Design and Operation of Anaerobic Membrane Bioreactors

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Abstract: Anaerobic processes for wasterwater treatment have several advantages over aerobic treatment processes. Anaerobic processes need less energy input. They can use the energy embedded in organic matter, and convert it to methane-rich biogas and operate as energy-neutral or even as energy-positive. They produce less biosolids and allow for possible nutrient recovery from the effluent. Efficient operation of anaerobic wastewater treatment requires heating wastewater to mesophilic or thermophilic temperatures. In cold climate conditions, operating anaerobic bioreactors is a challenge because the energy consumed to heat a large volume of wastewater outweighs the potential energy retrieval. To reduce the capital cost of wastewater treatment plants, it is important to treat high volume flow rate of wastewater with short hydraulic retention times. The slow growth of microbes at cold temperature, impacts the efficiency of anaerobic bioreactors; hence, long solid retention times (SRTs) are needed. Anaerobic membrane bioreactors (AnMBR) recently gained attention for high rate treatment of wastewater. They eliminate sludge washout, increase SRTs, and allow for treatment of wastewater at low temperatures. However, membrane fouling and reliable treatment at low temperatures remain as two primary challenges in AnMBRs. We have built a bench-scale AnMBR system that has a 2L continuously stirred tank bioreactor connected to an external cross flow membrane unit. Wastewater is fed from feed tank to the bioreactor using peristaltic pumps, and is recirculated between the bioreactor, the membrane unit and a chiller/heater. The effluent is collected from the membrane unit via a peristaltic pump that applies vacuum on the permeate side. A weighing scale determines the effluent mass. The bioreactor is equipped with a water level sensor, pH/temperature probe, and a 1L Tedlar bag for collecting biogas produced in the bioreactor. Transmembrane pressure is measured using a pressure transducer located on permeate line. AnMBR operation and data acquisition are automated and computer controlled using LabView. During the next two years, as part of a project funded through the Stimulus Research Program, we will evaluate different methods for mitigating membrane fouling, including determining the influence of soluble microbial products (SMPs) in fouling as well as studying effect of different membrane modifications.