Partial Nitrification of Municipal Wastewater

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Introduction

- The release of wastewater to natural waters in Canada is responsible for large volumetric pollutant load.
- The ammonia commonly found in wastewater is responsible for occurrence of acute and chronic toxicity in natural waters [1].
- Removal of ammonia can be achieved by the combination of nitrification, the two-step oxidation of ammonia (NH_4^+) to nitrite (NO_2^-) and then nitrate (NO_3^-), and denitrification processes.
- This procedure can be costly thus people are turning to alternatives such as anaerobic ammonia oxidation (Annamox). Partial nitrification, the oxidation of ammonia to nitrite, is a required pre-treatment for the use of Annamox[2].
- The objective of this research is to investigate design strategies to achieved partial nitrification of municipal wastewater using the moving bed biofilm reactor technology.

Methodology

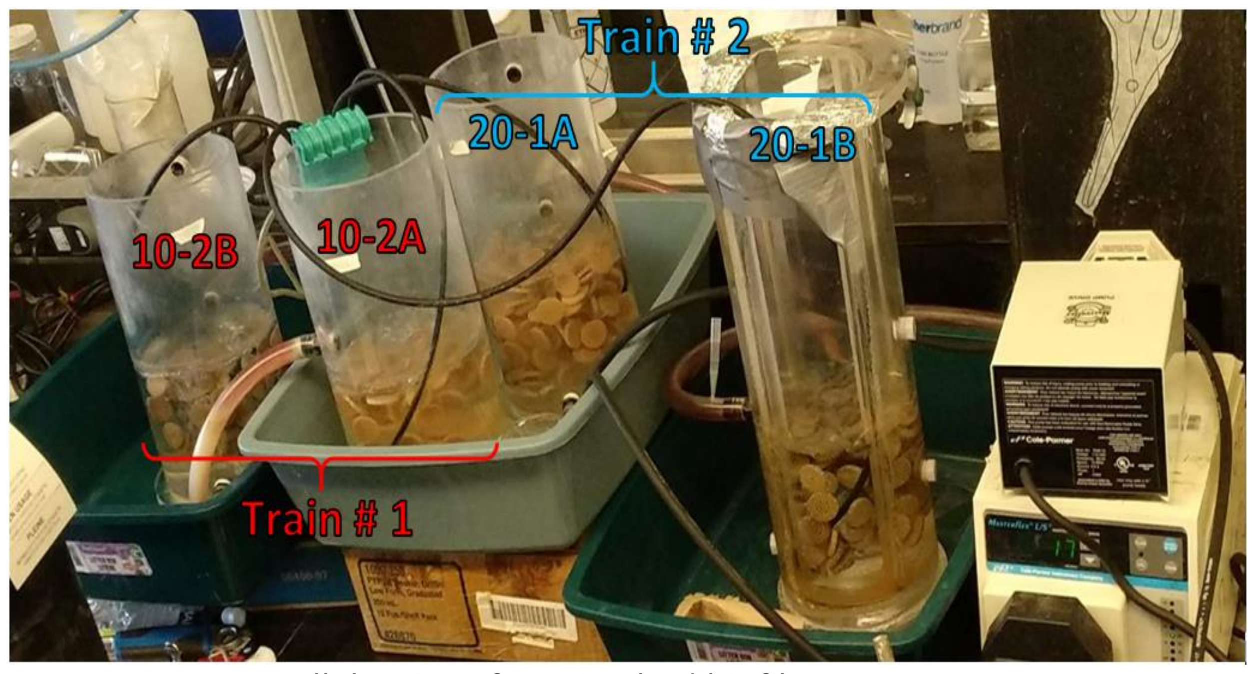

Figure 1. Two parallel trains of moving bed biofilm reactors set up.

- Train #1 (10-2) optimized for total surface area provided by the media with a fill fraction of 10 % and a hydraulic retention time of 2 hours.
- Train #2 (20-1) optimized for hydraulic retention time with a fill fraction of 20 % and a hydraulic retention time of 1 hour.
- The feed of the two reactors trains was synthetic wastewater with an influent ammonia concentration of 40 mg N/L which is a typical concentration for municipal waste water.
- The carriers use were taken from a train of two reactors in series achieving partial nitrification with an influent ammonia concentration of 125 mg N/L. Thus, the carriers for the 'A' reactors of both trains came from reactor A of the previous setting and similarly for the carriers in the 'B' reactors.

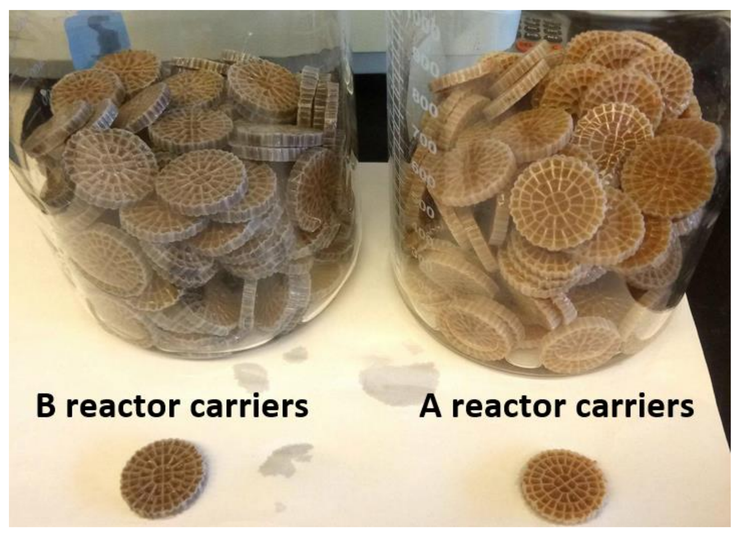

Figure 2. Carriers from 125 mg N /L ammonia feed set-up.

Results

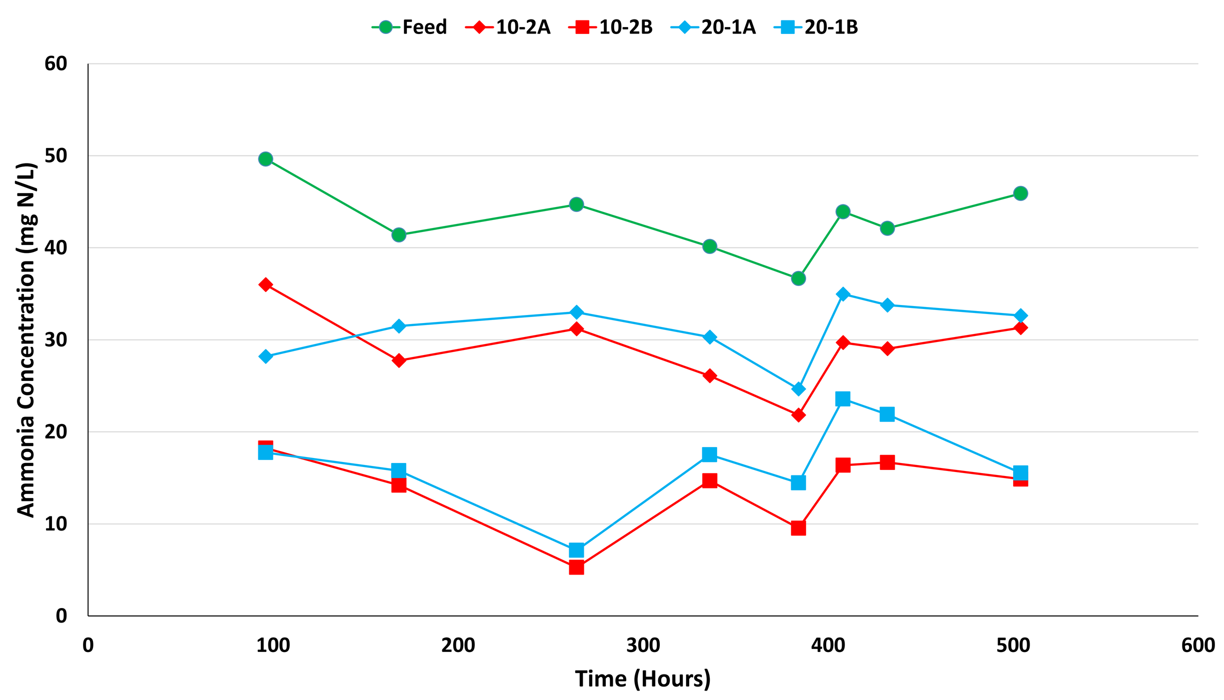

Figure 3. Ammonia concentration vs time.

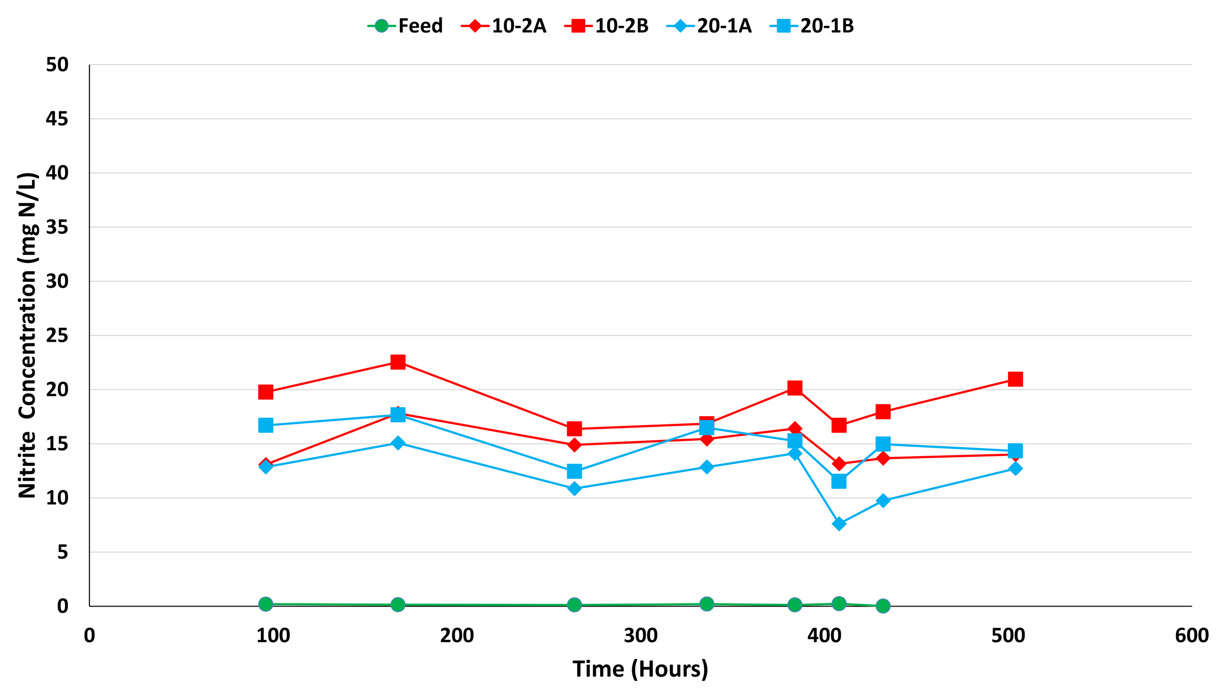

Figure 4. Nitrite concentration vs time.

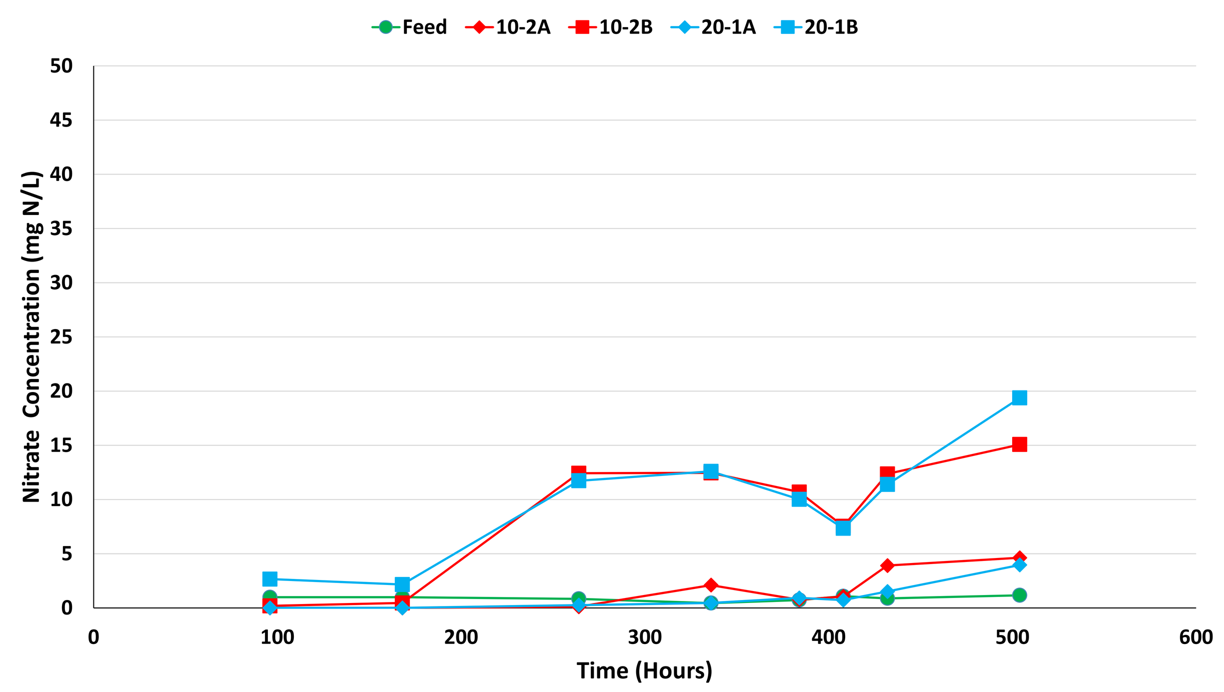

Figure 5. Nitrate concentration vs time.

Table 1. Percentage of total nitrogen as NH_4^+ and NO_2^- per reactors vs time

Time (h)	10-2A		10-2B		20-1A		20-1B	
	% NH_4^+	% NO_2^-	% NH_4^+	% NO_2^-	% NH_4^+	% NO_2^-	% NH_4^+	% NO_2^-
96	73.35	26.65	47.76	51.76	68.68	31.32	47.85	45.00
128	60.91	39.09	38.21	60.57	67.63	32.36	44.33	49.61
264	67.53	32.23	15.49	48.04	74.80	24.62	22.79	39.75
336	59.80	35.39	33.40	38.29	69.48	29.49	37.60	35.37
384	56.00	42.06	23.62	49.88	62.12	35.56	36.39	38.40
408	67.63	29.96	40.33	41.12	80.77	17.57	55.55	27.16
432	62.30	29.32	35.29	38.20	74.98	21.65	45.39	31.02
504	47.87	37.74	13.89	32.41	66.20	25.78	31.55	29.11

- Figure 3 suggests that Train#1(red) has slightly better ammonia removal than Train#2(blue) however both trains produced similar quantities of nitrate. Train#1 produced more nitrite than Train#2
- The low amount of nitrate produced in the 'A' reactors (diamond) suggests that partial nitrification was achieved.
- The production of nitrate in the 'B' reactors (square) and reduction in ammonia suggests that both steps of nitrification were achieved as opposed to partial nitrification.

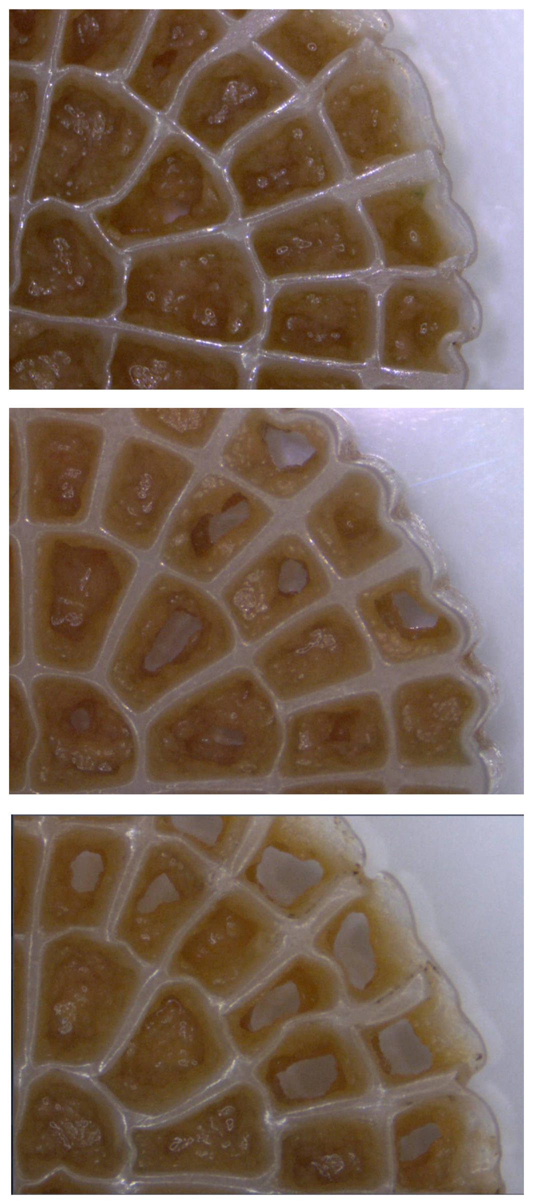

Figure 6. Carriers from (top to bottom); reactor A, 10-2A and 20-1A .

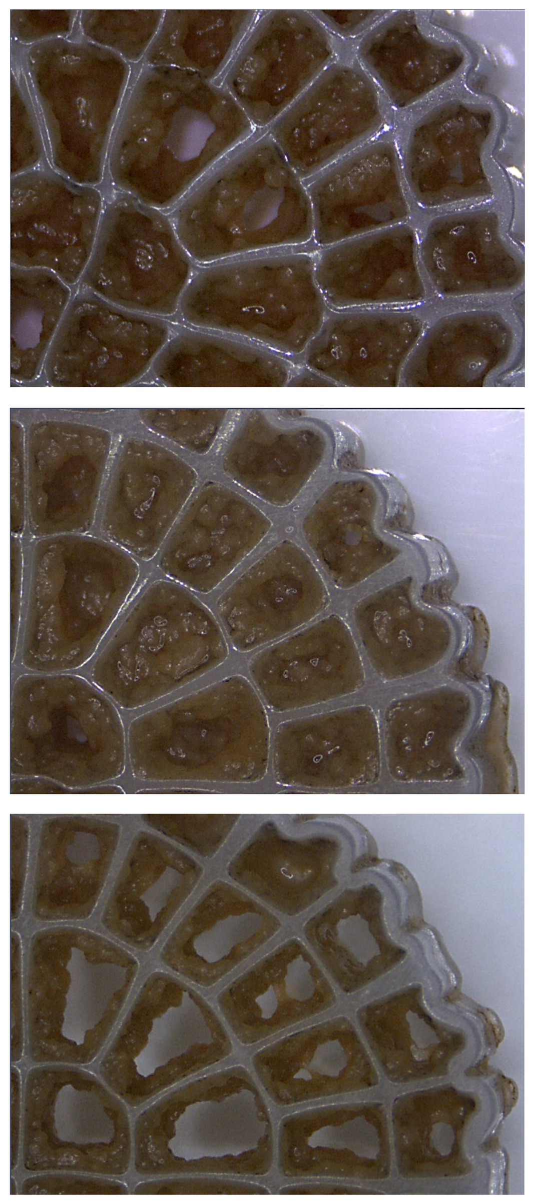

Figure 7. Carriers from (top to bottom); reactor B, 10-2B and 20-1B .

Conclusion

- Currently available data suggests that partial nitrification at municipal ammonia concentrations could be achieved using moving bed biofilm reactor technology.
- Further work is required to optimize the system and achieve steady state data.
- Success in optimising partial nitrification with MBBR would lead to more resource and cost efficient treatment process that has the potential to easily increase capacity to match growing demand.

Acknowledgement

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