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Case Study

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OPTIMIZATION OF AERATION IN A SINGLE-STAGE BIOLOGICAL AERATED FILTER FOR THE TREATMENT OF MUNICIPAL WASTEWATER

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1 Project Overview

A biological Aerated Filter (BAF), is a secondary biological treatment process where microorganisms are used to the treatment of wastewater from primary sedimentation tank (Pujol et al., 1992). Lou Romano Water Reclamation Plant (LRWRP) uses an up flow single stage BAF system in secondary treatment where chemically enhanced phosphorus treatment (CEPT) is used in the primary stage. The plant treats municipal wastewater from both the city of Windsor and a portion from the city of La Salle. LRWRP the plant

of 16 cells and is the second largest BAF system in Canada. The plan area for each BAF cell is 140 m^2 with 5.94 m water depth. The average water velocity is 6 m/h for each cell, with a 21 ML/d per cell average treatment capacity. At present, the treatment plant has an ultimate capacity of 227 ML/d. The media in BAF has a nominal settled height of 3.9 m. The effluent target for 5-day Carbonaceous biochemical oxygen demand ($CBOD_5$) and unionized ammonia nitrogen (NH_3-N) is 10 mg/L and 0.08 mg/L respectively. Currently, there is no problem in achieving this target. BAF uses process airflow for achieving the required DO level for the treatment and the microorganisms to survive. The plant was initially designed to use a constant process airflow of 2.26 m^3/h/ m^3 per cell. In BAF, process airflow can cost up to 70% of the total consumption of energy in the treatment plant (Hu and Wang, 2005). All the treatment plants are thriving for higher energy efficiency. A previous study revealed that the BAF effluent wastewater has a higher than normal dissolved oxygen (DO) concentration (≥5 mg/L) and the target NH_3-N level is achieved within the lower 50% of the cell height at 1.55 m^3/h/m^3 aeration rate (Ray et al., 2012). However, the study was limited to 1.55 m^3/h/m^3 and it suggested that a lower variable aeration rate be used in response to variable BOD loading and temperature.

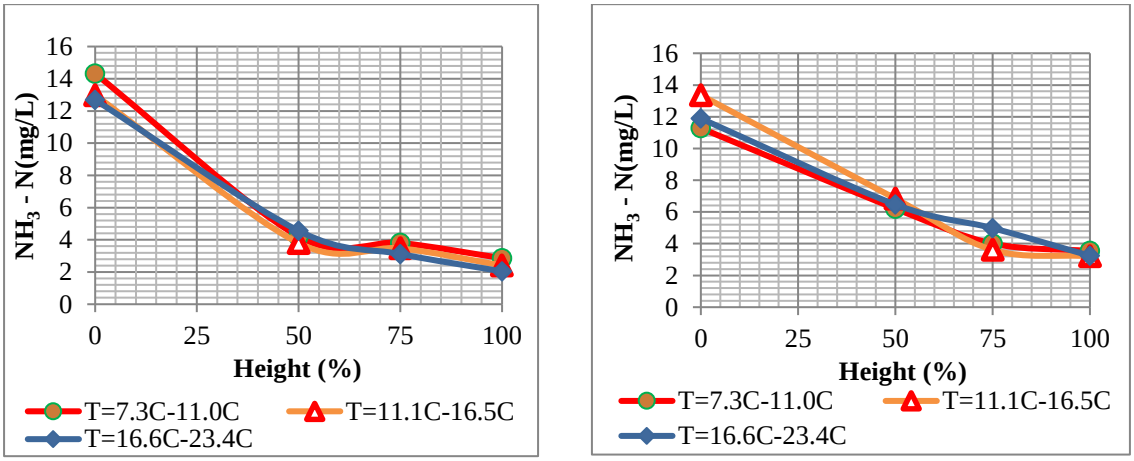
2 Innovation

In the current study, two years' of data consisting of influent and effluent BOD loading, DO, pH, NH_3-N, and the temperature was analyzed for various air flow rates to understand the seasonal variable requirements of airflow while achieving the target limits of NH_3-N and $CBOD_5$.

3 Lessons Learned

The results show that the aeration can be varied and further reduced between 1.07 m^3/h/m^3 to 1.55 m^3/h/m^3 per cell in response to various influent $CBOD_5$ and temperature without affecting effluent limits. Figure 1 shows that the nitrification is still completed within 75% of the cell height after 120 min of steady state operation. Three sets of temperatures were selected (7.3 °C-11.0°C, 11.1°C-16.5°C and 16.6°C-23.4°C) in

terms of year-round temperature variation. It was found that at 1.07 $m^3/h/ m^3$ air flow rate NH_3 -N reduction rate is highest when the temperature is between 11.1°C-16.5°C. NH_3 -N reduction rate is almost similar up to 50% height of the cell for other temperatures. However, the rate reduces between 50-75% height of the cell for temperature between 16.6°C-23.4°C. It suggests that BAF shows better efficiency between 11.1°C-16.5°C at this specific air flow rate and aeration can be safely reduced when the water temperature is within the level. No significant variation was observed for 1.55 $m^3/h/ m^3$ air flow rate. Effluent NH_3 -N varies between 3.2- 4.6 mg/L. BAF effluent DO concentration is ≥2 mg/L with the proposed variable aeration rate. Effluent $CBOD_5$ varies between 3-6 mg/L.



a b

Figure 1: Change of NH_3-N for different water temperature (°C) after 120 min of operation a) at 1.55 $m^3/h/ m^3$ per cell nominal air flow rates b) at 1.07 $m^3/h/ m^3$ per cell nominal air flow rates (steady flow rate)

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