Hydraulic Selection to Transform and Improve Activated-Sludge Based Wastewater Treatment

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Background

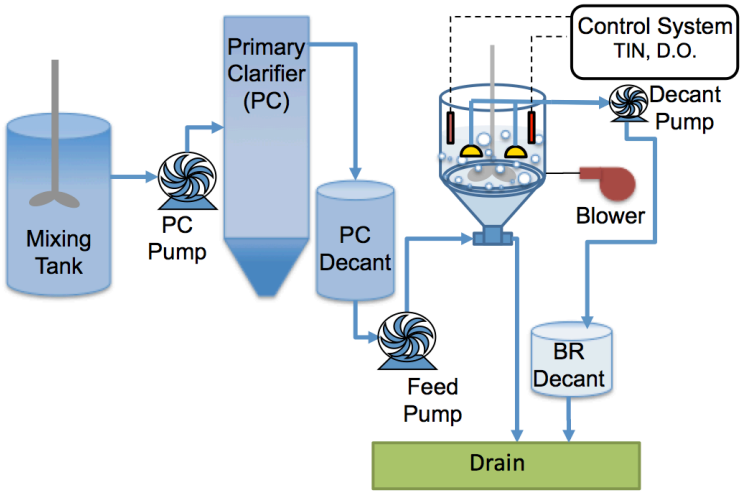
A majority of wastewater plants in the United States use conventional activated sludge (CAS) in their treatment process. While CAS is a common practice, it is not without faults. One of its drawbacks is the difficulty in maintaining the process, as it is often prone to bulking, which is caused by an undesired build up of filamentous bacteria and results in sludge that does not settle. Additional drawbacks include limited space for WWTPs to expand and the energy costs required for aeration during CAS treatment. Because CAS infrastructure is so common, optimizing this technology is crucial for the prevention of water pollution. In this study, we investigate the ability of hydraulic selectors to improve current CAS systems.

Objectives

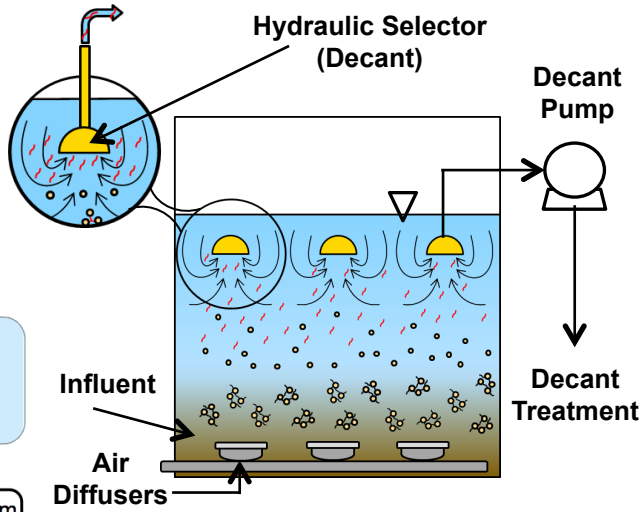
1. Improve settling velocity of sludge while maintaining mixed liquor suspended solids (MLSS) concentration in pilot scale SBR
2. Decrease concentration of filamentous bacteria in the system

Testbed

After testing the concept on a bench scale, experiments were conducted on a pilot scale at Mines Park, using a 30-gallon conical sequencing batch reactor (SBR). The SBR operated at the following cycle: 7 minute feed, 20 minute mixing, 139 minute mixing with aeration, 5 minute settling, and 10 minute decant, operating at a 30% exchange ratio. A schematic of the system is shown to the right.



What is hydraulic selection?



Hydraulic selection describes the use of an underdrain system that is operated at a specific flow rate to remove poor settling solids. The removal of poor settling solids is expected to accelerate the settling velocity of the activated sludge, allowing wastewater treatment plants (WWTPs) to shorten their treatment time as well as decreasing the occurrence of bulking sludge. A diagram of it's implementation in a SBR is seen in the figure above.

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Results

- By removing poor settling floc with the hydraulic selector, the settling velocity of the activated sludge increased with time until the selector could no longer remove any more light settling floc due to outflow velocity restriction (Figure 1).
- Sludge Volume Index (SVI) decreased while MLSS increased demonstrating that more dense flocs were produced due to the incorporation of hydraulic selection (Figure 2).
- The Filamentous Index (FI) decreased in concentrate solutions over time, proving a decrease in filamentous bacteria in the activated sludge (Figure 3). FI was determined from images taken of the concentrate solution with a phase contrast microscope.

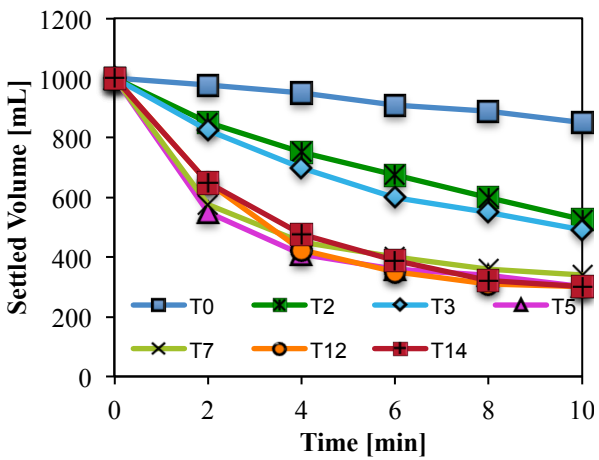

Figure 1. Settling time of mixed liquor in the mini pilot SBR at Mines Park. The slope of each line represents the settling velocity on a given experimental day.

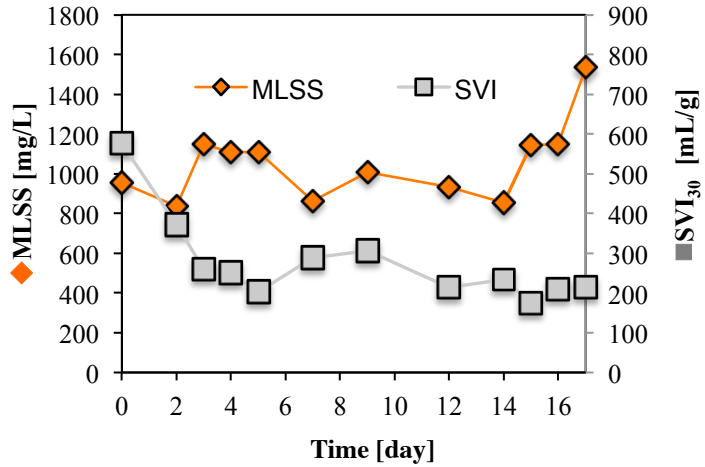

Figure 2. MLSS and SVI over time with hydraulic selection in the mini pilot SBR at Mines Park.

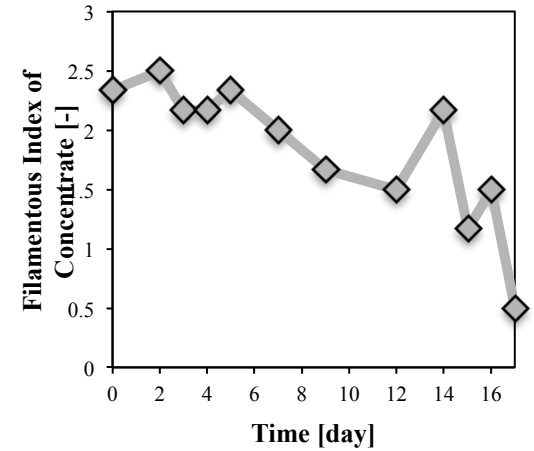

Figure 3. Filamentous Index (FI) of concentrate solution in mini pilot scale experiments. FI is a reference scale from 0-5 where 0 represents a scarcity of filamentous bacteria and 5 represents a high concentration of filamentous bacteria.

Conclusions

From this study, selectively removing poor settling floc through incorporating hydraulic selection can be shown to increase the settling velocity of activated sludge. This can have large implications in urban wastewater infrastructure by shortening the required treatment time in traditional WWTPs, which could allow plants to treat a higher volume of wastewater. Additionally, the ability for hydraulic selection to decrease the number of filamentous bacteria in activated sludge addresses the problem of process stabilization and could be a method to prevent bulking sludge.