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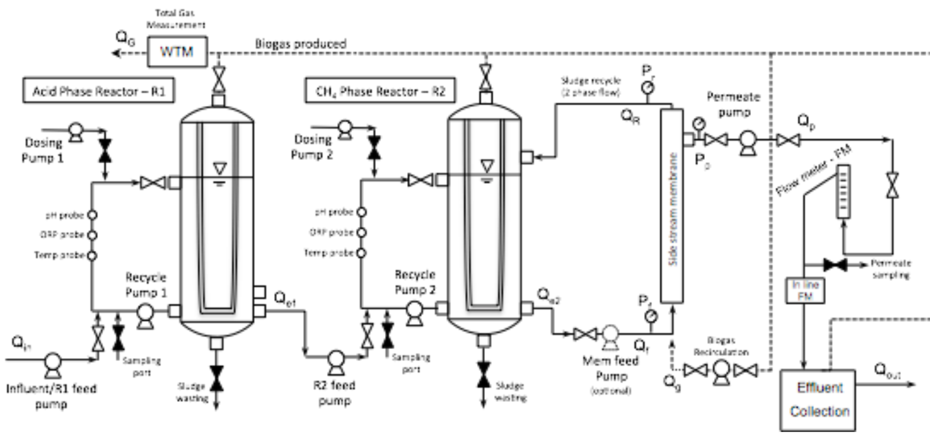
Start-up and Monitoring of a Gas-lift Anaerobic Membrane Bioreactor (Gl-AnMBR) for the treatment of wastewater and to recover nutrients for energy use purposes

The process of wastewater treatment through a gas-lift anaerobic membrane bioreactor (GL-AnMBR) was developed to allow for nutrient recovery and chemical oxygen demand (COD) removal, while being less energy intensive than traditional wastewater treatment practices. A GL-AnMBR is different from a regular anaerobic membrane bioreactor in that it uses gas for two purposes: scouring to keep the membrane fibers clean from fouling, and to pull the sludge through the membrane, rather than using a pump to push the sludge through, which would use more energy. The anaerobic nature of the membrane allows for COD to be removed from the system while the nutrient content remains untouched. The ultimate goal of the GL-AnMBR was to achieve about 90% COD removal and 60% nutrient recovery. The majority of my work on this project was in the start-up and preparatory phases. A detailed schematic of the system is shown below.



The purpose of this experiment was to monitor the performance of the GL-AnMBR during the start-up phase of the system. This included trouble-shooting, sample testing, and general maintenance. Initially, we ran the system with clean water in order to ensure that everything was working. We tested the system for both liquid and gas leaks and set up the operating parameters using Labview. When the system was running smoothly and consistently with clean water, we drained the system so that it could take up sludge. We started the sludge feed with seed sludge from the Denver Metropolitan wastewater treatment plant. The seed sludge was in the methane phase with total solids and total suspended solids concentrations, and a volatile fraction of 15540 mg/L, 15370 mg/L, 37.22%, respectively . The system is fed with raw sewage from the sewer line in Mines Park, Golden, Colorado. For the first few days, the system circulated the seed sludge, flushing the background from the treatment it had already undergone. Once the seed sludge had been almost completely filtered through the membrane, the feed from the clarifying tank, where the raw sewage was held, began to be pumped in. As the feed sludge circulated, the effluent became more and more clear, indicating that the system was working accordingly.

After the feed had been in the system for several days, we began our performance analysis. This consisted primarily of sampling the influent and effluent of the system and testing for nitrate, phosphorus, COD, and ammonia. We also took samples of the sludge in the recirculation line twice a week to determine the total solids (TS) and total suspended solids (TSS) concentrations, which helped us determine the age of sludge. Due to the extended amount of time spent calibrating and trouble-shooting, we only have a week's worth of test results. From our results so far, we can see that the progress towards the nutrient recovery and COD removal goals, as can be seen in Table 1. The trends from the nutrient and COD tests can also be seen in Figure 2.

% Recovery			% Removal	
Ammonia	Nitrate	Phosphorus	COD	
104.96	75.31	161.18	46.93	
97.45	82.89	165.38	53.89	
105.53	71.88	131.26	68.13	
114.92	69.99	113.95	76.89	
140.09	49.81	119.72	67.54	
average:				
112.59	69.97	138.30	62.68	

Table 1. *Recovery and removal efficiencies:* Average recovery rates indicate that ammonia levels for the most part were kept about the same, so no ammonia was being created. Some nitrogen has been nitrified, since there is not 100% recovery, but that was to be expected. Some phosphorus has also been created, but this is due to the fact that the Gl-AnMBR is not yet completely anaerobic. The average COD removal rate is lower than the goal, but this is probably due to the background from the
seed sludge still being flushed.

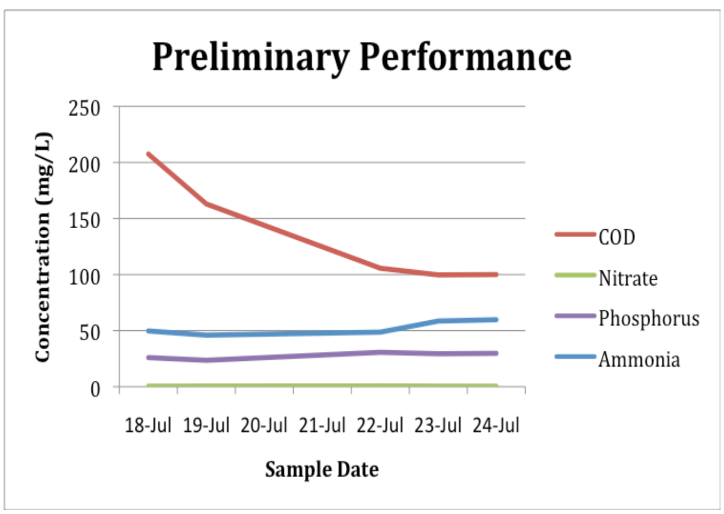


Figure 1: *Preliminary Performance curves:* The removal of COD and recovery of nitrate, phosphorus, and nitrogen can be seen in this chart tracking their concentrations in mg/L the course of one week.

These results are promising, and the overall performance of this GL-AnMBR is a good indicator for the future of wastewater treatment. This specific reactor could be paired with other treatment systems to for improved pathogen removal, purification, or biogas capture. All of these things would allow the treatment of wastewater to become more energy neutral and would help alleviate the stresses put on our world by our intense wastewater and water use needs.