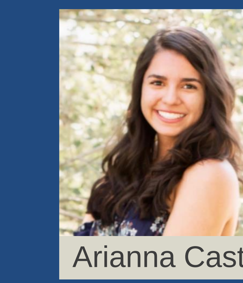
Dissolved methane removal and recovery (RRS3)

Energy and resource recovery

Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)



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Background

Methane Information

- Methane is a very powerful greenhouse gas produced by anaerobic degradation of organic compounds, such as those found in food waste and municipal wastewater.
- Methane is a colorless, odorless, tasteless, and combustible gas.
- Methane can be captured and used to produce electricity and heat.
- As a greenhouse gas, methane increases the effects of climate change due to its ability to absorb 25 times more heat than carbon dioxide.
- Methane becomes an explosive hazard in poorly ventilated and confined areas.
- Methane is soluble in water, and its solubility increases at low temperatures.

The Colorado School of Mines is investigating microscreen filtration to recover dissolved methane and remove residual solids from treated wastewater. Municipal wastewater is treated in an anaerobic baffled reactor (ABR), which is three up-flow anaerobic sludge blankets. Naturally present methanogenic bacteria consume organics found in wastewater, and methane is released as a by-product. Due to its high solubility in low temperatures (<20°C), about 40% of the methane produced by the ABR is dissolved in the effluent. The dissolved methane needs to be removed to comply with regulatory standards, mitigate negative environmental impacts, and for its potential as energy-rich biogas. Dissolved methane can be removed from wastewater through air stripping to avoid the risks of explosion or fire. However, this method is not ideal because a substantial amount of methane is lost in the process. This lost methane has potential to be collected and used as an energy source. Recovery of methane released by a microscreen may be a more controlled method for methane capture. In addition, residual solids removed though microscreen filtration may improve the quality of treated water. The goal of this work was to test the effectiveness of a microscreen for solids polishing and determine if frequent backwashing will be necessary in the final design to prevent clogging of the screen.

Approach

- Multiple samples of effluent from the ABR were run through different microscreens (Table 1) to determine the difference in solid removal between the filters.
- Effluent samples were tested for their total suspended solids (TSS) and volatile suspended solids (VSS).
- TSS measures the total concentration of suspended (non-soluble) solids in the cell four effluent.
- VSS is the total volatile (easily evaporated at normal temperatures) suspended solids that are used to estimate the concentration of organic solids.
- Dissolved methane remains in the ABR effluent.

Table 1: Dimensions of the stainless steel microscreens.

Microscreen Number	Mesh Pore Size (mm)
1	0.6858
2	1.0033
4	0.8763
5	0.889
6	0.9906
7	0.6858

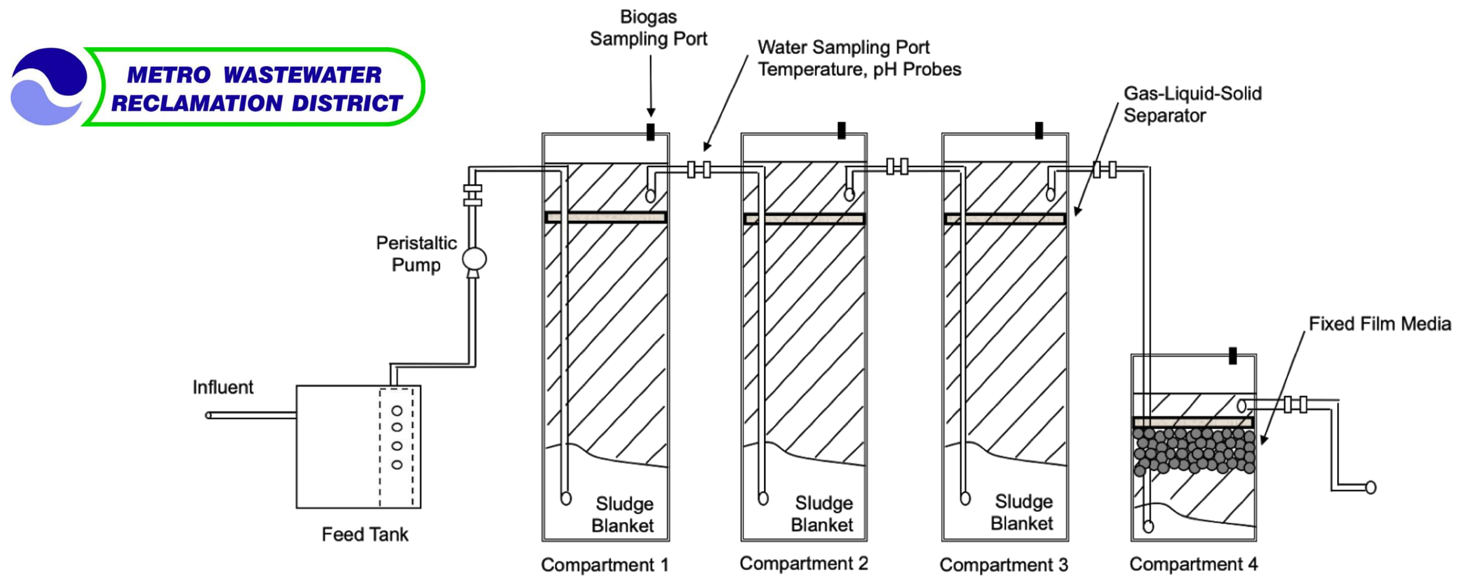

Figure 1: A schematic of the pilot-scale ABR used to anaerobically treat raw wastewater. Effluent samples were collected for dissolved methane and solids removal testing.

Results

Methane Removal

Testing was previously completed to determine if different microscreen sizes or wastewater effluent flow angles affected the amount of dissolved methane collected.

Solids Removal

After running the effluent water through the different sized microscreens, analysis of residual TSS determined whether or not there was additional solids removal with the microscreen. TSS was analyzed according to APHA Standard Methods for the Examination of Water and Wastewater

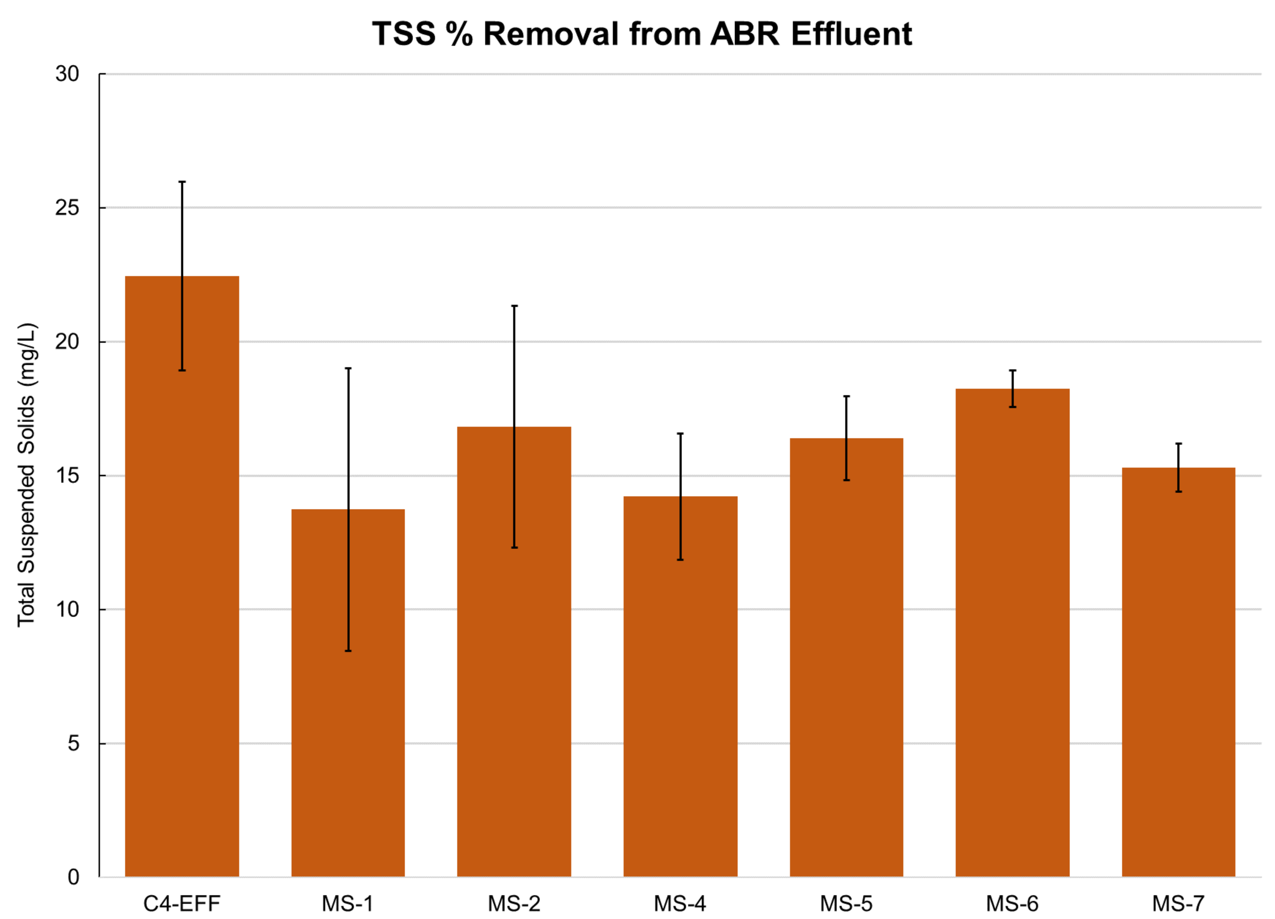

Figure 2: The remaining total suspended solids collected from the effluent after it was run thorough each microscreen.

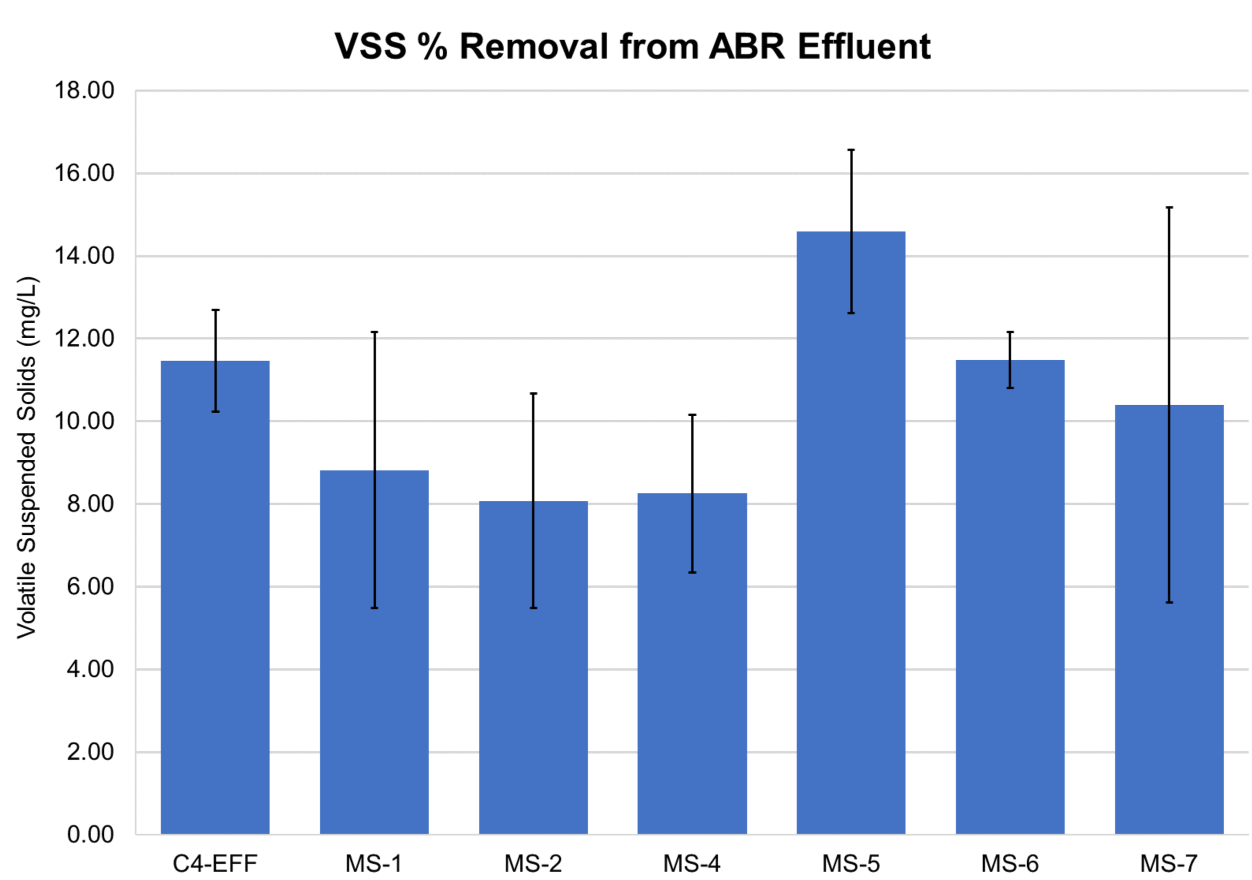

Figure 3: The remaining volatile suspended solids from the effluent after it was run through each microscreen.

Conclusions

Current domestic wastewater treatment systems are energy intensive and fail to recover potential resources available in the wastewater. A microscreen was used to remove dissolved methane and collect residual solids from anaerobically treated wastewater. Recovering the maximum amount of methane from waste water could:

- Decrease chances of explosion due to methane.
- Increase potential for methane recovery and beneficial use as an energy source.

Collecting residual solids from effluent could:

- Improve quality of water though solids removal.
- Clog microscreen pores.
- Be a potential source of organic material for biological methane generation.

More testing needs to be done to determine the most effective microscreen pore size and angle because the TSS/VSS analysis demonstrated that normal variability within samples can't confirm significant differences between the microscreens and the screen-filtered effluent quality.

Though anaerobic wastewater treatment systems are not currently used in todays domestic wastewater treatment paradigm, they have a lot of potential in resource recovery. Anaerobic treatment processes require longer solid retention times, and post-treatment is required to produce effluent suitable for discharge into the environment. However, implementing the microscreen could reduce energy demand for post-treatment and mitigate environmental impacts, while recovering resources from the water. This would help make anaerobic wastewater treatment technologies a promising solution for the future.

Next Steps

To decrease waste and increase efficiency of current wastewater treatment systems, more testing needs to be done to determine how to capture the maximum amount of dissolved methane with microscreens. Specifically testing in anaerobic wastewater treatment systems because they require less energy input because they do not need aeration, produce little biosolids, and offer possible energy sources from generation of methane.

To positively determine if residual solids in the effluent make a large impact on the microfilter and to determine if those solids can be used more precise testing needs to be done to get more accurate results. Equally important, testing of the dissolved methane can be done with more filters of different material and pore sizes to find the ideal screen. Identifying the ideal pore size and angle of the microscreen opens up many doors and allows for wastewater resource recovery.

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