN LIQUID RATE = 30.0 CC/MIN
RISE VELOCITY = 24.91 CM/SEC

69	0.31	-3.57	-30.27	0.2272	1.3094	0.6126	0.822	0.7451
70	0.40	-5.86	-33.70	0.2779	1.7406	0.7783	1.007	0.7729
71	0.53	-7.20	-35.71	0.3448	2.2909	0.9911	1.271	0.7796
72	0.62	-7.20	-35.71	0.3840	2.7426	1.1382	1.443	0.7890
73	0.87	-7.20	-35.71	0.4773	3.5001	1.4302	1.924	0.7432
74	1.12	-7.20	-35.71	0.5551	4.2576	1.6938	2.406	0.7039
75	1.37	-7.20	-35.71	0.6233	5.0152	1.9379	2.888	0.6710
76	1.62	-7.20	-35.71	0.6848	5.7727	2.1671	3.370	0.6431
77	1.87	-7.20	-35.71	0.7411	6.5302	2.3841	3.851	0.6190
78	2.12	-7.20	-35.71	0.7935	7.2877	2.5910	4.333	0.5979
79	2.62	-7.20	-35.71	0.8890	8.3590	2.9271	5.297	0.5526
80	3.62	-7.20	-35.71	1.0544	9.8740	3.4668	7.224	0.4799
81	5.12	-7.20	-35.71	1.2626	11.7295	4.1394	10.114	0.4093

SYSTEM: N-HEXANE-HELIUM-HEAVY PARAFFIN OIL
DG= 0.2744 CM2/SEC DL= 0.1150E-05 CM2/SEC
ABSORBER DIAMETER = 0.793 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN
RISE VELOCITY = 20.36 CM/SEC

82	0.20	1.66	-17.87	0.0610	1.2646	0.2484	0.517	0.4802
83	0.31	-1.45	-22.53	0.0977	1.9185	0.3935	0.748	0.5263
84	0.41	-3.58	-25.73	0.1206	2.5978	0.4948	0.940	0.5266
85	0.50	-4.29	-26.80	0.1415	3.3046	0.5890	1.119	0.5263
86	0.56	-4.52	-27.14	0.1541	3.8879	0.6501	1.237	0.5256
87	0.81	-4.52	-27.14	0.1969	5.0561	0.8332	1.701	0.4899
88	1.06	-4.52	-27.14	0.2319	6.2243	0.9886	2.165	0.4567
89	1.31	-4.52	-27.14	0.2624	7.3925	1.1267	2.629	0.4286
90	1.56	-4.52	-27.14	0.2896	8.5608	1.2525	3.092	0.4050
91	1.81	-4.52	-27.14	0.3145	9.7290	1.3691	3.556	0.3850
92	2.06	-4.52	-27.14	0.3375	10.8972	1.4781	4.020	0.3677
93	2.56	-4.52	-27.14	0.3794	12.5494	1.6671	4.948	0.3369
94	3.56	-4.52	-27.14	0.4518	14.8858	1.9839	6.803	0.2916
95	5.06	-4.52	-27.14	0.5425	17.7474	2.3799	9.586	0.2483

SYSTEM: N-HEXANE-FREON-14-HEAVY PARAFFIN OIL
DG= 0.0446 CM2/SEC DL= 0.1150E-05 CM2/SEC
ABSORBER DIAMETER = 0.793 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN
RISE VELOCITY = 18.25 CM/SEC

96	0.20	3.11	-13.58	0.0527	0.4413	0.1664	0.517	0.3217

97	0.31	0.59	-17.36	0.0848	0.6726	0.2621	0.748	0.3506
98	0.41	-1.13	-19.95	0.1050	0.9138	0.3363	0.940	0.3580
99	0.50	-1.71	-20.81	0.1235	1.1649	0.4070	1.119	0.3637
100	0.56	-1.89	-21.09	0.1346	1.3722	0.4557	1.237	0.3684
101	0.81	-1.89	-21.09	0.1725	1.7873	0.5869	1.701	0.3451
102	1.06	-1.89	-21.09	0.2034	2.2025	0.7020	2.165	0.3243
103	1.31	-1.89	-21.09	0.2302	2.6177	0.8067	2.629	0.3069
104	1.56	-1.89	-21.09	0.2541	3.0328	0.9039	3.092	0.2923
105	1.81	-1.89	-21.09	0.2760	3.4480	0.9950	3.556	0.2798
106	2.06	-1.89	-21.09	0.2963	3.8631	1.0812	4.020	0.2690
107	2.56	-1.89	-21.09	0.3332	4.4503	1.2240	4.948	0.2474
108	3.56	-1.89	-21.09	0.3969	5.2806	1.4563	6.803	0.2141
109	5.06	-1.89	-21.09	0.4766	6.2975	1.7456	9.586	0.1821

SYSTEM: N-HEXANE-FREON-14-LIGHT PARAFFIN OIL

DG= 0.0446 CM²/SEC DL= 0.3640E-05 CM²/SEC

ABSORBER DIAMETER = 0.793 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

RISE VELOCITY = 17.40 CM/SEC

110	0.31	-0.53	-18.20	0.1747	0.7456	0.4047	0.822	0.4923
111	0.40	-1.98	-20.36	0.2144	0.9938	0.5190	1.007	0.5153
112	0.53	-2.82	-21.62	0.2667	1.3111	0.6655	1.271	0.5235
113	0.62	-2.82	-21.62	0.2974	1.5714	0.7692	1.443	0.5332
114	0.87	-2.82	-21.62	0.3703	2.0080	0.9699	1.924	0.5040
115	1.12	-2.82	-21.62	0.4310	2.4446	1.1535	2.406	0.4794
116	1.37	-2.82	-21.62	0.4842	2.8813	1.3251	2.888	0.4588
117	1.62	-2.82	-21.62	0.5321	3.3179	1.4874	3.370	0.4414
118	1.87	-2.82	-21.62	0.5760	3.7545	1.6421	3.851	0.4264
119	2.12	-2.82	-21.62	0.6168	4.1911	1.7903	4.333	0.4132
120	2.62	-2.82	-21.62	0.6912	4.8086	2.0264	5.297	0.3826
121	3.62	-2.82	-21.62	0.8201	5.6818	2.3999	7.224	0.3322
122	5.12	-2.82	-21.62	0.9821	6.7513	2.8646	10.114	0.2832

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

DG= 0.0813 CM²/SEC DL= 0.1150E-05 CM²/SEC

ABSORBER DIAMETER = 0.594 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

RISE VELOCITY = 30.85 CM/SEC

123	0.21	5.91	-21.99	0.0501	0.5901	0.1774	0.365	0.4855
124	0.26	4.67	-23.85	0.0584	0.7621	0.2131	0.430	0.4955
125	0.30	3.99	-24.86	0.0661	0.9394	0.2469	0.491	0.5023
126	0.41	2.47	-27.14	0.0822	1.2292	0.3111	0.637	0.4883
127	0.50	1.64	-28.38	0.1060	1.5095	0.3961	0.762	0.5200
128	0.75	1.64	-28.38	0.1377	1.9766	0.5156	1.095	0.4709
129	1.00	1.64	-28.38	0.1633	2.4437	0.6181	1.428	0.4329
130	1.25	1.64	-28.38	0.1854	2.9107	0.7103	1.761	0.4033
131	1.50	1.64	-28.38	0.2052	3.3778	0.7950	2.094	0.3796
132	1.75	1.64	-28.38	0.2232	3.8448	0.8739	2.427	0.3600
133	2.00	1.64	-28.38	0.2399	4.3119	0.9481	2.761	0.3435
134	2.50	1.64	-28.38	0.2702	4.9724	1.0733	3.427	0.3132
135	3.50	1.64	-28.38	0.3223	5.9065	1.2792	4.760	0.2688
136	5.00	1.64	-28.38	0.3875	7.0506	1.5357	6.759	0.2272

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

DG= 0.0813 CM²/SEC DL= 0.3640E-05 CM²/SEC

ABSORBER DIAMETER = 0.594 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

RISE VELOCITY = 30.77 CM/SEC

137	0.21	3.32	-25.79	0.1080	0.6587	0.2988	0.394	0.7584
138	0.26	1.29	-28.83	0.1271	0.8607	0.3683	0.465	0.7922

139	0.30	-0.66	-31.76	0.1453	1.0785	0.4376	0.536	0.8167
140	0.41	-3.33	-35.76	0.1846	1.4394	0.5669	0.695	0.8156
141	0.50	-4.92	-38.15	0.2476	1.7925	0.7380	0.831	0.8878
142	0.75	-4.92	-38.15	0.3272	2.3804	0.9772	1.193	0.8191
143	1.00	-4.92	-38.15	0.3909	2.9684	1.1879	1.555	0.7641
144	1.25	-4.92	-38.15	0.4456	3.5564	1.3809	1.916	0.7206
145	1.50	-4.92	-38.15	0.4942	4.1443	1.5610	2.278	0.6852
146	1.75	-4.92	-38.15	0.5385	4.7323	1.7307	2.640	0.6556
147	2.00	-4.92	-38.15	0.5795	5.3202	1.8919	3.002	0.6303
148	2.50	-4.92	-38.15	0.6536	6.1518	2.1528	3.725	0.5779
149	3.50	-4.92	-38.15	0.7812	7.3277	2.5699	5.172	0.4969
150	5.00	-4.92	-38.15	0.9406	8.7679	3.0875	7.343	0.4205

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

DG= 0.0813 CM2/SEC DL= 0.1150E-05 CM2/SEC

ABSORBER DIAMETER = 1.000 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

RISE VELOCITY = 18.37 CM/SEC

151	0.21	-2.43	-22.02	0.0932	0.9507	0.3155	0.767	0.4111
152	0.26	-3.87	-24.17	0.1087	1.2479	0.3820	0.896	0.4264
153	0.30	-5.23	-26.22	0.1233	1.5634	0.4465	1.021	0.4372
154	0.41	-8.75	-31.50	0.1560	2.1159	0.5753	1.319	0.4361
155	0.50	-11.05	-34.95	0.2122	2.6713	0.7667	1.563	0.4906
156	0.61	-13.11	-38.04	0.2462	3.3127	0.9062	1.842	0.4919
157	0.86	-13.11	-38.04	0.3144	4.3016	1.1626	2.452	0.4742
158	1.11	-13.11	-38.04	0.3703	5.2905	1.3850	3.061	0.4525
159	1.36	-13.11	-38.04	0.4188	6.2793	1.5860	3.670	0.4321
160	1.61	-13.11	-38.04	0.4622	7.2682	1.7712	4.279	0.4139
161	1.86	-13.11	-38.04	0.5019	8.2571	1.9442	4.889	0.3977
162	2.11	-13.11	-38.04	0.5387	9.2459	2.1072	5.498	0.3833
163	2.61	-13.11	-38.04	0.6055	10.6444	2.3816	6.717	0.3546
164	3.61	-13.11	-38.04	0.7209	12.6221	2.8328	9.154	0.3095
165	5.11	-13.11	-38.04	0.8656	15.0443	3.3957	12.810	0.2651

SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL

DG= 0.0813 CM2/SEC DL= 0.3640E-05 CM2/SEC

ABSORBER DIAMETER = 1.000 CM

GAS RATE = 245.0 CC/MIN LIQUID RATE = 30.0 CC/MIN

RISE VELOCITY = 16.67 CM/SEC

166	0.30	-5.12	-24.34	0.2339	1.2062	0.5978	1.073	0.5573
167	0.39	-8.23	-29.02	0.2908	1.7104	0.7915	1.336	0.5924
168	0.50	-10.67	-32.68	0.4004	2.3045	1.0789	1.624	0.6644
169	0.59	-11.89	-34.50	0.4567	2.8795	1.2829	1.861	0.6892
170	0.61	-11.89	-34.50	0.4656	3.1145	1.3424	1.899	0.7069
171	0.86	-11.89	-34.50	0.5942	4.0709	1.7307	2.518	0.6874
172	1.11	-11.89	-34.50	0.6995	5.0272	2.0788	3.136	0.6628
173	1.36	-11.89	-34.50	0.7910	5.9836	2.4001	3.755	0.6391
174	1.61	-11.89	-34.50	0.8729	6.9399	2.7012	4.374	0.6176
175	1.86	-11.89	-34.50	0.9477	7.8963	2.9860	4.993	0.5981
176	2.11	-11.89	-34.50	1.0171	8.8526	3.2572	5.611	0.5805
177	2.61	-11.89	-34.50	1.1432	10.2051	3.6951	6.849	0.5395
178	3.61	-11.89	-34.50	1.3609	12.1178	4.3946	9.324	0.4713
179	5.11	-11.89	-34.50	1.6339	14.4604	5.2646	13.036	0.4038

Table 2-8

Effective Slug Mass Transfer Areas $\bar{a}$

NO	G	Q_L	H	L_s	$K_{OG} \times 10^4$	$\overline{K_{OG}^a}$	$\bar{a}$
D _p = 0.793 cm							
SYSTEM: N-HEXANE-NITROGEN-LIGHT PARAFFIN OIL $\times 10^4$							
APPROXIMATE YON = 0.023 M.F.							
1	165.0	30.0	5.7	0.31	0.7240	0.0458	0.063
2	165.0	30.0	10.0	0.41	0.7075	0.0570	0.081
3	165.0	30.0	15.0	0.53	0.6895	0.0553	0.080
4	165.0	30.0	17.4	0.59	0.6814	0.0546	0.080
5	165.0	30.0	20.0	0.64	0.6736	0.0551	0.082
6	165.0	45.0	5.7	0.43	0.6979	0.0366	0.052
7	165.0	45.0	10.0	0.55	0.6808	0.0404	0.059
8	165.0	45.0	17.4	0.74	0.6546	0.0398	0.061
9	165.0	45.0	20.0	0.80	0.6466	0.0414	0.064
10	165.0	45.0	25.0	0.89	0.6341	0.0350	0.055
11	165.0	60.0	15.0	0.74	0.6546	0.0373	0.057
12	165.0	60.0	17.4	0.80	0.6466	0.0330	0.051
13	245.0	30.0	5.7	0.66	0.7772	0.0757	0.097
14	245.0	30.0	10.0	0.82	0.7524	0.0682	0.091
15	245.0	30.0	15.0	1.00	0.7272	0.0746	0.103
16	245.0	30.0	17.4	1.08	0.7158	0.0759	0.106
17	245.0	30.0	25.0	1.27	0.6902	0.0591	0.086
18	245.0	45.0	5.7	0.73	0.7286	0.0590	0.081
19	245.0	45.0	10.0	0.93	0.7012	0.0899	0.128
20	245.0	45.0	15.0	1.12	0.6758	0.0758	0.112
21	245.0	45.0	17.4	1.17	0.6693	0.0845	0.126
22	245.0	45.0	20.0	1.21	0.6643	0.0817	0.123
23	245.0	60.0	5.7	0.63	0.7698	0.0905	0.118
24	245.0	60.0	10.0	0.77	0.7472	0.1085	0.145
25	245.0	60.0	15.0	0.93	0.7247	0.1016	0.140
26	245.0	60.0	17.4	0.98	0.7172	0.1101	0.154
27	245.0	60.0	20.0	1.05	0.7072	0.1054	0.149
28	326.0	30.0	5.7	1.14	0.7022	0.2066	0.294
29	326.0	30.0	10.0	1.36	0.6753	0.1772	0.262
30	326.0	30.0	15.0	1.66	0.6405	0.1486	0.232
31	326.0	30.0	17.4	1.77	0.6289	0.1435	0.228
32	326.0	30.0	24.0	2.01	0.6056	0.1177	0.194
33	326.0	45.0	5.7	1.13	0.7342	0.1802	0.245
34	326.0	45.0	10.0	1.33	0.7069	0.1587	0.225
35	326.0	45.0	15.0	1.55	0.6811	0.1423	0.209
36	326.0	45.0	17.4	1.61	0.6731	0.1336	0.198
37	326.0	45.0	20.0	1.68	0.6661	0.1257	0.189
38	326.0	60.0	5.7	1.13	0.6871	0.1740	0.253
39	326.0	60.0	10.0	1.41	0.6537	0.1551	0.237
40	326.0	60.0	15.0	1.68	0.6245	0.1389	0.222
41	326.0	60.0	17.4	1.80	0.6116	0.1310	0.214
42	326.0	60.0	20.0	1.90	0.6021	0.1234	0.205
APPROXIMATE YON = 0.052 M.F.							
43	165.0	30.0	5.7	0.31	0.7240	0.1265	0.175
44	165.0	30.0	7.5	0.34	0.7187	0.1231	0.171
45	165.0	30.0	10.0	0.41	0.7075	0.1314	0.186

46	165.0	30.0	12.0	0.45	0.7015	0.1325	0.189
47	165.0	30.0	17.4	0.59	0.6814	0.1241	0.182
48	165.0	30.0	20.0	0.64	0.6736	0.1247	0.185
49	165.0	30.0	25.0	0.74	0.6597	0.1103	0.167
50	165.0	45.0	5.7	0.43	0.6979	0.0761	0.109
51	165.0	45.0	10.0	0.55	0.6808	0.0757	0.111
52	165.0	45.0	14.0	0.65	0.6665	0.0786	0.118
53	165.0	45.0	17.4	0.74	0.6546	0.0725	0.111
54	165.0	60.0	14.0	0.65	0.6665	0.0836	0.125
55	165.0	60.0	17.4	0.74	0.6546	0.0772	0.118
56	245.0	30.0	5.7	0.67	0.7759	0.2855	0.368
57	245.0	30.0	10.0	0.82	0.7524	0.2534	0.337
58	245.0	30.0	14.0	0.97	0.7309	0.2349	0.321
59	245.0	30.0	18.0	1.09	0.7140	0.2117	0.296
60	245.0	45.0	5.7	0.75	0.7262	0.1853	0.255
61	245.0	45.0	10.0	0.93	0.7012	0.1822	0.260
62	245.0	45.0	14.0	1.09	0.6793	0.1765	0.260
63	245.0	45.0	18.5	1.19	0.6664	0.1636	0.245
64	245.0	45.0	20.0	1.21	0.6643	0.1692	0.255
65	245.0	45.0	25.0	1.25	0.6601	0.1405	0.213
66	245.0	60.0	5.7	0.63	0.7693	0.1887	0.245
67	245.0	60.0	10.0	0.77	0.7472	0.1737	0.232
68	245.0	60.0	14.0	0.90	0.7284	0.1692	0.232
69	245.0	60.0	17.4	0.97	0.7179	0.1703	0.237
70	245.0	60.0	20.0	1.04	0.7088	0.1634	0.230
71	245.0	60.0	25.0	1.11	0.7003	0.1475	0.211
72	326.0	30.0	5.7	1.13	0.7036	0.2318	0.330
73	326.0	30.0	10.0	1.36	0.6753	0.2615	0.387
74	326.0	30.0	14.0	1.59	0.6484	0.2634	0.406
75	326.0	30.0	17.4	1.77	0.6289	0.2411	0.383
76	326.0	30.0	20.0	1.88	0.6178	0.2377	0.385
77	326.0	30.0	25.0	2.01	0.6056	0.2369	0.391
78	326.0	45.0	5.7	1.13	0.7335	0.3877	0.529
79	326.0	45.0	10.0	1.33	0.7069	0.3107	0.440
80	326.0	45.0	14.0	1.50	0.6860	0.2832	0.413
81	326.0	45.0	17.4	1.61	0.6731	0.2543	0.378
82	326.0	45.0	20.0	1.68	0.6661	0.2291	0.344
83	326.0	45.0	25.0	1.73	0.6602	0.2014	0.305
84	326.0	60.0	5.7	1.13	0.6871	0.4946	0.720
85	326.0	60.0	10.0	1.40	0.6547	0.3682	0.562
TAW 86	326.0	60.0	14.0	1.64	0.6284	0.3082	0.490
ATIQU 87	326.0	60.0	17.4	1.80	0.6116	0.2702	0.442
88	326.0	60.0	20.0	1.87	0.6054	0.2452	0.405
89	326.0	60.0	25.0	1.95	0.5971	0.2016	0.338
APPROXIMATE YON =				0.072	M.F.		
90	165.0	30.0	5.7	0.31	0.7240	0.0187	0.026
91	165.0	30.0	10.0	0.41	0.7075	0.0574	0.081
92	165.0	30.0	14.0	0.51	0.6933	0.0802	0.116
93	165.0	30.0	16.5	0.53	0.6902	0.1002	0.145
94	165.0	30.0	17.4	0.59	0.6814	0.1519	0.223
95	165.0	45.0	5.7	0.43	0.6979	0.0687	0.098
96	165.0	45.0	10.0	0.55	0.6808	0.0905	0.133
97	165.0	45.0	14.0	0.65	0.6665	0.0982	0.147
98	165.0	45.0	17.4	0.74	0.6546	0.1128	0.172
99	165.0	60.0	14.0	0.65	0.6665	0.0955	0.143
100	165.0	60.0	17.4	0.74	0.6546	0.1002	0.153

101	245.0	30.0	5.4	0.66	0.7772	0.3646	0.469
102	245.0	30.0	7.5	0.73	0.7662	0.3318	0.433
103	245.0	30.0	11.5	0.87	0.7446	0.2848	0.382
104	245.0	30.0	14.0	0.97	0.7309	0.2708	0.370
105	245.0	30.0	17.4	1.08	0.7158	0.2368	0.331
106	245.0	45.0	5.7	0.75	0.7262	0.1953	0.269
107	245.0	45.0	17.4	0.90	0.7048	0.1750	0.248
108	245.0	45.0	10.0	1.08	0.6801	0.2262	0.333
109	245.0	45.0	14.0	1.17	0.6693	0.2018	0.301
110	245.0	45.0	20.0	1.21	0.6643	0.1932	0.291
111	245.0	45.0	25.0	1.25	0.6601	0.1727	0.262
112	245.0	60.0	5.7	0.63	0.7693	0.1251	0.163
113	245.0	60.0	10.0	0.77	0.7472	0.1855	0.248
114	245.0	60.0	14.0	0.90	0.7284	0.1889	0.259
115	245.0	60.0	17.4	0.97	0.7179	0.1985	0.276
116	245.0	60.0	20.0	1.04	0.7088	0.1939	0.274
117	245.0	60.0	25.0	1.11	0.7003	0.1533	0.219
118	326.0	30.0	5.7	1.13	0.7036	0.2744	0.390
119	326.0	30.0	10.0	1.21	0.6930	0.3018	0.435
120	326.0	30.0	7.5	1.36	0.6753	0.3626	0.537
121	326.0	30.0	14.0	1.59	0.6484	0.3032	0.468
122	326.0	30.0	17.4	1.77	0.6289	0.3213	0.511
123	326.0	30.0	25.0	23.12	0.1514	0.2652	1.752
124	326.0	45.0	5.7	1.13	0.7335	0.3472	0.473
125	326.0	45.0	10.0	1.33	0.7069	0.3197	0.452
126	326.0	45.0	14.0	1.50	0.6860	0.2958	0.431
127	326.0	45.0	17.4	1.61	0.6731	0.2743	0.407
128	326.0	45.0	25.0	1.72	0.6617	0.2377	0.359
129	326.0	60.0	5.7	1.13	0.6871	0.1131	0.165
130	326.0	60.0	10.0	1.40	0.6547	0.2292	0.350
131	326.0	60.0	14.0	1.64	0.6284	0.1975	0.314
132	326.0	60.0	17.4	1.80	0.6116	0.1692	0.277
133	326.0	60.0	20.0	1.90	0.6021	0.1944	0.323
134	326.0	60.0	25.0	1.95	0.5971	0.1803	0.302

SYSTEM: N-HEXANE-NITROGEN-HEAVY PARAFFIN OIL

APPROXIMATE YON = 0.024 M.F.

135	165.0	30.0	5.7	0.56	0.4526	0.0339	0.075
136	165.0	30.0	10.0	0.75	0.4283	0.0363	0.085
137	165.0	30.0	17.4	1.13	0.3892	0.0327	0.084
138	165.0	30.0	22.4	1.44	0.3636	0.0314	0.086
139	165.0	45.0	5.7	0.88	0.3882	0.0530	0.137
140	165.0	45.0	10.0	1.04	0.3722	0.0623	0.167
141	165.0	45.0	17.4	1.19	0.3593	0.0430	0.120
142	165.0	45.0	22.4	1.25	0.3547	0.0392	0.110
143	165.0	60.0	5.7	0.43	0.4390	0.0772	0.176
144	165.0	60.0	10.0	0.53	0.4253	0.0674	0.158
145	165.0	60.0	17.4	0.75	0.4007	0.0554	0.138
146	245.0	30.0	5.7	1.06	0.4087	0.0582	0.142
147	245.0	30.0	10.0	1.39	0.3788	0.0642	0.170
148	245.0	30.0	17.4	2.22	0.3231	0.0512	0.158
149	245.0	30.0	22.4	2.68	0.3001	0.0483	0.161
150	245.0	45.0	5.7	1.50	0.4163	0.0682	0.164
151	245.0	45.0	10.0	1.69	0.4012	0.0651	0.162
152	245.0	45.0	17.4	1.95	0.3817	0.0573	0.150
153	245.0	45.0	22.4	2.01	0.3770	0.0534	0.142
154	245.0	60.0	5.7	0.83	0.4567	0.0446	0.098
155	245.0	60.0	10.0	1.07	0.4299	0.0524	0.122

156	245.0	60.0	17.4	1.61	0.3817	0.0424	0.111
157	245.0	60.0	22.4	1.86	0.3634	0.0330	0.091
158	326.0	30.0	5.7	1.72	0.4175	0.1174	0.281
159	326.0	30.0	10.0	2.22	0.3815	0.0987	0.259
160	326.0	30.0	17.4	3.57	0.3128	0.0864	0.276
161	326.0	30.0	22.4	4.56	0.2794	0.0752	0.269
162	326.0	45.0	5.7	2.06	0.3970	0.1176	0.296
163	326.0	45.0	10.0	2.51	0.3677	0.0915	0.249
164	326.0	45.0	13.5	2.69	0.3574	0.0950	0.266
165	326.0	45.0	17.4	2.87	0.3482	0.0830	0.238
166	326.0	45.0	22.4	2.98	0.3424	0.0697	0.204
167	326.0	60.0	5.7	1.37	0.4455	0.0997	0.224
168	326.0	60.0	8.0	1.49	0.4346	0.0862	0.198
169	326.0	60.0	10.0	1.66	0.4195	0.0814	0.194
170	326.0	60.0	13.0	1.95	0.3969	0.0916	0.231
171	326.0	60.0	17.4	2.33	0.3716	0.0832	0.224
172	326.0	60.0	22.4	2.60	0.3558	0.0686	0.193

APPROXIMATE YON = 0.053 M.F.

173	165.0	30.0	5.7	0.56	0.4526	0.0588	0.130
174	165.0	30.0	10.0	0.75	0.4283	0.0655	0.153
175	165.0	30.0	14.2	0.94	0.4074	0.0559	0.137
176	165.0	30.0	17.4	1.13	0.3892	0.0550	0.141
177	165.0	30.0	22.6	1.44	0.3636	0.0505	0.139
178	165.0	45.0	5.7	0.88	0.3882	0.0631	0.163
179	165.0	45.0	10.0	1.04	0.3729	0.0580	0.155
180	165.0	45.0	17.4	1.19	0.3593	0.0518	0.144
181	165.0	45.0	22.6	1.26	0.3537	0.0470	0.133
182	165.0	60.0	5.7	0.43	0.4390	0.0619	0.141
183	165.0	60.0	10.0	0.53	0.4253	0.0612	0.144
184	165.0	60.0	17.4	0.75	0.4007	0.0534	0.133
185	165.0	60.0	22.6	0.92	0.3833	0.0498	0.130
186	245.0	30.0	5.7	1.06	0.4087	0.0719	0.176
187	245.0	30.0	10.0	1.39	0.3788	0.0712	0.188
188	245.0	30.0	17.4	2.22	0.3231	0.0645	0.200
189	245.0	30.0	22.6	2.72	0.2981	0.0606	0.203
190	245.0	45.0	5.7	1.50	0.4163	0.0768	0.185
191	245.0	45.0	10.0	1.69	0.4012	0.0781	0.195
192	245.0	45.0	17.4	1.95	0.3817	0.0637	0.167
193	245.0	45.0	22.6	2.01	0.3770	0.0596	0.158
194	245.0	60.0	5.7	0.81	0.4581	0.0541	0.118
195	245.0	60.0	10.0	1.07	0.4299	0.0650	0.151
196	245.0	60.0	17.4	1.61	0.3817	0.0572	0.150
197	245.0	60.0	22.6	1.86	0.3634	0.0566	0.156
198	326.0	30.0	5.7	1.72	0.4175	0.1022	0.245
199	326.0	30.0	10.0	2.24	0.3801	0.0901	0.237
200	326.0	30.0	15.0	3.11	0.3324	0.0877	0.264
201	326.0	30.0	17.4	3.57	0.3128	0.0890	0.285
202	326.0	30.0	22.8	4.66	0.2766	0.0787	0.285
203	326.0	45.0	5.7	2.06	0.3970	0.0592	0.149
204	326.0	45.0	10.0	2.51	0.3677	0.0981	0.267
205	326.0	45.0	17.4	2.91	0.3463	0.0681	0.197
206	326.0	45.0	22.6	2.98	0.3424	0.0668	0.195
207	326.0	60.0	5.7	1.30	0.4525	0.1603	0.354
208	326.0	60.0	10.0	1.66	0.4195	0.1312	0.313
209	326.0	60.0	17.4	2.33	0.3716	0.1000	0.269
210	326.0	60.0	22.6	2.63	0.3542	0.0851	0.240

APPROXIMATE YON = 0.073 M.F.							
211	165.0	30.0	5.7	0.56	0.4526	0.0689	0.152
212	165.0	30.0	10.0	0.75	0.4283	0.0720	0.168
213	165.0	30.0	17.4	1.13	0.3892	0.0688	0.177
214	165.0	30.0	20.9	1.37	0.3685	0.0704	0.191
215	165.0	30.0	25.0	1.51	0.3582	0.0619	0.173
216	165.0	45.0	5.7	0.88	0.3882	0.0831	0.214
217	165.0	45.0	10.0	1.04	0.3729	0.0777	0.208
218	165.0	45.0	17.4	1.19	0.3593	0.0758	0.211
219	165.0	45.0	20.3	1.24	0.3556	0.0739	0.208
220	165.0	45.0	25.0	1.26	0.3537	0.0614	0.174
221	165.0	60.0	5.7	0.43	0.4390	0.0640	0.146
222	165.0	60.0	10.0	0.53	0.4253	0.0639	0.150
223	165.0	60.0	12.5	0.61	0.4162	0.0684	0.164
224	165.0	60.0	17.4	0.75	0.4007	0.0658	0.164
225	165.0	60.0	20.9	0.87	0.3887	0.0658	0.169
226	165.0	60.0	25.0	1.01	0.3746	0.0635	0.170
227	245.0	30.0	5.7	1.06	0.4087	0.0879	0.215
228	245.0	30.0	10.0	1.38	0.3797	0.0798	0.210
229	245.0	30.0	13.5	1.70	0.3553	0.0888	0.250
230	245.0	30.0	17.4	2.19	0.3247	0.0784	0.242
231	245.0	30.0	20.9	2.55	0.3059	0.0800	0.262
232	245.0	30.0	25.0	2.81	0.2941	0.0698	0.237
233	245.0	45.0	5.7	1.50	0.4163	0.0753	0.181
234	245.0	45.0	10.0	1.69	0.4012	0.0751	0.187
235	245.0	45.0	17.4	1.95	0.3817	0.0688	0.180
236	245.0	45.0	20.9	2.01	0.3770	0.0701	0.186
237	245.0	45.0	25.0	2.01	0.3770	0.0649	0.172
238	245.0	60.0	5.7	0.83	0.4567	0.0599	0.131
239	245.0	60.0	10.0	1.07	0.4299	0.0700	0.163
240	245.0	60.0	17.4	1.61	0.3817	0.0631	0.165
241	245.0	60.0	20.9	1.81	0.3674	0.0640	0.174
242	326.0	30.0	5.7	1.72	0.4175	0.1197	0.287
243	326.0	30.0	10.0	2.24	0.3801	0.1206	0.317
244	326.0	30.0	13.0	2.76	0.3496	0.1114	0.319
245	326.0	30.0	17.4	3.63	0.3105	0.0949	0.306
246	326.0	30.0	20.9	4.29	0.2878	0.0923	0.321
247	326.0	45.0	5.7	2.06	0.3970	0.0820	0.206
248	326.0	45.0	10.0	2.51	0.3677	0.0981	0.267
249	326.0	45.0	17.4	2.91	0.3463	0.0792	0.229
250	326.0	45.0	20.9	2.98	0.3424	0.0798	0.233
251	326.0	60.0	5.0	1.25	0.4577	0.1630	0.356
252	326.0	60.0	5.7	1.30	0.4525	0.2273	0.502
253	326.0	60.0	10.0	1.66	0.4195	0.1602	0.382
TAV 254	326.0	60.0	13.5	1.99	0.3945	0.1403	0.356
255	326.0	60.0	17.4	2.33	0.3716	0.1271	0.342
ATIO 256	326.0	60.0	20.9	2.57	0.3575	0.1068	0.299

APPENDIX 3

THEORETICAL

3. Evaluation of Interfacial Area in Plate Column

3. Evaluation of Interfacial Area in Plate Column

The interfacial areas a' per unit volume of dispersion in foam and froths have been evaluated by Calderbank (80), Golderen (81) and Crozier (82) as

$$a' = \frac{6 H_g}{D_b} \quad (3-1)$$

where ; H_g = volume fraction of gas in dispersion

D_b = bubble diameter

In foams where liquid hold up is low, H_g can be assumed to be 1.0 while in froths, Crozier (82) reported that

$$\ln \frac{1}{1-H_g} = 0.715 F' + 0.45 \quad (3-2)$$

where ; $F' = U_g' (\rho_g')^{\frac{1}{2}}$

U_g' = superficial velocity based on bubbling area
ft/sec

ρ_g' = gas phase density lb/ft³

In plate column, it has been found that superficial gas velocities normally used in industrial plate columns ranged from 1 to 6 ft/sec. Under these conditions, the bubbles are formed at a rate of 20 bubbles per sec (16,80). At low gas and liquid rates ($U_g' < 2$ ft/sec), bubbles rose with its formation sizes and cellular foams were formed. Calderbank (16) showed that under these conditions,

$$D_p = \frac{0.15}{4\pi} \left(\frac{G_s}{M_p} \right)^{1/3} \quad (3-3)$$

where ; G_s = gas flow rate cc/sec

M_p = total number of orifice or slot per tray

At high gas rate, bubbles collapsed as has been reported (80) and froths of smaller bubbles were formed. Calderbank (80) reported that the froths contained only bubbles whose radii from experimental measurement were about 0.45 cm. Hence, with $D_p = 0.45$ cm, a' in froths from equations (3-1) and (3-2) were as in figure (3-1). These values of a' were however several times higher than those reported by Porter (18) who considered that the majority of bubble size in froths was similar to those at formation and a' was also given by equations (3-1) and (3-3).

In selecting the equation to use for evaluation of a' mass transfer coefficients were calculated for the methanol-water system (19). When using the model proposed by Porter (18), K_{OG} values were higher than those reported for single rising bubbles into a liquid pool (20) although the reported efficiency data for the froths were lower than those observed for single bubbles (20). Porter model was hence considered invalid. This was confirmed by the work of Dillon and Harris (83) who found that in froths D_p values approached those suggested by Calderbank (80).

VARIATIONS OF CALCULATED GAS HOLD UP AND MASS TRANSFER
EFFECTIVE AREA WITH F-FACTOR IN FROTHS

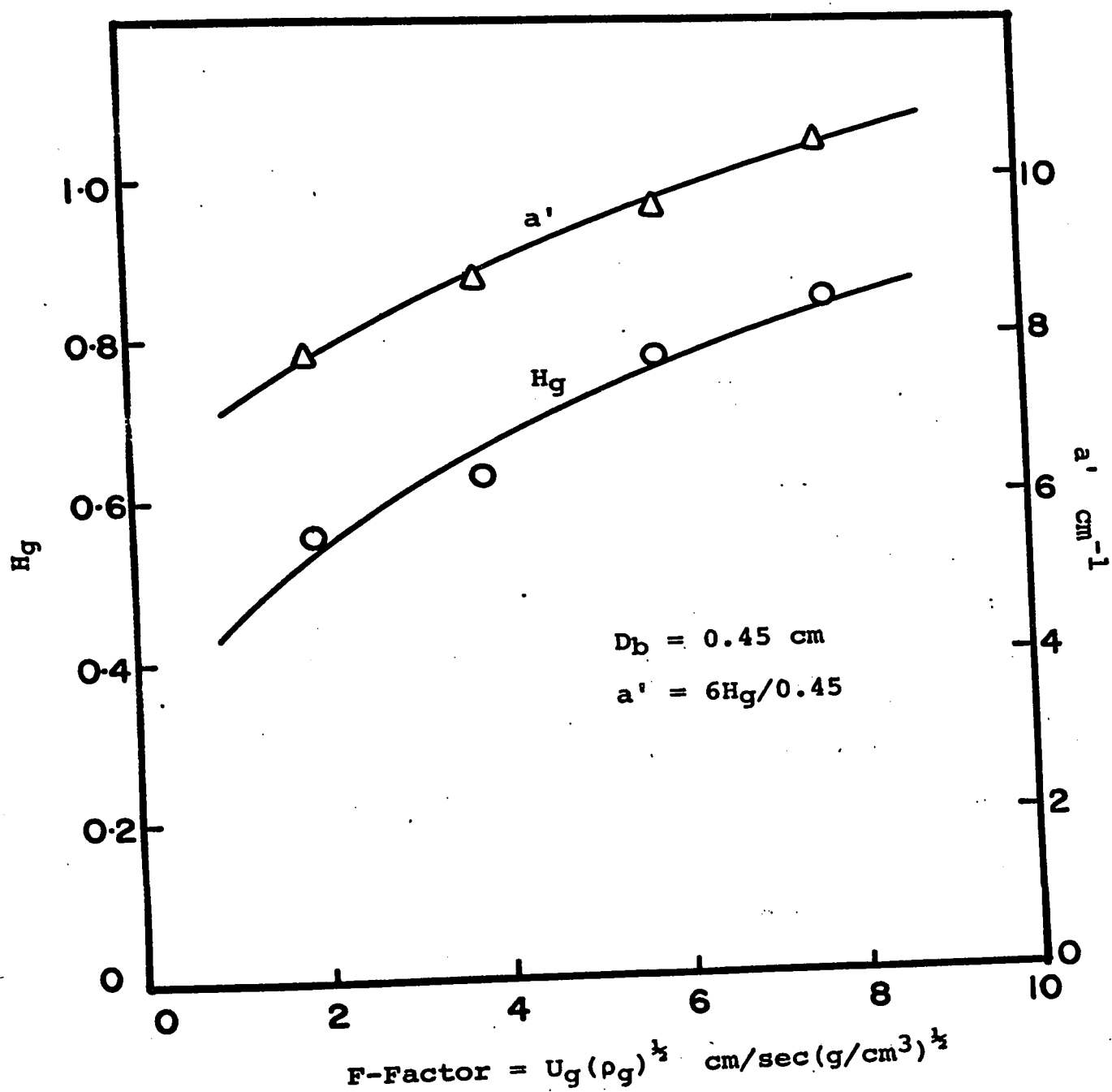


Figure 3-1

APPENDIX 4

SLUG FLOW CHARACTERISTICS

- 4-A. Surface Tension and Viscosity Effects on Slug Shape
- 4-B. Correlation of Slug Surface Area to Volume Ratios
- 4-C. Correlation of Slug Rise Velocities
- 4-D. Formation Bubble Length and The Slug Developing Region

4-A. Surface Tension and Viscosity Effects on Slug Shapes

White and Beardmore (33) and Brown (31) have studied the effect of surface tensions and liquid viscosities on the slug rise velocities in stagnant liquids. Brown and other investigators (5,29,32) further found that the slug rise velocity was the unique function of the frontal curvature of the slug nose. It was then proposed that the effects of surface tension and viscosity on slug rise velocity or shape would be negligible if the following conditions are fulfilled :

White and Beardmore (33) - negligible liquid viscosity effect

$$\text{if } \frac{\rho_L^2 g D_p^3}{\mu_L} > 3 \times 10^5 \quad (4-1)$$

Brown (32) - negligible surface tension effect

$$\text{if } \frac{\rho_L g R^2}{\sigma} \left(1 - \frac{\delta_o}{R}\right)^2 > 5.0 \quad (4-2)$$

$$\text{where } \delta_o = \frac{-1 + (1 + 2\bar{N}R)^{\frac{1}{2}}}{\bar{N}}$$

$$\bar{N} = \left(14.5 \frac{\rho_L^2 g}{\mu_L^2} \right)^{1/3}$$

and assumption of potential flow around the slug nose region is valid if

$$2\bar{N}R > 60.0 \quad (4-3)$$

Calculations of the L.H.S. of equation (4-1), (4-2) and (4-3) in this study were illustrated in the following Table 4-1.

Table 4-1

Surface Tension and Viscosity Parameters Proposed by White and Beardmore (33) and Brown (32)

Solvent	D_p cm	$2NR$	$\frac{\rho g R^2}{\sigma} (1 - \frac{\delta_o}{R})$	$\frac{\rho_L g D_p^3}{\mu_L}$
Heavy Paraffin Oil	1.0	17.53	2.44	844
	0.793	13.90	1.37	421
	0.594	10.46	0.66	179
Light Paraffin Oil	1.000	39.70	3.35	9784
	0.793	30.90	1.89	4579
	0.594	23.17	0.95	1998

As can be seen from these results surface tension and viscosity effects cannot be neglected in this study and would be expected to affect slug shape and rise velocity.

4-B. Correlation of Slug Surface Area to Volume Ratios

As described previously, when the results of $\ln(\bar{A}_S/\bar{V}_S)$ were plotted against the absorber length H , each curve could be considered as made up of two parts, $\Delta(\bar{A}_S/\bar{V}_S)_H$ and $(\bar{A}_S/\bar{V}_S)_C$ which were dependent and independent of H , i.e.:

$$\left(\frac{\bar{A}_S}{\bar{V}_S}\right) = \Delta\left(\frac{\bar{A}_S}{\bar{V}_S}\right)_H + \left(\frac{\bar{A}_S}{\bar{V}_S}\right)_C \quad (4-4)$$

In addition to H , $(\bar{A}_S/\bar{V}_S)$ was expected to depend on the gas flow rate, liquid flow rate, absorber diameter and liquid viscosity. The dependence of $(\bar{A}_S/\bar{V}_S)_C$ on gas flow rate G

liquid viscosity μ_L and tube diameter D_p were shown in figure 4-1. Normally only a slight dependence of $(\bar{A}_S/\bar{V}_S)$ on liquid flow rate Q_L was observed but at the lowest gas rate and high liquid rate, the ratios increased rapidly with increasing Q_L due to the fact that slugs under these conditions were usually small and spherical cap in shape. Consequently, the results of the ratios at different Q_L were correlated separately.

From the linear dependence of $(\bar{A}_S/\bar{V}_S)_C$ on G , μ_L and D_p , figure 4-1, the effects of these variables on $(\bar{A}_S/\bar{V}_S)_C$ could be readily determined by simple substitution. The final equation for $(\bar{A}_S/\bar{V}_S)_C$ obtained was

$$(\bar{A}_S/\bar{V}_S)_C = q_C - a_1 D_p + \mu_L (a_5 + a_4 D_p) - G (a_6 \mu_L + a_2) \quad (4-5)$$

where ; $q_C = 0.793 a_1 + 326 a_2 + (\bar{A}_S/\bar{V}_S)_I + 142 a_3$

and a_1, a_2, a_3, a_4, a_5 and a_6 are constants. $(\bar{A}_S/\bar{V}_S)_I$ was the selected value of $(\bar{A}_S/\bar{V}_S)_C$ at $G = 326$ cc/min for the n-Hexane-Nitrogen-Heavy Paraffin Oil system and in the 0.793 cm I.D. absorber. The effect of the absorber length on $(\bar{A}_S/\bar{V}_S)_H$ was then determined and $(\bar{A}_S/\bar{V}_S)_H$ expressed as Be^{-bH} , with B being the a function of G, μ_L and D_p or

$$\Delta \left(\frac{\bar{A}_S}{\bar{V}_S} \right)_H = k_C G^g \mu_L^u D_p^d e^{-bH} \quad (4-6)$$

The constant g, u and d were evaluated using the linear regression techniques. The general equation obtained was as

EFFECT OF GAS RATE G , LIQUID VISCOSITY μ_L

AND ABSORBER DIAMETER ON $(\bar{A}_g/\bar{V}_g)_c$

System : n-Hexane-Nitrogen-Paraffin Oil

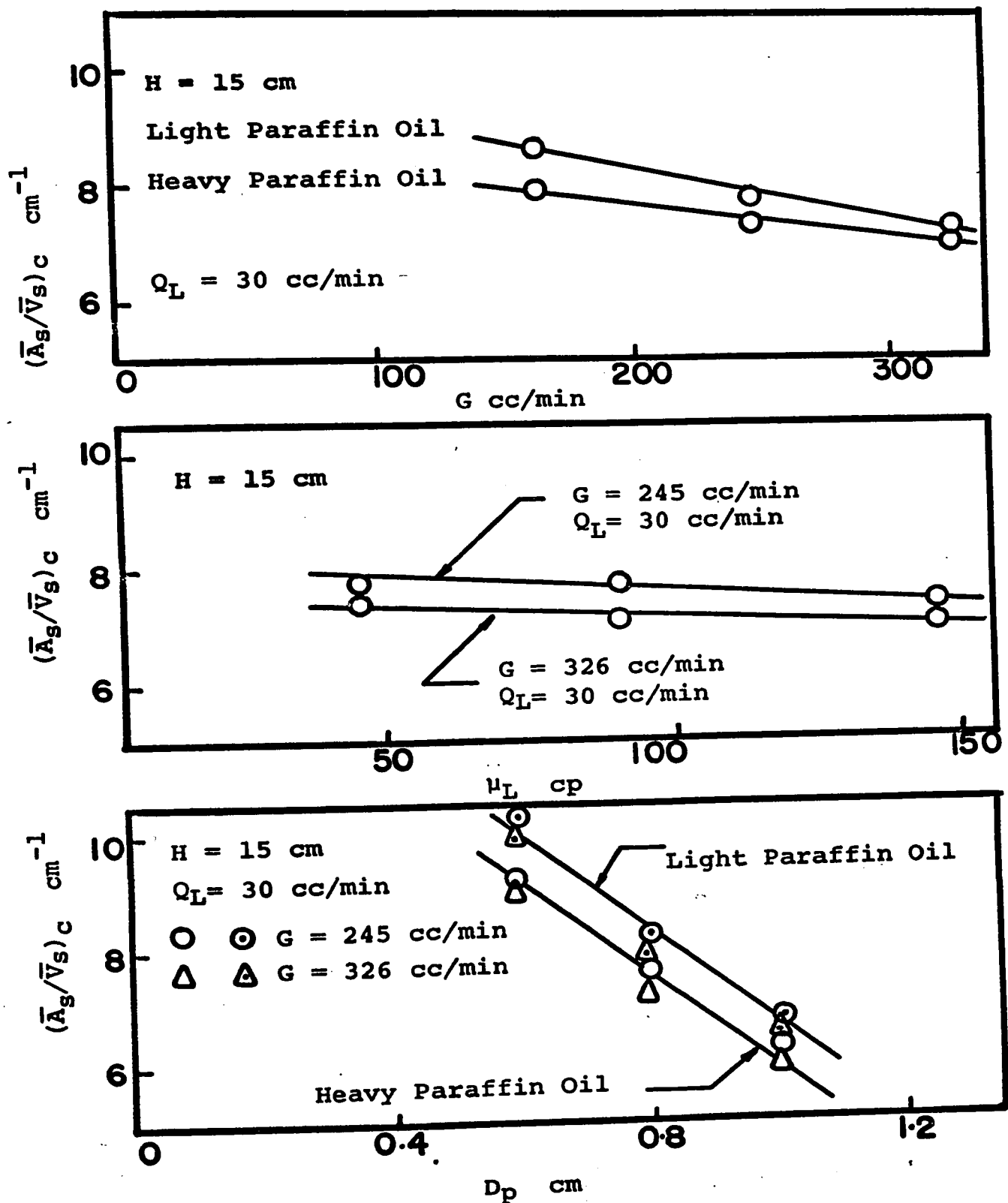


Figure 4-1

reported previously, page 83,

$$\begin{aligned}
 (\bar{A}_S/\bar{V}_S) = & 16.0 - \{8.35D_p + 9.2 \times 10^{-3} \mu_L \\
 & + 0.33G_S (1.0 - 0.0037\mu_L)\} \\
 & + 4.3 \times 10^3 G_S^{-4.1} \mu_L^{-0.57} e^{-0.11H} \quad (4-7)
 \end{aligned}$$

Where $G_S = G/60$ cc/sec.

4-C. Correlation of Slug Rise Velocities

It was found that the rise velocities for non-coalescing slugs in this study were not well correlated by a two constant equation (II-7) as had been used by previous investigators, figure (4-2), in which (U_S/U_L) was plotted against $(g_c D_p)^{1/2}/U_L$. This was because in addition to G , Q_L and D_p , the effects of μ_L , σ , ρ_g and H on U_S were also important. Consequently, a correlation based on a similar form i.e. $U_S = C_1 U_L + C_0 (g_c D_p)^{1/2}$, was attempted by considering C_1 constant and allowing C_0 to vary such that the effects of liquid phase viscosity, surface tension, gas phase density, flow rates and absorber length on U_S could be taken into account.

In the equation, $U_S = C_1 U_L + C_0 (g_c D_p)^{1/2}$, Brown (32) has suggested that the group $(g_c D_p)^{1/2}$ or $(g_c R)^{1/2}$ can be written in the more general form as $(g_c r_o)^{1/2}$ with r_o being the slug nose radius. As r_o has been shown (32) to be the linear function of R_c or $(R - \delta_o)$ as $r_o = \zeta R_c$, it would be more convenient to express $(g_c r_o)^{1/2}$ in the following form :

$$(g_c r_o)^{1/2} = (g_c \zeta R_c)^{1/2} = (g_c R)^{1/2} \left(\zeta \frac{R_c}{R} \right)^{1/2}$$

COMPARISON OF SLUG RISE VELOCITIES

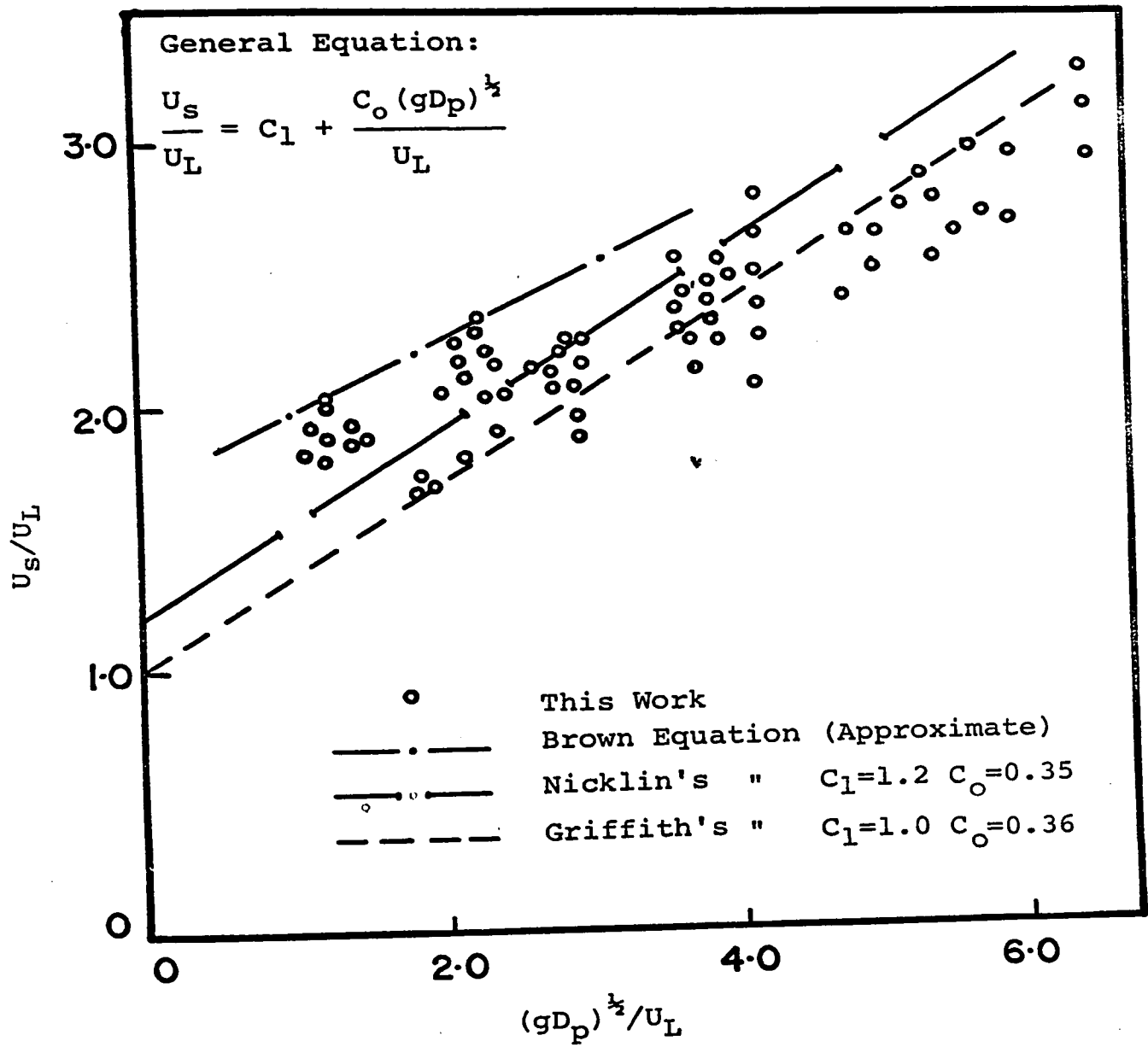


Figure 4-2

$$= 4(g_c D_p)^{1/2} (\zeta \beta)^{1/2} = C_o (g_c D_p)^{1/2} \quad (4-8)$$

where ; $\beta = (R_c/R)^2$

$$R_c = R - \delta_o$$

Street (36) has shown that

$$\beta = f(U, N_{We}, Z_D, N_{Fr}/N_{Re}) \quad (4-9)$$

where ; $U = (U_s - U_L)/U_s$

$$N_{Fr} = U_s^2 / g_c D_p$$

$$N_{Re} = D_p U_s \rho_L / \mu_L$$

$$N_{We} = U_s^2 \rho_L D_p / \sigma$$

$$Z_D = \ell g_c / U_s$$

As ζ and β are both the function of similar variables, $(\zeta \beta)^{1/2}$ might be also expected to be the function as $f'(U, N_{We}, Z_D, N_{Fr}/N_{Re})$ or

$$(\zeta \beta)^{1/2} = f'(U, N_{We}, Z_D, N_{Fr}/N_{Re}) \quad (4-10)$$

As $\beta = (1 - \delta_o/R)^2$ with δ_o being the equilibrium laminar liquid film thickness, δ_o is independent of ℓ . Further, since U_s in this study was found to virtually have no effect on δ_o , see Table 4-2, it could be further assumed that δ_o was also independent of U_s and the group $Z_D = \ell g_c / U_s$ in equation (4-10) could be omitted. The group U or $(U_s - U_L)/U_s$ representing the effects of fluid flow rates could be further expressed as $\{1.0 - \frac{1.0}{U_s/U_L}\}$ which, as U_s is an unknown quantity, was further

Table 4-2

Effects of Flow Rates and Liquid Viscosity on Equilibrium

Liquid Film Thickness

H = 15 cm

System : n-Hexane-Nitrogen-Paraffin Oil

D_p cm G cc/min Q_L cc/min U_s cm/sec δ_o^1 cm δ_o^2 (36) cm

Heavy Paraffin Oil

0.594	245	30	30.85	0.085	0.081
0.793	165	30	16.77	0.101	0.114
0.793	165	60	16.88	0.101	0.107
0.793	245	30	20.59	0.101	0.108
0.793	245	60	22.87	0.101	0.108
0.793	326	30	27.59	0.101	0.111
0.793	326	60	28.60	0.101	0.108
1.000	245	30	18.84	0.112	0.140

Light Paraffin Oil

0.594	245	30	30.77	0.067	0.068
0.793	165	30	15.88	0.090	0.098
0.793	165	60	18.76	0.090	0.101
0.793	245	30	21.85	0.090	0.100
0.793	245	60	22.68	0.090	0.097
0.793	326	30	24.91	0.090	0.094
0.793	326	60	25.60	0.090	0.091
1.000	245	30	16.67	0.109	0.119

where δ_o^1 and δ_o^2 are the experimental and theoretical equilibrium liquid film thickness respectively.

approximated as $(1.0 - \frac{1.0}{G/Q_L})$ or $(1 - 1/R_v)$. In addition, U_s also appeared in the other dimensionless groups but it was ~~however not a convenient quantity for use in calculations of~~ these groups. In practice, U_s is replaced by U_g (3), the superficial gas phase velocity and in this investigation, U_s was found to be approximately linearly proportional to U_g or G_s/A_p . In addition, gas phase density ρ_g and absorber length H also affected rise velocity and the effects could be taken into account by the dimensionless groups, (ρ_g/ρ_L) and (H/D_p) respectively. Therefore C_0 or $4(\zeta\beta)^{1/2}$ can be assumed to be the function as

$$C_0 = f\{N_{Re}, (1-1/R_v), N_{Fr}, N_{We}, (\rho_g/\rho_L), (H/D_p)\}$$

$$\text{or } C_0 = k_0 N_{Re}^a (1 - 1/R_v)^b N_{Fr}^c N_{We}^d (\rho_g/\rho_L)^e (H/D_p)^f$$

where k_0 , a , b , c , d , e and f are constants.

$$U_s = C_1 U_L + \{k_0 N_{Re}^a (1 - 1/R_v)^b N_{Fr}^c N_{We}^d (\rho_g/\rho_L)^e (H/D_p)^f\} (g D_p)^{1/2} \quad (4-11)$$

It was obvious that C_1 had to be known before the constants a , b , c , d , e and f could be evaluated by linear regression method. C_1 was determined by trial and error method the minimum deviation being evaluated for a value C_1 equal to 1.2 as showed below,

C_1	Mean Square Deviation
1.0	1.99
1.2	1.86
1.4	2.01
1.6	2.07

Consequently, the final correlation for U_s was

$$U_s = 1.2 U_L + \{0.0819 (1 - 1/R_v)^{-0.798} N_{Re}^{-0.0575} N_{We}^{0.512} N_{Fr}^{-0.102} (\rho_g/\rho_L)^{-0.163} (H/D_p)^{0.099}\} (g D_p)^{1/2} \quad (4-12)$$

$$\text{or } U_s \approx 1.2 U_L + \{0.098 (1 - 1/R_v)^{-0.8} N_{We}^{0.5} N_{Fr}^{-0.1} (\rho_g/\rho_L)^{-0.16} (H/D_p)^{-0.1}\} (g D_p)^{1/2} \quad (4-13)$$

mean square deviation = 1.86

The experimental and predicted values of U_s were compared in figure 4-3.

It was found that when the effects of fluid flow rates, ρ_g , U_L and H on C_o were accounted for, $C_o / (1 - \frac{1}{R_v})^{-0.18} (\frac{\rho_g}{\rho_L})^{-0.16} (\frac{H}{D_p})^{-0.1}$ tended to approach a limiting value of 0.35 as σ decreased or $N_{We}^{0.5} N_{Fr}^{-0.1}$ increased, see figure 4-4. The correlation was then reduced to the fully developed equation $U_s = 1.2 U_L + 0.35 (g D_p)^{1/2}$, proposed by Nicklin et al (5).

4-D. Formation Bubble Length and the Slug Developing Region

D-1. Formation Bubble Length

Formation bubble lengths, h_o were required before the actual contact time between the slug and liquid during the

COMPARISON OF EXPERIMENTAL AND PREDICTED
SLUG RISE VELOCITIES

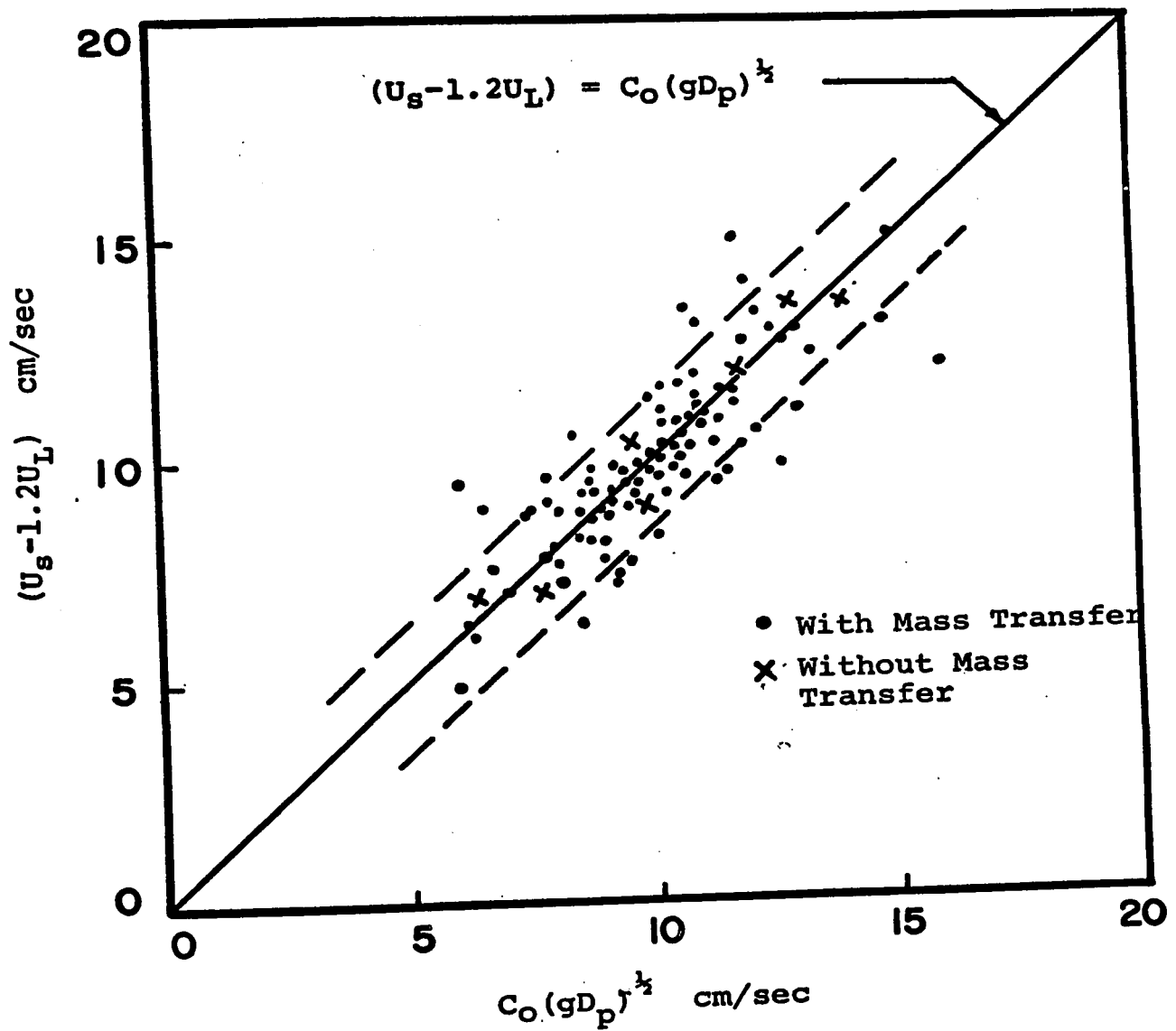


Figure 4-3

LIMITING VALUE OF C_o

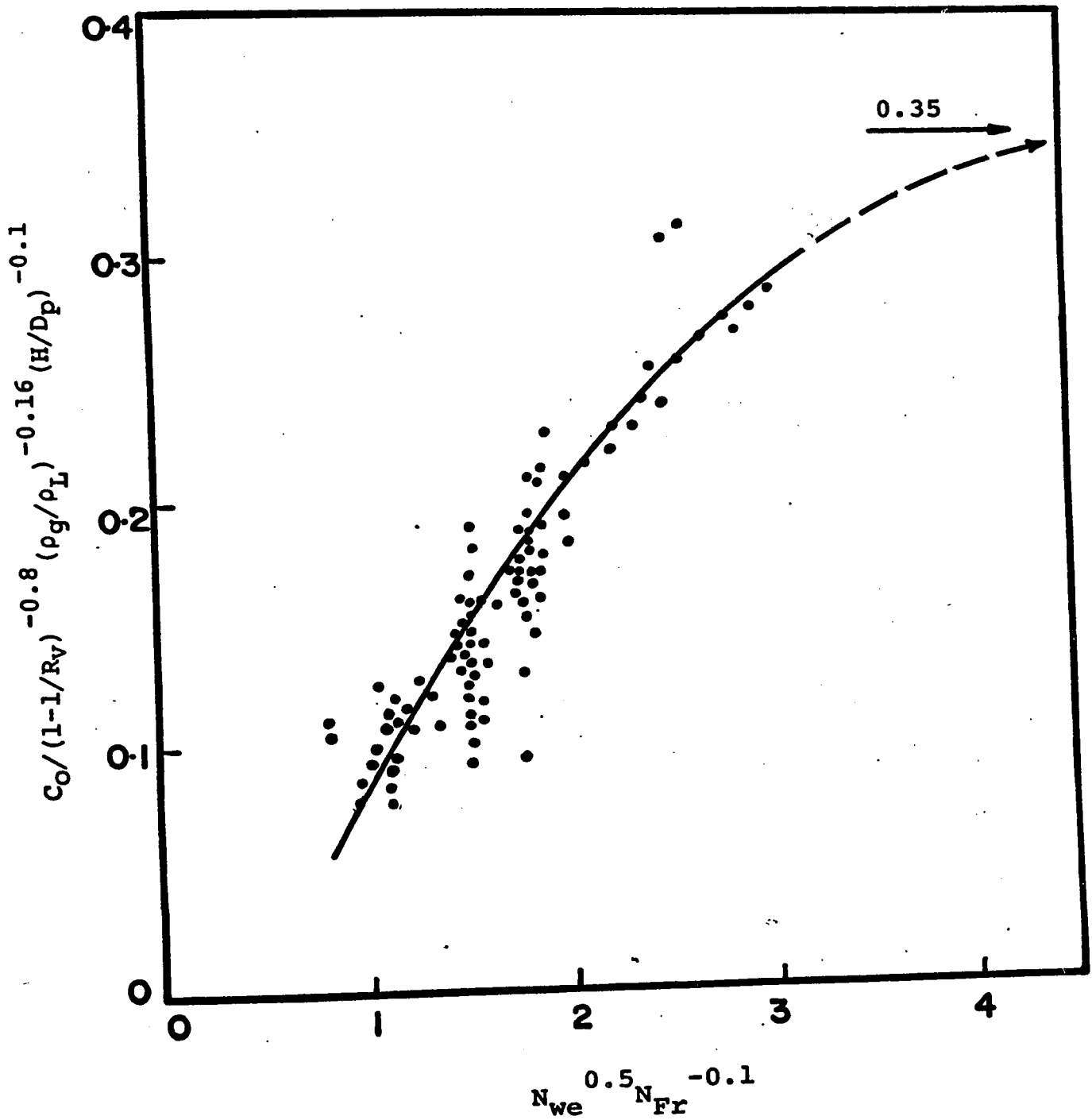


Figure 4-4

rise period could be evaluated from the equation $\theta_z = \frac{H-h_o-W}{U_s}$. They were measured from the photographs taken and found to depend on gas rate, absorber diameter and liquid phase viscosity, figure 4-5. h_o increased with increasing gas rate and liquid viscosity but decreased with absorber diameter. Further, they were also observed to be slightly affected by liquid rate and absorber length. The effect of H on h_o was illustrated in Table 4-4.

Table 4-3
Effect of Absorber Length H on Formation Bubble Length h_o

Liquid Solvent	G cc/min	Q_L cc/min	H cm	h_o cm
Heavy Paraffin Oil	245	30	15	0.91
	245	30	40	1.01
	326	30	15	1.49
	326	30	40	1.18
Light Paraffin Oil	245	30	15	0.65
	245	30	40	0.71
	326	30	15	1.05
	326	30	40	0.80

Hence, as an approximation, let

$$h_o \propto f(G, Q_L, \mu_L, H, D_p)$$

By linear regression method,

$$h_o = 0.84 \times 10^{-3} G^{0.937} Q_L^{-0.049} \mu_L^{0.307} H^{0.047} D_p^{-0.647} \quad (4-14)$$

or

VARIATION OF FORMATION BUBBLE LENGTH

h_o WITH GAS FLOW RATE G

System : n-Hexane-Nitrogen-Paraffin Oil

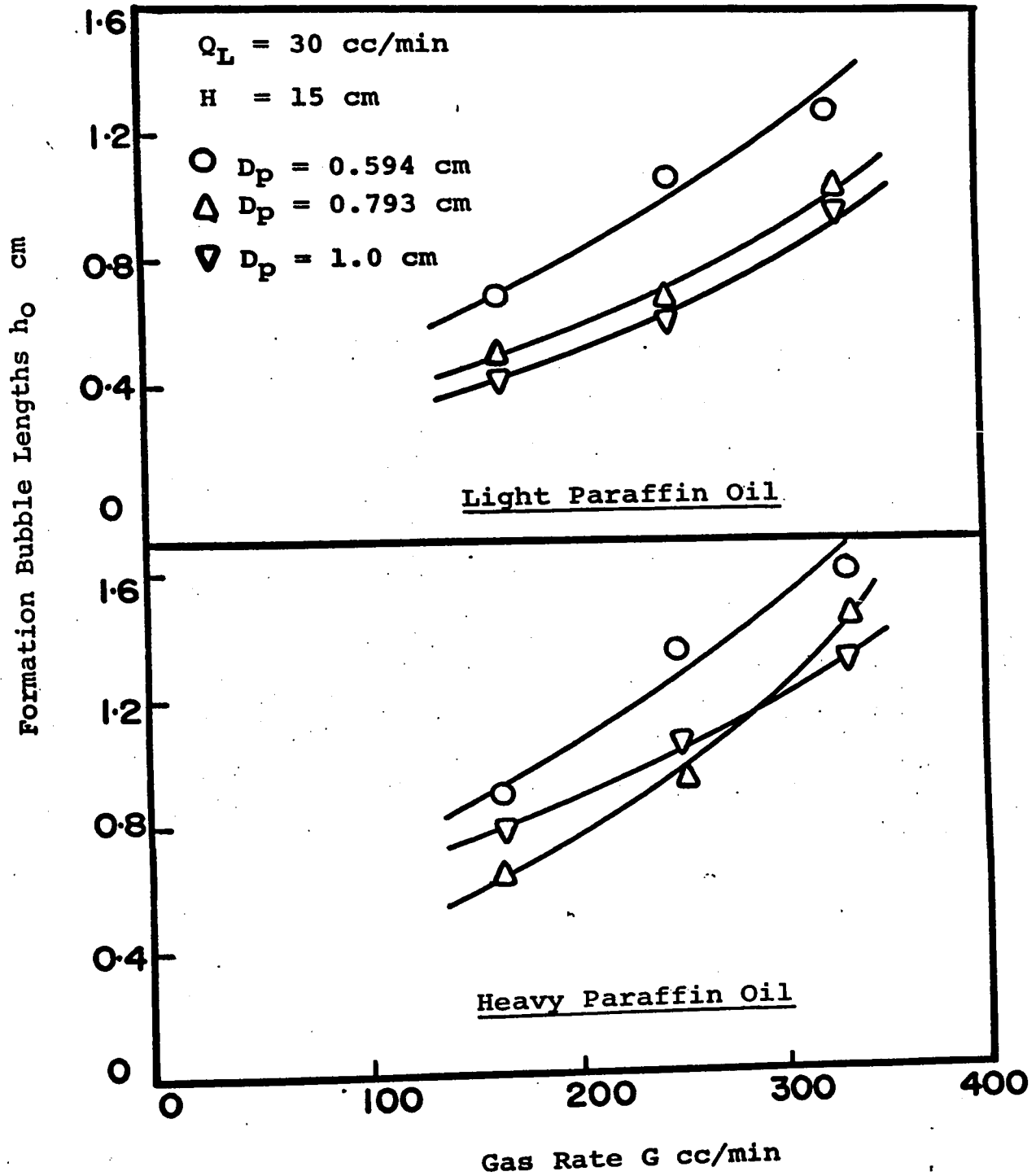


Figure 4-5

$$\approx 0.054 (G_S \mu_L^{0.3} / D_p^{0.7})$$

where $G_S = G/60.0$, with a mean square deviation of ± 0.17 . The predicted and experimental values were compared in figure 4-6.

Equation (4-14) was also used to evaluate h_o values for the runs with helium and Freon-14 carrier gases even though h_o was dependent on ρ_g as the error involved did not greatly affect the results of contact time in the mass transfer calculations.

D-2. Slug Developing Region

After formation, the bubbles became detached from the top of the capillary and entered a region in which rapid bubble coalescence took place. The coalescence characteristics in this region can be considered to be different from those of slugs in the upper part of the absorber. The length of this region W also required for the evaluation of rise period contact time and the values of W were measured from the photographs and found to scatter randomly ranging from 1.8 to 0.9 cm. An average value was determined for all the readings and found to be equal to 1.5 cm.

COMPARISON OF EXPERIMENTAL AND PREDICTED FORMATION

BUBBLE LENGTHS

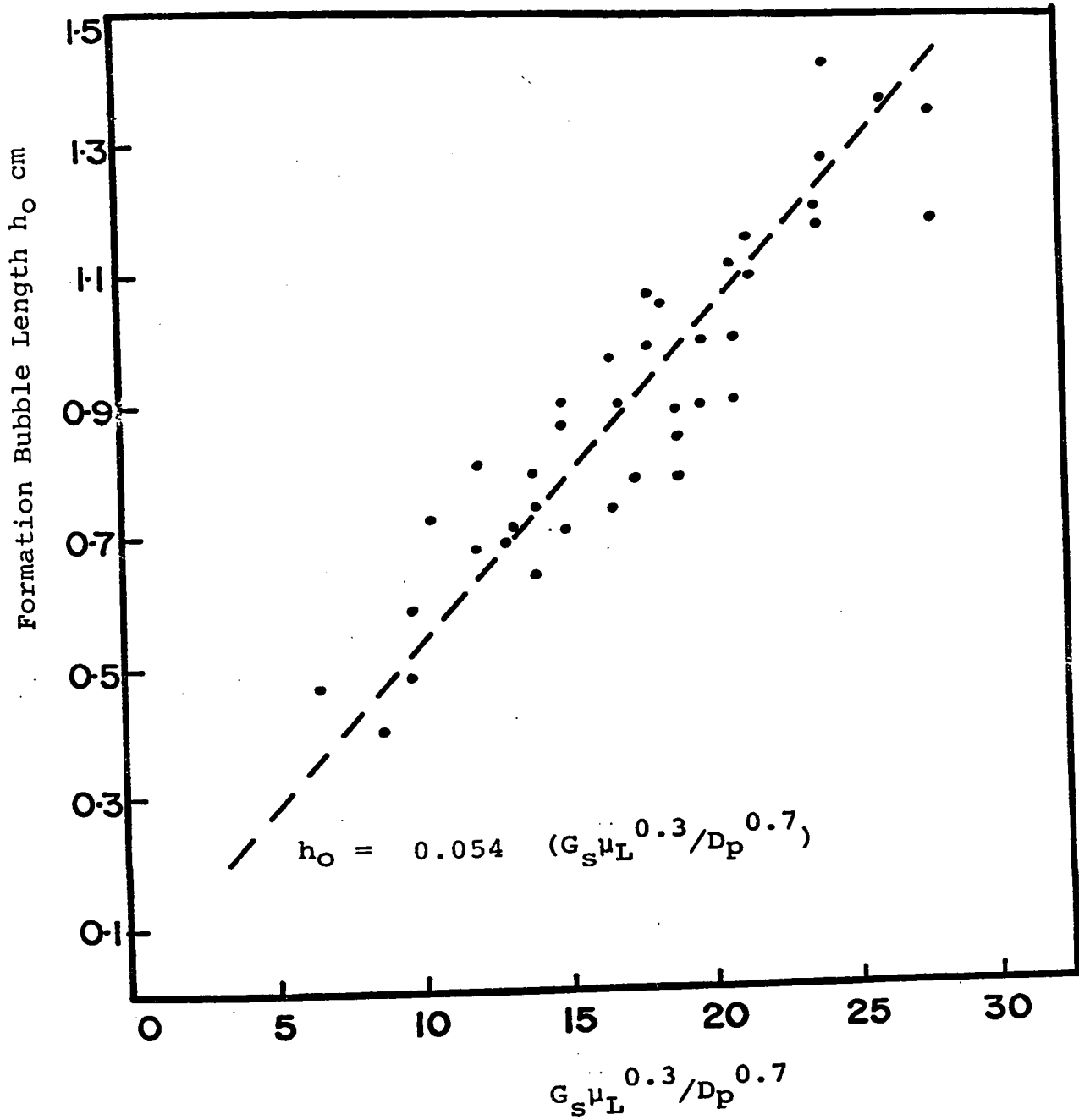


Figure 4-6

APPENDIX 5

EXPERIMENTAL DETAILS AND EQUIPMENT SPECIFICATIONS

- 5-A. Measurement of Gas Phase Concentration
- 5-B. Saturation of Carrier Gas With Hexane
- 5-C. Mean Volumetric Gas Flow Rates
- 5-D. Distortion of the Slug Images
- 5-E. Equipment specifications

5-A. Measurement of Gas Phase Concentration

The concentration of hexane in the gas phase was determined from thermal conductivity measurements using a Gow-Mac T.C. cell.

The temperature of the T.C. cell was maintained at around 30°C by placing it in an aluminum container filled with asbestos. The inside of the container was heated by means of a heating tape and the temperature control was achieved by attaching the tape to a temperature controller. The current supply to the T.C. cell was from a Gow Mac power supply controller unit.

The cell was initially calibrated by passing carrier-hexane gas mixture of various known compositions through one side of the cell and pure nitrogen through the reference side of the cell and measuring the cell imbalance with potentiometer. The saturated gas mixtures were prepared by passing carrier gases through liquid phase in the saturators as previously described. The variation in composition was achieved by changing the temperature of the second water bath.

It was previously found that the current passing through the cell affected the magnitude of imbalance while the optimum current was 150 milliamperes (12). In this study, for all the experiments the current to the T.C. cell was set constant at 150 milliamperes. The gas flow rate was found to have virtually no effect on the cell imbalance. With nitrogen and helium identical calibration curves were obtained, but with Freon-14 the opposite effects of vapor composition on the thermal conductivity of the mixture was observed. Two cali-

bration curves were shown in figure 5-1. The Freon-14 curve, though had been repeated several times, had to be carefully checked because of the apparent inconsistency in T.C.cell millivolt reading at zero hexane composition. Hexane compositions less than one percent in the calibration curve were determined by condensing the hexane in the dry ice traps after the gas mixtures passing through the absorber. Only a limited number of experimental runs were made using the Freon-14 as the carrier gas.

The gas mixtures after the saturators were also tested for saturation by condensing the hexane vapor in the gas in the dry ice traps. Further, the T.C.cell imbalances were found to be negligible when nitrogen and helium gases were bubbled through the paraffin oil respectively at room temperature while with pure Freon-14, the cell imbalance was about 2.0 to 2.5 M.V. which had to be accounted for in the millivolt reading of the mass transfer runs.

5-B. Saturation of Carrier Gas With Hexane

In general, complete saturation of an inert gas with the vapor of a liquid has been assumed after passing an inert gas through a column of liquid. However, it has been found (85) that complete saturation could not always be assumed and the degree of saturation was largely dependent on the gas flow rate and residence times of the inert gas through the liquid column. In order to check that the gas phase was saturated with hexane, tests were made to determine the range of gas

CALIBRATION CURVES OF T.C.CELL

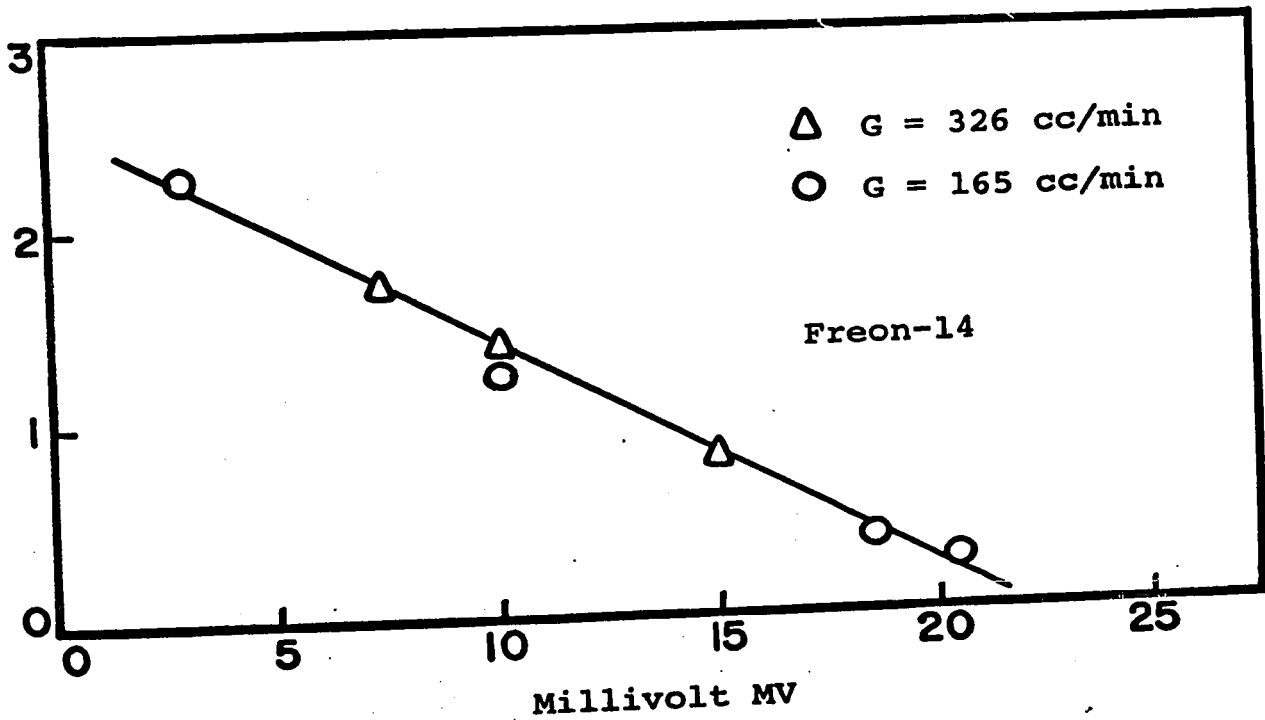
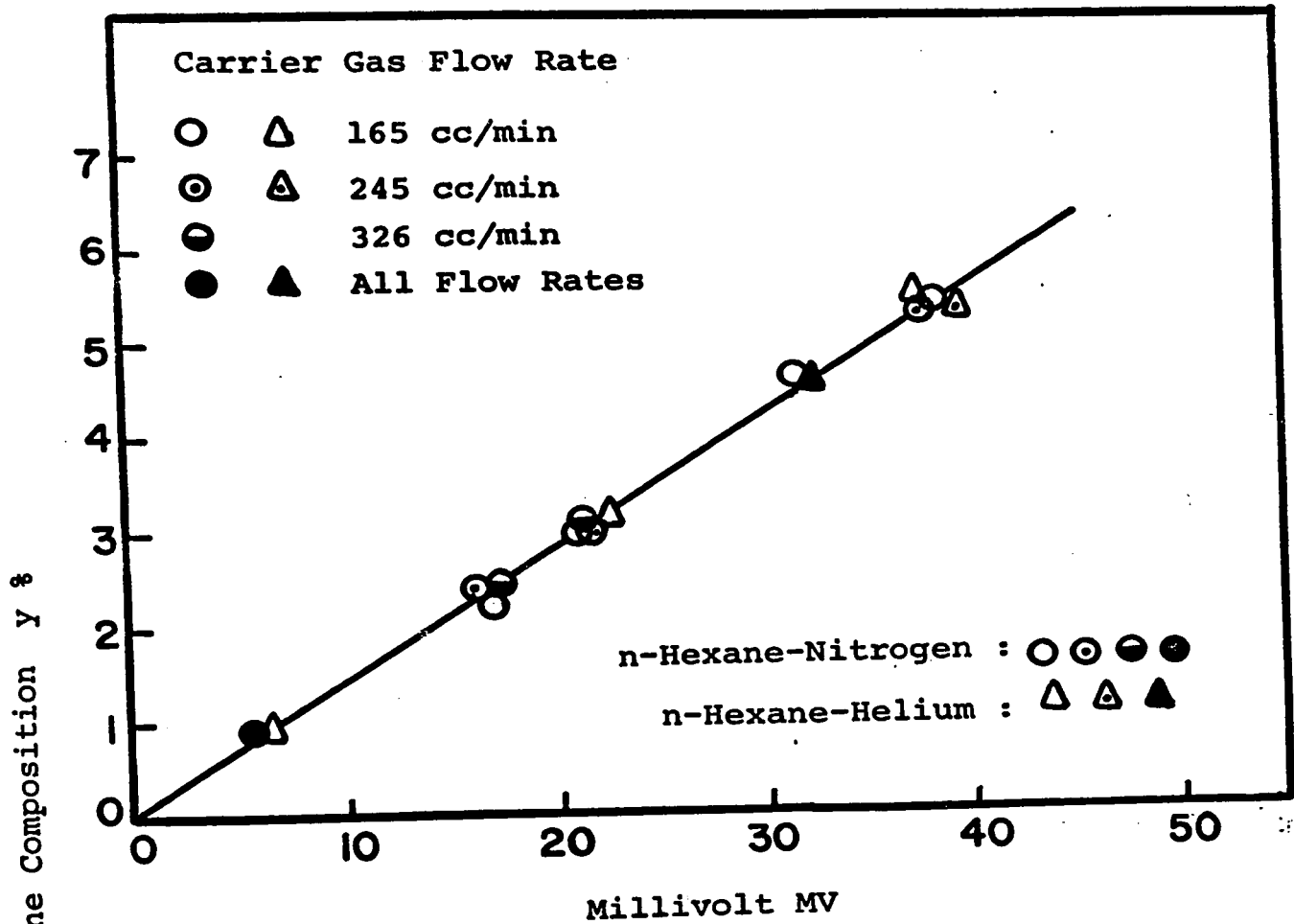


Figure 5-1

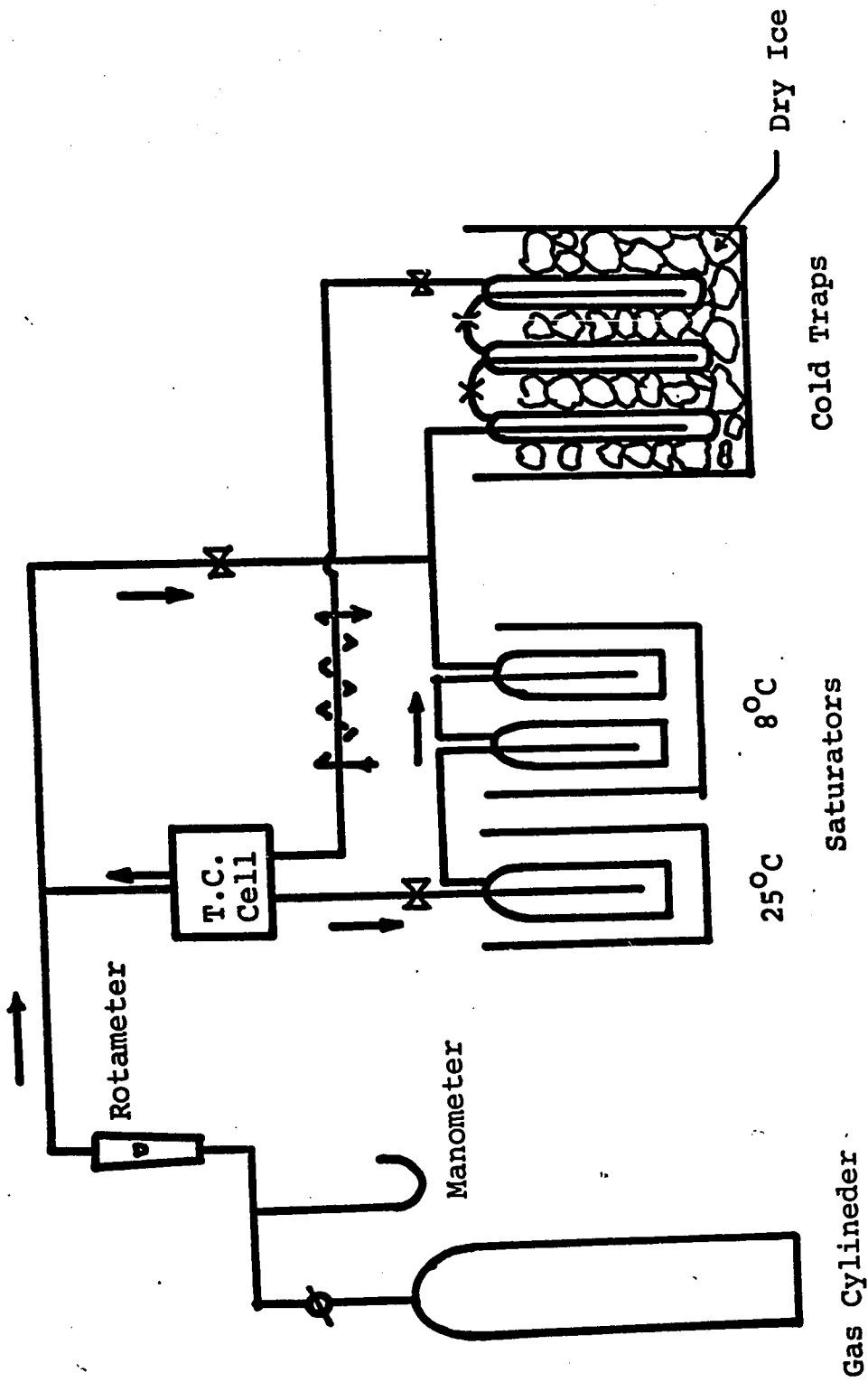
flow rate over which complete saturation of the carrier gas could be expected to take place.

A schematic apparatus used for the tests is shown in figure 5-2. Inert carrier gas flowing at a known rate entered the saturators placed in the baths at 25 and 8°C respectively. After passing through the saturators, the gas mixture was condensed in a series of dry ice traps at about -78°C. The outlet gas was then heated to room temperature and entered the T.C.cell for analysis. The condensate collected in each of the traps was weighed and the composition of hexane in the gas phase calculated. This was compared with that calculated assuming that the inert gas was completely saturated with hexane after passing through the saturator, Table 5-1.

Table 5-1
Degree of Saturation of Inert Gas With Hexane Vapor

G cc/min	Y _{on} m.f.	Hexane Calc. moles	Hexane Con- densed moles	percent Saturation
137.53	0.0926	0.01706	0.01705	99.89
135.50	0.0904	0.01678	0.01644	99.20
256.70	0.0903	0.03049	0.02974	99.50
488.00	0.0902	0.05944	0.05880	99.00
506.00	0.0902	0.06880	0.06840	99.60
709.70	0.0912	0.13660	0.13990	102.50

It was decided therefore that the inert gas flow rate should be maintained below 500.0 cc/min to ensure complete



SCHEMATIC DIAGRAM OF APPARATUS USED FOR SATURATION TEST

Figure 5-2

saturation of the gas phase with hexane after passing through the saturators.

5-C. Mean Volumetric Gas Flow Rates

The gas flow rates employed in this study as noted previously ranged from 165 to 326 cc/min and were the average gas flow rates at the inlet and outlet of the absorber as illustrated in Table 5-2.

Table 5-2

Mean Volumetric Flow Rate

atmospheric pressure = 760 mm Hg

room temperature = 25°C

$Q_L = 30$ cc/min

$D_p = 0.793$ cm

G_f cc/min ($Z = H$)	Y_{on} m.f.	H cm	ΔP_T mm Hg	$G_{Q_{Z=0}}$ cc/min	G cc/min (mean)
320.5	0.023	10.0	3.24	325.6	322.6
		40.0	11.74	322.1	320.7
	0.053	10.0	3.24	335.9	327.7
		40.0	11.74	332.2	325.9
	0.073	10.0	3.24	343.2	331.3
		40.0	11.74	339.4	329.5

Average $G = 326.29 \approx 326$

5-D. Distortion of the Slug Images

In order to have an accurate measurement of the slug size from the slug image projected on a calibrated screen,

the extent of distortion of the slug image by the absorber tube had to be determined. A distortion test was made in the following manner. A small and round rod was used as an object. Its length and size were first measured by a cathetometer. Then, it was placed into the center of the absorber and the size was again measured. Hence, the difference of the two measurement is simply the degree of distortion.

Exact length of the rod = 4.0 cm

O.D. of the rod = 0.361 cm

I.D. of the absorber = 0.793 cm

Apparent length of the rod in the absorber = 4.0 cm

Apparent O.D. of the rod in the absorber = 0.353 cm

$$\begin{aligned}\text{Percentage of distortion} &= \left(1 - \frac{0.353}{0.361} \right) \times 100\% \\ &= 2.27\%\end{aligned}$$

5-E. Equipment Specifications

a. Milroyal D Controlled Volume Pump

Manufacturer : Milton Roy Company

Model : DB-1-60R

Specifications : Maximum discharge rate = 135 cc/min

Accuracy : $\pm 1\%$ of mean delivered volume

(see calibration curve in figure 5-3)

b. Thermal Conductivity Cell

Manufacturer : Gow-Mac Instrument Company

Model : 9454

Specification : Detector element : 4 Tungsten filaments

Response Speed : 10 sec

CALIBRATION CURVE OF MILROYAL D

CONTROLLED VOLUMETRIC PUMP

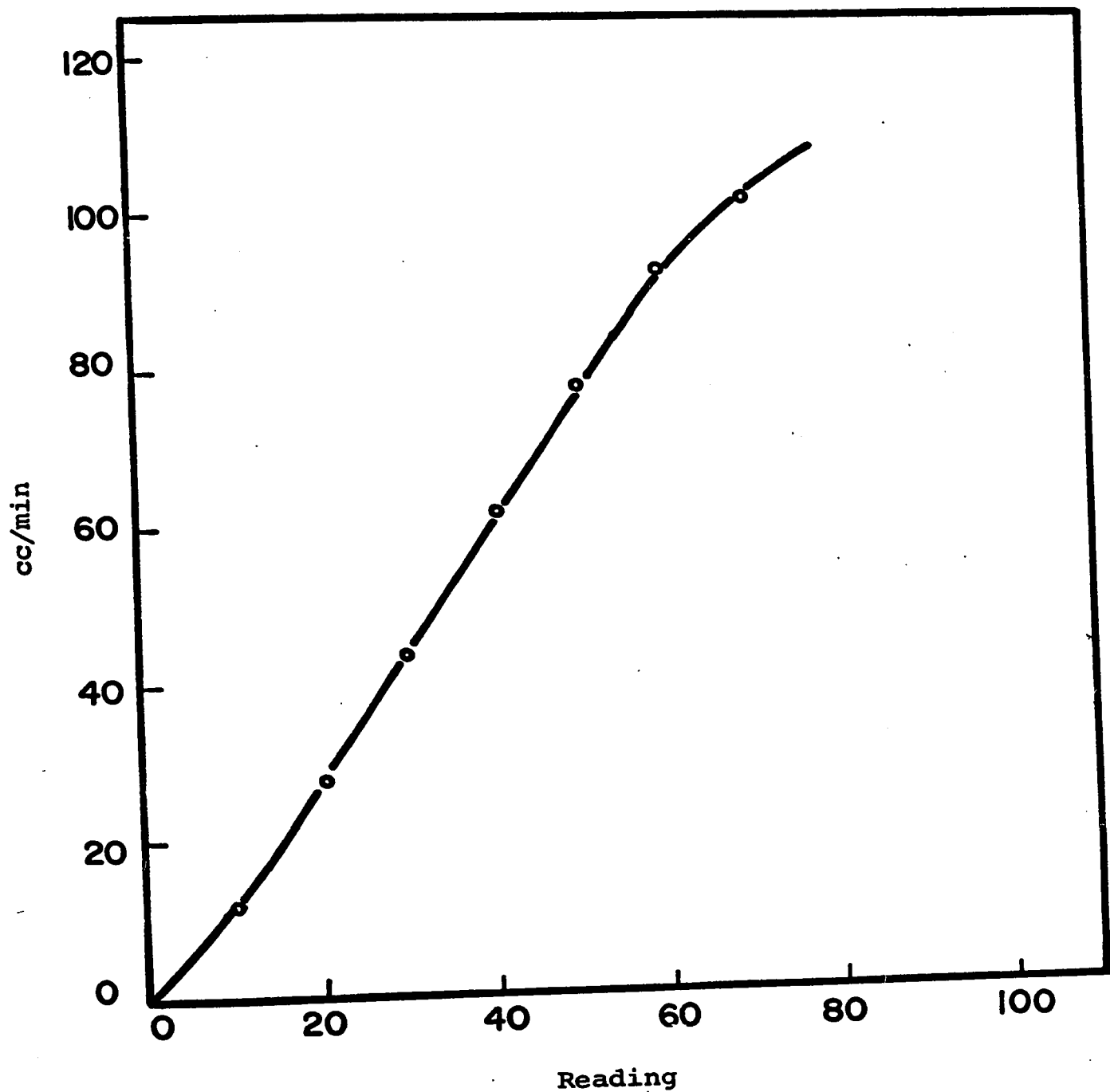


Figure 5-3

c. Power Supply Control Unit

Manufacturer : Gow-Mac Instrument Company

Model : 40 - 50C

Specification : output : 0 - 40 volts D.C.

0 - 500 ma

d. Rotameter

Manufacturer : Matheson of Canada

Model : 620BBV with 602 tube

Specification : Material floats : Pyrex and st. steel

Maximum flow rate : 400 cc/min with pyrex
float

846 cc/min with st.

steel float

(see calibration curve in figure 5-4)

e. Photographic Equipment

Hycam Camera : Model K20S1AR by Red Lake Laboratories Inc.
with 25mm and 75mm comiscar television lens,
for 16mm ($\frac{1}{2}$ frames) and variable frame rate
controlled by external power supply.

Timing light generator : Model TLG3, by Red Lake Lab. Inc.,
with a maximum frequency of 1000 cycles/sec.

Lighting : Model LCQ - II, by Berkey Colortran of 1000 watts
at 120 volt inlet and 0-300 volts outlet

Light Meter : Model spotmeter III, by Ashi Pentax

Projector : Model 900B by L-W Photo Inc. With minimum
speed of one frame at a time.

CALIBRATION CURVE OF ROTAMETER

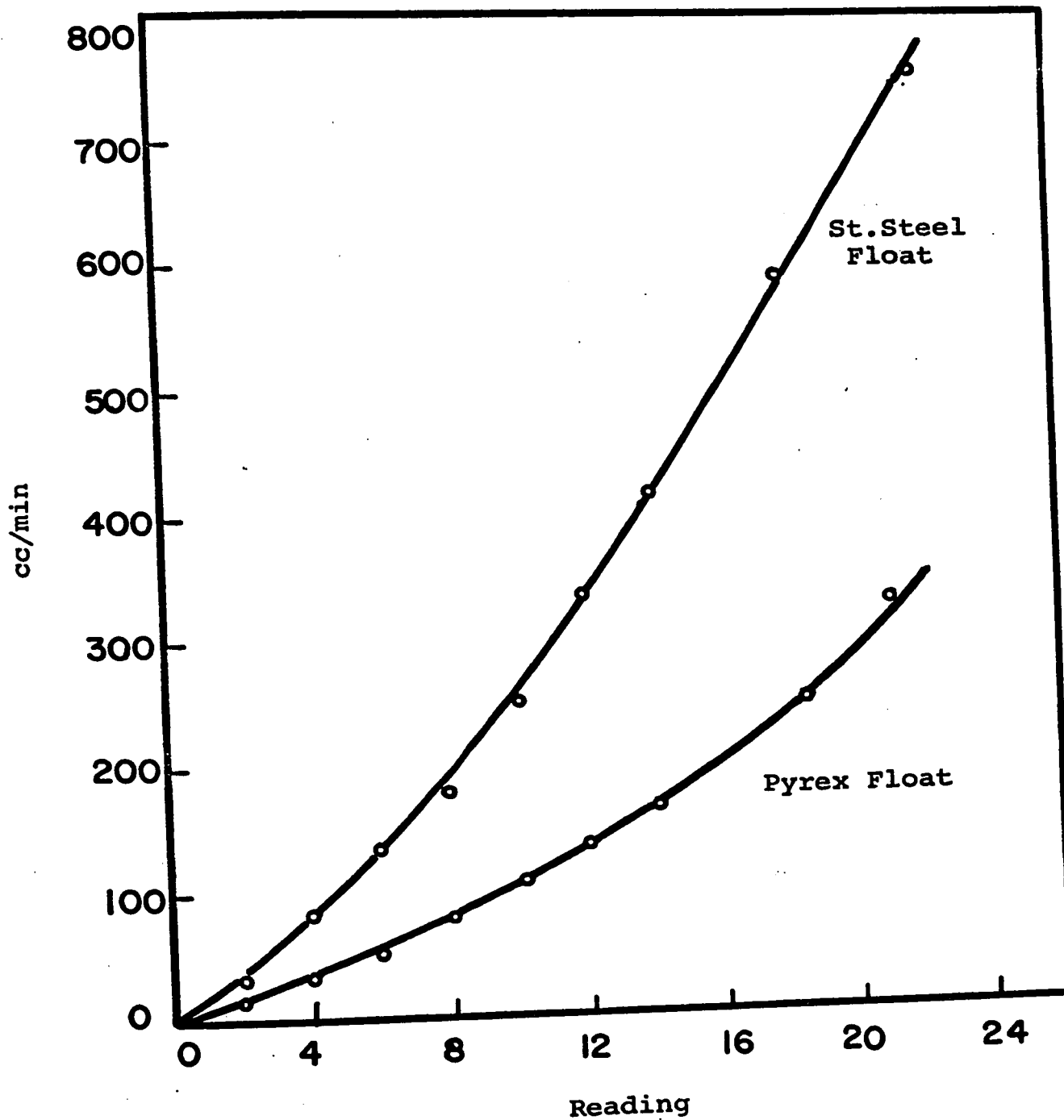


Figure 5-4

APPENDIX 6

SPECIFICATIONS AND PROPERTIES OF MATERIALS

- 6-A. Purity and Chemical Properties
- 6-B. Effect of Hexane on the Physical Properties of Materials
- 6-C. Gas and Liquid Diffusivities of n-Hexane
- 6-D. Slope of Equilibrium Line

6-A. Purity and Chemical Properties

a. Nitrogen

The N₂ gas was supplied by Union Carbide Canada Limited in pressure cylinder at about 2,500 psig and with a 99.9 volume percent purity.

b. Helium

The He gas was from the Canadian Liquid Air Limited and was of a minimum specified purity of 99.99 volume percent He. The gas was supplied in high pressure at approximately 2,700 psig.

c. Freon-14

The Freon-14 gas was supplied by Matheson of Canada Limited. The minimum specified purity of the gas was 99.7 volume percent.

d. n-Hexane

The normal hexane used was from Fisher Scientific Company and with a specified minimum 99 mol percent purity.

e. Heavy Paraffin Oil

This oil was obtained from Fisher Scientific Company and had the following physical properties :

Table 6-1

Heavy Paraffin Oil

Specific Gravity, 25°C	0.8806
Saybolt Viscosity, 25°C	335/350
Absolute Viscosity, 25°C	142 cp

Table 6-1 cont.

Initial Boiling Point at	660°F
Atmospheric Pressure	
End Point of Boiling Curve at	952°F
Atmospheric Pressure	
Average Molecular Weight (86)	420 g/g-mole
Surface Tension	37 dynes/cm

f. Light Paraffin Oil

This oil was also obtained from the Fisher Scientific Company and had the following physical properties :

Table 6-2

Light Paraffin Oil

Specific Gravity, 25°C	0.8586
Saybolt Viscosity, 25°C	125/135
Absolute Viscosity, 25°C	40 cp
Initial Boiling Point at	610°F
Atmospheric Pressure	
End Point of Boiling Curve	937°F
at Atmospheric Pressure	
Average Molecular Weight (86)	375 g/g-mole
Surface Tension	35 dynes/cm

g. Mixtures of Paraffin Oil

In order to study the viscosity effect on the slug flow characteristics and mass transfer rate, three different mixtures of heavy and light paraffin oils were prepared.

Their absolute viscosities were about 92.08, 72.24 and 61.5 cp respectively.

In the above, the paraffin oil absolute viscosities were measured using the Cannon-Fenske Routine Viscometer by Cannon Instrument Company while the surface tensions were by the Cenco Interfacial Tensiometer from Central Scientific Company, Chicago, U.S.A.

6-B. Effect of Hexane on the Physical Properties of Materials

When the inert carrier gases and paraffin oil were mixed with hexane, a check was made of the changes in physical properties in both the gas and liquid phases. In Table 6-3, the effects of hexane on the gas phase densities and viscosities were illustrated, variations of gas phase viscosities with hexane composition being calculated from the equation reported by Curtiss and Hirschfelder (87). Liquid phase densities, viscosities and surface tensions in the presence of hexane at various compositions were measured and shown in figure 6-1.

Table 6-3

Effect of Hexane on Gas Phase Properties

Inert Carrier Gas	$Y_{on}(m.f.)$	$\rho_g(g/cc) \times 10^3$	$\mu_g(cp) \times 10^3$
Nitrogen	0.000	1.220	0.1768
	0.023	1.260	0.1686
	0.053	1.280	0.1591
	0.073	1.290	0.1534
Helium	0.000	0.174	0.1984
	0.023	0.218	0.1782

EFFECT OF HEXANE CONCENTRATIONS ON PROPERTIES OF MATERIALS

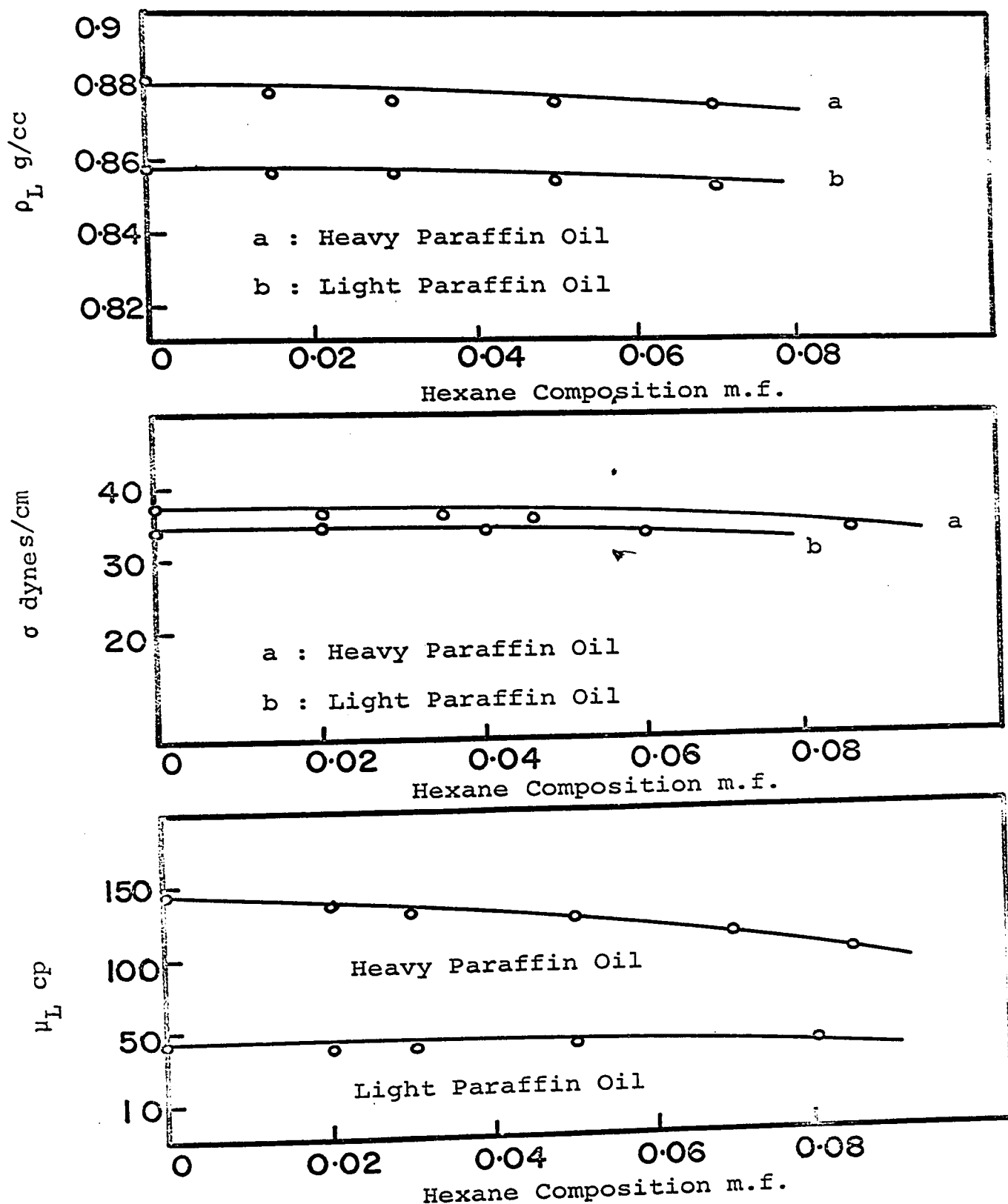


Figure 6-1

	0.053	0.271	0.1587
	0.073	0.304	0.1486
Freon-14	0.000	3.880	0.1881
	0.023	3.880	0.1828
	0.053	3.820	0.1762
	0.073	3.780	0.1719

6-C. Gas and Liquid Diffusivities of n-Hexane

C-1. Gas Phase Diffusivities

The diffusion coefficients of n-hexane in helium, nitrogen and Freon-14 gases were determined from the Wilke and Lee (88) formula.

$$D_g = \frac{B_c T^{3/2} (1/MW_1 + 1/MW_2)^{1/2}}{P r_{12}^2 f\{(kT/\epsilon_{12})\}} \quad (6-1)$$

where ; $B_c = 0.00107 - 0.000246(1/MW_1 + 1/MW_2)^{1/2}$

r_{12} = molecular separation at collision $\text{\AA}^0$

$$= (r_1 + r_2)/2$$

T = absolute temperature ($^{\circ}\text{K}$)

P = total pressure (atm)

$\epsilon_{12} = (\epsilon_1 \epsilon_2)^{1/2}$ = energy of molecular interaction (ergs)

k = Boltzmann's constant

$f\{(kT/\epsilon_{12})\}$ = collision function

In cases where ϵ/k or r are not directly available from tables in literature, they were estimated from the following relationships:

$$r = 1.18 (V)^{1/3}$$

$$\epsilon/K = 1.21 T_b$$

where ; V = molecular volume or sum of atomic volume
 T_b = normal boiling point ($^{\circ}\text{K}$)

Table 6-4

Gas Phase Diffusivities of n-Hexane at 25°C and 1 atm

Carrier Gas	r_{12} cm	$f(kT/\epsilon_{12})$	D_g cm^2/sec
Helium	4.597	0.428	0.2740
Nitrogen	4.853	0.594	0.0813
Freon-14	5.159	0.678	0.0447

C-2. Liquid Phase Diffusivities

The liquid phase diffusivities of hexane in various paraffin oils were evaluated using the formula proposed by Wilke (75) :

$$D_L = \frac{7.4 \times 10^{-8} (X MW)^{1/2} T}{\mu_L V_b^{0.6}} \quad (6-2)$$

where ; X = association parameter weight
 T = absolute temperature $^{\circ}\text{K}$
 V_b = molal volume of hexane at normal boiling point

No experimental value of the association parameter for hexane in the paraffin oil was available. However, from

results for the diffusion coefficient of methane into oils as reported by Hill (89) and Reamer (90), Pontanen (21) after a private communication with Wilke calculated the apparent association parameters for methane in oils using the Wilke formula (6-2). The results were reproduced and showed in figure 6-2. X was equal to 49 at 25°C. The high apparent association factor is unrealistic indicating the unsuitability of the Wilke formula for predicting the diffusion coefficients in paraffin oils. Values therefore can only be considered approximate but could be used in estimating individual liquid phase mass transfer coefficients. The liquid diffusion coefficients for n-hexane in paraffin oils are shown in Table 6-5.

Table 6-5
Diffusivities of n-Hexane in Paraffin Oils

Paraffin oil	μ_L cp	MW g/g-mole	V_b cm ³	D_L cm ² /sec
Heavy	142.0	420.0	140.6	0.115×10^{-5}
MIX-I	92.0	397.5	140.6	0.172×10^{-5}
MIX-II	72.3	388.6	140.6	0.217×10^{-5}
MIX-III	61.5	385.2	140.6	0.259×10^{-5}
Light	40.0	375.0	140.6	0.366×10^{-5}

6-D. Slope of Equilibrium Line

The solution of paraffin gases in hydrocarbons might be considered as an ideal solution with which Raoult's Law was applicable at room temperature and atmospheric pressure. Hence,

APPARENT ASSOCIATION PARAMETERS FOR OILS AT
DIFFERENT TEMPERATURES (21)

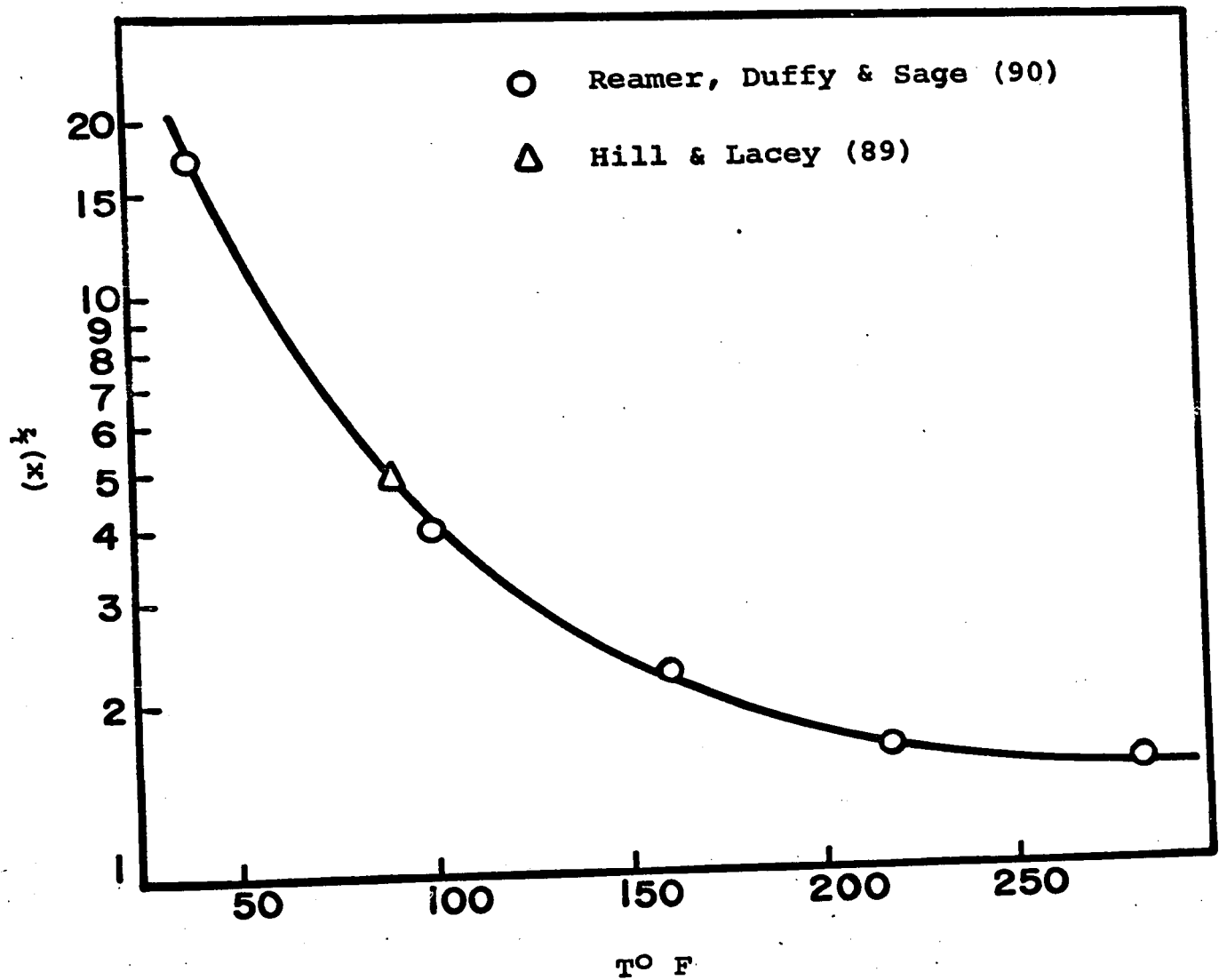


Figure 6-2

the partial pressure P_H of n-hexane in the paraffin oil would be

$$P_H = P_v x = 151 x \quad \text{at } 25^\circ\text{C} \quad (6-3)$$

where P_v is the vapor pressure of n-hexane at 25°C and x the mole fraction of n-hexane in the liquid.

At atmospheric pressure of 760 mm, equation (6-3) can be further written as

$$\begin{aligned} y &= (P_v/760)x = 0.1988 x \\ &= mx \end{aligned} \quad (6-4)$$

APPENDIX 7

COMPUTER PROGRAMMES

COMPUTER PROGRAM I

EVALUATIONS OF EXPERIMENTAL MASS TRANSFER EFFICIENCIES EOT AND
COEFFICIENTS KOGAE AND KOGAE/AT

NOMENCLATURE:

DG GAS PHASE HEXANE DIFFUSIVITY CM²/SEC

DEK CONSTANT FOR THE EFFECT OF X

WM SOLUTION MOLECULAR WT G/G-MOLE

D ABSORBER DIAMETER CM

U LIQUID VISCOSITY CP

DS LIQUID DENSITY G/CC

DSG GAS PHASE DENSITY G/CC

YIN,YO INLET HEXANE COMPOSITION M.F

GM MOLAR GAS FLOW RATE G-MOLE/MIN

ABS MOLAL GAS FLOW RATE G-MOLE/MIN

H ABSORBER LENGTH CM

TCA MILLIVOLT READING

TCB MILLIVOLT READING

YFA,YFB OUTLET HEXANE COMPOSITION M.F

FP POINT SLUG FREQUENCY SLUG/SEC

PA MEAN SLUG FREQUENCY SLUG/SEC

AP POINT SLUG SURFACE AREA CM²

AT MEAN SLUG SURFACE AREA CM²

BP POINT SLUG LENGTH CM

BA MEAN SLUG LENGTH CM

V SLOG VELOCITY CM/SEC

VS SUPERFICIAL GAS VELOCITY CM/SEC

VF LIQUID PLUG VELOCITY CM/SEC

RATT G/QL

FR FROUDE NUMBER

REP REYNOLD NUMBER D*VS*DS/U

C	REL	REYNOLD NUMBER D*VF*DS/U
C	WE	WEBER NUMBER
C	EOTA,FOTB	MASS TRANSFER EFFICIENCIES
C	EVA	MEAN MASS TRANSFER EFFICIENCIES
C	AV	-LN(1.0-EVA)
C	Q,QT	CONTACT TIME SEC
C	RAT	SLUG SURFACE AREA AND VOLUME RATIO CM-1
C	SC,AHTU	THE GROUP KOG*F*AE/GM SEC-1
C	HTU	HEIGHT OF TRANSFER UNIT
C	FFF	MEAN OVERALL MASS TRANSFER COEFFICIENT KOG*AE/AT
C		G-MOLF/SEC CM2 ATM
C	FFO	POINT OVERALL MASS TRANSFER COEFFICIENT KOG*AE/AT
C		G-MOLE/SEC CM2 ATM
C	XE	INTERFACIAL HEXANE CONCENTRATION M,F
C	ACTF	MEAN OVERALL MASS TRANSFER COEFFICIENT CORRECTED
C		XE EFFECT G-MOLE/SEC CM2 ATM
C	XL	HEXANE CONCENTRATION IN LIQUID PHASE
C	AAA4	END EFFECT EFFICIENCIES
C		DIMENSION GM(50),ABS(50),H(50),YIN(50),YFA(50),YFB(50),GG(50), 1YFG(50),HS(50),FP(50),AP(50),BP(50),FA(50),AT(50),BA(50),GS(50), 1VS(50),VRT(50),REP(50),WE(50),RAH(50),FR(50),RAD(50),C(50), 1V(50),HO(50),RH(50),QF(50),RH3(50),RHH(50),Q(50),QT(50),HA(50), 1HB(50),XA(50),XB(50),YEA(50),YEB(50),EOTA(50),EOTB(50),EVA(50)
C		DIMENSION AA(50),BR(50),AV(50),YNN(50),YYA(50),YYB(50),EEA(50), 1YE(50),COEFF(6),YCALC(50),YR(50),XR(50,2),QS(50),SC(50),RAT(50), 1FFO(50),FFF(50),HTU(50),AHTU(50),KGA(50),KGAA(50),KG3(50), 1OP(50),YQ(50),FGF(50),FLF(50),RTR(50),XL(50),AB(50),BC(50), 1VF(50),XE(50),DDT(50),ACIF(50),KG2(50),RATT(50),AVA(50),REL(50)
C		DIMENSION 1CA(50),TCB(50),FFO(50),FFE(50),DHC(50),PP(50),HC(50) 1,EEB(50)

C

REAL KGA,KGAA,KG3,KG2

GV=980.0

W=1.5

P5=5.0

LM=0

JJ=0

ST=36.0

PT=150.0/760.0

WRITE(3,10)

10 FORMAT(1H1)

2005 READ(1,20)NN

20 FORMAT(I3)

READ(1,500)D,U,DS,DSG,DG,DL

500 FORMAT(5F10.0,E10.4)

C

IF(DS-.88)6655,6656,6656

6655 DEK=1.03

WM=375.0

GO TO 6657

6656 DEK=1.7

WM=420.0

6657 CONTINUE

TR=(SQRT(DG/DL))*((PT*WM)/(DL*82.06*298.0))

TR1=(2.0-TR)/2.0

TR2=1.0-TR1

WRITE(3,192)

192 FORMAT(//////////)

WRITE(3,190)D

190 FORMAT(24X,'ABSORBER DIAMETER = ',F5.3,2X,'CM',/)

WRITE(3,1890)

1890 FORMAT(24X,'SATURATOR TEMPERATURE = ',4X,'C',/)

MN=0

1000 READ(1,30)N

30 FORMAT(I3)


```

READ(1,49)QV
49 FORMAT(F10.0)

DO 2 I=1,N
  READ(1,38)GM(I),ABS(I),H(I),VIN(I),YFA(I),YFB(I),YCA(I),TCB(I)
38 FORMAT(8F10.0)

  GG(I)=GM(I)*22414.0
  YFG(I)=(YFA(I)+YFB(I))/2.0
2 CONTINUE

C
  WRITE(3,298)
298 FORMAT(/)
  WRITE(3,195)GG(N),QV
195 FORMAT(24X,'GAS RATE = ',F5.1,2X,'CC/MIN',5X,'LIQUID RATE = ',
1F4.1,2X,'CC/MIN',/)

  KK=0
DO 3 J=1,N
  A =(3.1416/4.0)*(D**2.0)*60.0
  GS(J)=GG(J)/60.0
  VF(J)=(GG(J)+QV)/A
  VS(J)=GG(J)/A
  REL(J)=(D*VF(J)*DS)/U
  VRT(J)=VS(J)/VF(J)
  REP(J)=(D*VS(J)*DS)/U
  REL(J)=(D*VF(J)*DS)/U
  WE(J)=(D*(VS(J)**2)*DS)/ST
  RAH(J)=H(J)/D
  RAD(J)=DG/DS
  RATT(J)=GG(J)/QV
  FR(J)=(VS(J)**2)/(GV*D)

C  C(J)=0.09*(REP(J)**(-1.25))*(REL(J)**1.2)*(WE(J)**0.4)*
C  V(J)=(1.2*VF(J))+(C(J)*SQRT(GV*D))+(4.0*EXP((-0.6*H(J))/D))
C  1(RAD(J)**(-0.14))

C  OR
C  C(J)=0.098*((1.0-1.0/RATT(J))**(-0.8))*(RAD(J)**(-0.16))*
1(RAH(J)**(-0.1))*(WE(J)**0.5)*(FR(J)**(-0.1))

```

V(J)=1.2*VF(J)+C(J)*SQRT(GV*D)
H0(J)=0.054*((GS(J)*(U**0.3))/(D**0.7))

RH(J)=H(J)-H0(J)-W

QF(J)=(RH(J)+W)/V(J)

IF(RH(J)-0)222,212,212

222 GO TO 232

212 KK=KK+1

RH3(KK)=H(J)

RHH(KK)=RH(J)

QT(KK)=RHH(KK)/V(J)

232 CONTINUE

Q(J)=RH(J)/V(J)

I=J FOR IDENTIFICATION PURPOSE

I=J

HA(I)=GM(I)*((YIN(I)/(1.0-YIN(I)))-(YFA(I)/(1.0-YFA(I))))

HB(I)=GM(I)*((YIN(I)/(1.0-YIN(I)))-(YFB(I)/(1.0-YFB(I))))

XA(I)=HA(I)/(HA(I)+ABS(I))

XB(I)=HB(I)/(HB(I)+ABS(I))

YEA(I)=(150.0/760.0)*XA(I)

YEB(I)=(150.0/760.0)*XB(I)

YE(I)=(YEA(I)+YEB(I))/2.0

SY=SY+YE(I)

EOTA(I)=(YIN(I)-YFA(I))/(YIN(I)-YEA(I))

EOTB(I)=(YIN(I)-YFB(I))/(YIN(I)-YEB(I))

EVA(I)=(EOTA(I)+EOTB(I))/2.0

C

IF(GG(I)-245.0)150,151,151

151 IF(DSG.EQ.0.001285)GO TO 153

GO TO 150

153 IF(D.EQ.0.793)GO TO 156

GO TO 150

156 IF(U.GT.100.0)GO TO 154

GO TO 155

155 IF(U.LT.45.0)GO TO 154

GO TO 150

154 P9=50.0

GO TO 152

150 P9=28.0

152 CONTINUE

IF(H(I)-P9)80,80,81

81 GO TO 85

80 CONTINUE

400 AA(I)=-ALOG(1.0-EOTA(I))

AB(I)=-ALOG(1.0-EOTB(I))

AV(I)=-ALOG(1.0-EVA(I))

AVA(I)=(AA(I)+AB(I))/2.0

3 CONTINUE

C

NL=N

GO TO 815

85 NL=KK-1

815 DO 4 I=1,N

YNN(I)=YIN(I)*100.0

YYA(I)=YFA(I)*100.0

YYB(I)=YFB(I)*100.0

EEA(I)=YFA(I)*100.0

EEB(I)=YEB(I)*100.0

JJ=JJ+1

WRITE(3,86)JJ,H(I),PP(I),ICA(I),YNN(I),YYA(I),EEA(I),EOTA(I),

1EVA(I),AVA(I),Q(I)

86 FORMAT(24X,

I4,3X,F5.1,3X,F5.1,3X,F5.2,3X,F6.4,3X,F6.4,3X,F6.4,3X,

1F6.4,3X,F5.3,3X,F5.3,3X,F5.2)

JJ=JJ+1

WRITE(3,87)JJ,H(I),PP(I),ICB(I),YNN(I),YYB(I),EEB(I),EOTB(I),

1EVA(I),AVA(I),Q(I)

87 FORMAT(24X,

I4,3X,F5.1,3X,F5.1,3X,F5.2,3X,F6.4,3X,F6.4,3X,F6.4,3X,

1

1F6.4,3X,F5.3,3X,F5.3,3X,F5.2)

4 CONTINUE

AY=SY/N

C

DO 620 I=1,NL
READ(1,630)HS(I),FP(I),AP(I),BP(I),FA(I),AT(I),BA(I)

630 FORMAT(7F10.0)

620 CONTINUE

CALL CURVE(QF,YFG,3,NL,COEFF,YCALC)

Z1=COEFF(1)

Z2=COEFF(2)

Z3=COEFF(3)

Z4=COEFF(4)

GJ=GM(NL)

DO 5685 KI=1,NL

YR(KI)=AV(KI)

XR(KI,1)=QT(KI)

XR(KI,2)=OT(KI)*AV(KI)

5685 CONTINUE

NDATA=NL

CALL REG(XR,YR,2,NDATA,COEFF)

CS1=COEFF(1)

CS3=-COEFF(3)

CS2=COEFF(2)-CS1*CS3

A4=COEFF(1)

AA4=EXP(-A4)

AAA4=1.0-AA4

DO 100 K=1,NL

MASS TRANSFER COEFFICIENTS

QS(K)=(HS(K)-W-HO(NL))/V(NL)

SC(K)=((1.0+CS3 *QS(K))*(-1))*CS2)-(CS2*CS3*QS(K))*((1.0+

1CS3*QS(K))*(-2))

V(K)=(1.2*VF(NL))+(C(NL)*SQRT(GV*D))

HS(K)=QS(K)*V(NL)+HO(NL)+W

C

C

IF(QV-30.0)1230,1230,1230,1240

1230 RAT (K)=(18.49)-(10.68*D)+(0.025*U *(0-1.15))-(0.0077*GJ *(1.0

1-0.0025*U))+(491.0*((GJ /60.0))*(-2.9))*(U**(-0.17))*EXP(-0.18

1*HS(K))

GO TO 1270

1240 IF(QV-45.0)1250,1250,1250,1260

1250 RAT (K)=(16.04)-(8.25*D)-(0.0092*U)-(0.0055*GJ *(1.0-0.0037

1*U))+(3235.0*((GJ /60.0))*(-2.8))*(U**(-0.8))*EXP(-0.18*HS(K))

GO TO 1270

1260 RAT (K)=17.82-8.96*D+(0.011*U*(D-1.02))-(0.00938*GJ *(3521.0*((

1GJ /60.0))*(-3.9))*(U**(-0.4))*EXP(-0.15*HS(K))

1270 FFO(K)=SC(K)/(RAT(K)*22414.0)

HTU(K)=AV(K)-A4

AHTU(K)=HTU(K)/QS(K)

KGAK(K)=(SC(K)*GM(NL))/(FP(K)*60.0)

KGAA(K)=(AHTU(K)*GM(NL))/(FA(K)*60.0)

KG3(K)=KGAA(K)/AT(K)

FFF(K)=((AV(K)-A4)/QT(K))/(RAT(K)*22414.0)

KG2(K)=KGA(K)/AP(K)

EFFECT OF XE ON MASS TRANSFER COEFFICIENTS

QP(K)=(HS(K)-H0(NL))/V(NL)

YQ(K)=Z1+Z2*QP(K)+Z3*(QP(K)**2.0)+Z4*(QP(K)**3.0)

FGF(K)=(1.0)/((1.0/KG3(K))*TR1)

FLF(K)=PT/((1.0/KG3(K))*TR2)

RTR(K)=-FLF(K)/FGF(K)

XL(K)=AY/PT

AB(K)=-RTR(K)+PT

BA(K)=((QV*DL)/WM)+(GM(K)*S)

BC(K)=-RTR(K)*GM(K)*S

XE(K)=((YQ(K))*((QV*DL)/WM))+HC(K))/(AB(K)*BA(K))

DDT(K)=1.0+(DEK*XE(K))

ACTF(K)=KG3(K)/DDT(K)

100 CONTINUE
C MASS TRANSFER COEFFICIENT FOR H=15.0 CM

HHS=15.0

QQS=(HHS-W-HO(NL))/V(NL)

SSC=CS1+((CS2*QQS)/(1.0+CS3*QQS))

SCC=((1.0+CS3*QQS)**(-1))*CS2

1-(CS2*CS3*QQS*((1.0+CS3*QQS)**(-2)))

HTU2=SSC-A4

AHTU2=HTU2/QQS

IF(R-30.0)7110,7110,7120

7110 RATAK =(18.49)-(10.68*D)+(0.025*U *(D-1.15))-(0.0077*GJ *(1.0

1-0.0025*U))+(491.0*((GJ /60.0)**(-2.9))*(U**(-0.17))*EXP(-0.18

1*HHS))

GO TO 7150

7120 IF(R-45.0)7130,7130,7140

7130 RATAK =(16.04)-(8.25*D)-(0.0092*U)-(0.0055*GJ *(1.0-0.0037

1*U))+((3235.0*((GJ /60.0)**(-2.8))*(U**(-0.8))*EXP(-0.18*HHS))

GO TO 7150

7140 RATAK =17.82-8.96*D+(0.011*U*(D-1.02))-(0.00938*GJ *(3521.0*((

1GJ /60.0)**(-3.9))*(U**(-0.4))*EXP(-0.15*HHS))

7150 KGA2=AHTU2/(RATAK*22414.0)

S2C=SCC/(RATAK*22414.0)

H15=0.0

DO 6 L=1,NL

FFO(L)=FFO(L)*10000.0

FFE(L)=FFE(L)*10000.0

S1C=S2C*10000.0

KPGA=KGA2*10000.0

LM=LM+1

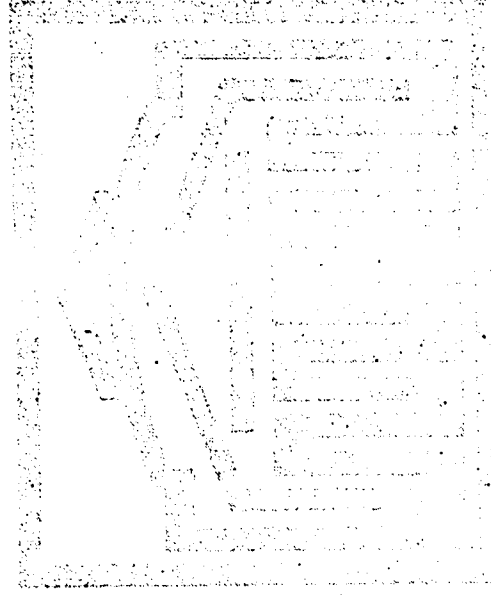
DHC(L)=HC(L)-15.0

IF(HC(L)-15.0)11,12,13

11 IF(ABS(DHC(L)).LE.0.01)H15=15.0

GO TO 9

12 H15=H15+15.0



```
GO TO 9
13 IF(DHC(L),GT.0,8)GO TO 144
GO TO 199
199 H15=HC(L)
GO TO 9
144 IF(H15-10,0)14,9,9
14 WRITE(3,19)LM,HHS,QOS,AAA4,HTU2,SCC,RATK,SIC,KPGA
19 FORMAT(24X,I3,3X,F5,2,3X,F5,3,3X,F6,3,3X,F6,3,3X,
1F7,4,3X,F7,4)
H15=HHS
LM=LM+1
9 WRITE(3,7)LM,HC(L),QT(L),AAA4,AHTU(L),SC(L),RAT(L),FFQ(L),FFE(L)
7 FORMAT(24X,I3,3X,F5,2,3X,F5,3,3X,F6,4,3X,F6,3,3X,F6,3,3X,
1F7,4,3X,F7,4)
6 CONTINUE
READ(1,1710)MI
1710 FORMAT(I3)
MN=MN+1
IF(MN>NN)1800,1900,1900
1800 GO TO 1000
1900 WRITE(3,1901)
1901 FORMAT(IH1)
GO TO 2005
999 RETURN
END
```


C

```

DIMENSION X(100),Y(100),A(100),DG(100),DL(100),WM(100),U(100),
1DS(100),DF(100),RR(100),VF(100),VO(100),VT(100),TNT(100),
1KLA(100),PA(100),KL(100),GP(100),KGA(100),YHGG(100),KG(100),
1KOGA(100),TON(100),KOG(100),RKG02(100),FFR(100),A3(100)

```

C

```

REAL KLA,KL,KGA,KG,KOGA,KOG
NR=0
BB=0.0
MM=2
MN=2
P=150.0/760.0
1000 READ(1,600)D,ARA,AR1,AR2
600 FORMAT(4F10.0)
R=D/2.0
READ(1,10)N
10 FORMAT(I3)
DO 1 I=1,N
READ(1,20)X(I),Y(I),A(I)
20 FORMAT(10X,3F10.0)
1 CONTINUE
READ(1,610)M
610 FORMAT(I3)
DO 613 J=1,M
READ(1,630)DG(J),DL(J),WM(J),DS(J)
630 FORMAT(F10.0,E10.4,2F10.0)
IF(DS(J)-0.88)690,690,695
690 VU=40.0*(1.0-BB)+0.2969*BB
UV=40.0
DF(J)=EXP(ALOG(DL(J))+(BB*ALOG(0.1005E-03/DL(J))))
GO TO 699
695 VU=142.0*(1.0-BB)+0.2969*BB
UV=142.0
DF(J)=EXP(ALOG(DL(J))+(BB*ALOG(0.9456E-04/DL(J))))
699 CONTINUE
613 CONTINUE

```

```

C
  WRITE(3,41)
41 FORMAT(1H1)
  WRITE(3,43)
43 FORMAT(24X,'SYSTEM = ',/)
  WRITE(3,44)DG(MM),DF(MM)
44 FORMAT(24X,'DG= ',1X,F6.4,1X,'CM2/SEC',2X,'DL= ',1X,
1F10.4,1X,'CM2/SEC',/)
  WRITE(3,42)D
42 FORMAT(24X,'ABSORBER DIAMETER = ',1X,F5.3,1X,'CM',/)

C
  READ(1,37)NO
37 FORMAT(I3)
  II=0
999 READ(1,30)G,O,BL,VB
30 FORMAT(4F10.0)
  BBBB=BL+1.5
  II=II+1
  SUM=0.0
  ADD=0.0
  AD=(3.1416/4.0)*(D**2)
  VAB=(G+O)/(6.0*AD)
  DO 640 J=MM,MN
  DO 3 K=2,100
  IF(X(K-1)-X(N))265,260,260
260 IF(X(K-1)-2.0)2150,2160,2160
2150 X(K)=X(N)+0.25*(K-N)
  JJ=JJJ+1
  GO TO 2170
2160 X(K)=X(K-1)+0.5*(K-N-JJJ)
2170 RR(K)=Y(N)
  GO TO 268
265 RR(K)=Y(K)
268 CONTINUE
C
  INTERFACIAL VFLOCITIES
  VF(K)=(VAB*(R**2)-VB*(RR(K)**2))/((R**2)-(RR(K)**2))

```

```

VO(K)=3.0*VF(K)/2.0
VT(K)=VO(K)-VB
IF(X(K)-ARA)100,110,110
100 DAX=AR1
GO TO 180

C
110 DAX=AR2
180 CONTINUE
TNT(K)=((VT(K-1)+VT(K))/2.0)*(X(K)-X(K-1))
SUM=SUM+TNT(K)
Z=SQRT(-SUM)
KLA(K)=(2.0*((DF(J)/3.1416)**(1.0/2.0)))*(DAX)*Z*(DS(J)/WM(J))
FFR(K)=KLA(K)*10000.0
IF(X(K)-X(N))300,300,310
300 PA(K)=A(K)
GO TO 350
310 PA(K)=A(N)+(X(K)-X(N))*(2.0*3.1416*RR(K))
A(K)=A(N)
350 CONTINUE

C
KL(K)=KLA(K)/PA(K)
GAS PHASE MASS TRANSFER COEFFICIENT
GP(K)=(1.0/(82.06*298.0))*SORT(DG(J))*(-VT(K))/(3.1416*(X(K)-X(K-1)
1)))*(PA(K)-PA(K-1))*2.0
ADD=ADD+GP(K)
KGA(K)=ADD
THGG(K)=KGA(K)*10000.0
KG(K)=KGA(K)/PA(K)
OVERALL MASS TRANSFER COEFFICIENT
KOGA(K)=(KLA(K)*KGA(K))/(KLA(K)+KGA(K)*P)
T00(K)=KOGA(K)*10000.0
A3(K)=PA(K)+3.1416*(RR(K)**2)
KOG(K)=KOGA(K)/A3(K)
RKG02(K)=KOG(K)*10000.0
L=K
IF(X(K)-BBBB)550,560,560

```

550 GO TO 5
560 GO TO 888
3 CONTINUE
888 CONTINUE

C

DO 49 K=2,1
50 NR=NR+1
WRITE(3,51)NP,X(K),VH,VF(K),V0(K),VT(K),FFR(K),IHGG(K),T00(K),
1A3(K),RKG02(K)
51 FORMAT(24X,I4,3X,F5.2,3X,F5.2,3X,F6.2,3X,F6.2,3X,
1F7.4,3X,F7.4,3X,F7.4,3X,F6.3,3X,F7.4)

49 CONTINUE

640 CONTINUE
IF(II-N0)650,660,660

650 WRITE(3,52)

52 FORMAT(/)

GO TO 999

660 GO TO 1000

105 RETURN

END