An Evaluation of Mainstream Anaerobic Fluidized Bed Reactors (AFBR) to Treat Domestic Wastewater

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Objective: Explore chemically enhanced primary treatment (CEPT) as a way to remove reliance on filtration membranes in anaerobic secondary treatment

Background:

- Anaerobic secondary wastewater treatment produces less biosolids and utilizes less energy than traditional aerobic processes
- Staged Anaerobic Fluidized Membrane Bioreactor (SAF-MBR) systems are promising, but the membranes are expensive and must be maintained to reduce membrane fouling[1]
- Membranes are used to increase solids retention time (SRT) of particulate substrate to avoid limitations in hydrolysis

Methods:

Jar Test and COD testing (Fig. 1a)

- Vary coagulant dosages and test efficiency using a standard Jar Test Apparatus
- Measure Total and Soluble Chemical Oxygen Demand (COD) of supernatant

Biochemical Methane Potential Assay (Fig. 1b)

- Collect biofilmed GAC from SAF-MBR and set up serum bottles; include positive and negative controls
- Monitor methane production over time for CEPT supernatant and grit tank effluent using a Gas Chromatograph
- Model data to determine rate constants

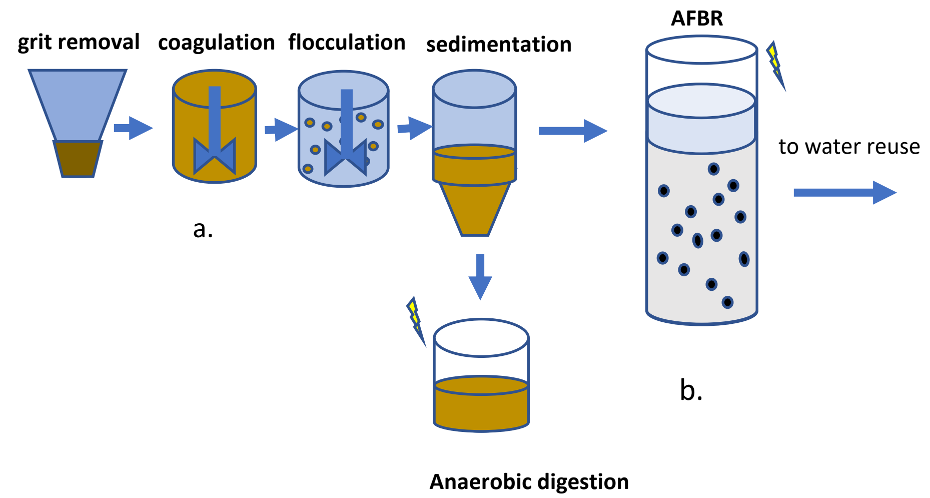

Figure 1. The Proposed Idea: CEPT (coagulation sequence) with solids fed into anaerobic digestion and supernatant fed into an AFBR; lightning bolts represent sources of methane production

Results: A ferric chloride dose of 50 ppm Fe^{3+} was determined to be the optimal concentration for particulate chemical oxygen demand (PCOD) reduction. Substrate consumption was monitored through methane production over time. These data are shown in Figure 2 below. Deviation between duplicates was negligible.

Discussion: The lengthy HRT required for necessary hydrolysis efficiency, as shown in Table 1, demonstrates that CEPT in tandem with an AFBR is not a viable alternative to membrane-focused anaerobic secondary treatment. The typical HRT within a SAF-MBR system is 4 hours, whereas the HRT within this proposed system would be 360 hours. The membranes ensure that the solids retention time (SRT) is much longer (> 480 hours) to create an adequate time for hydrolysis and PCOD breakdown, while keeping the HRT low .

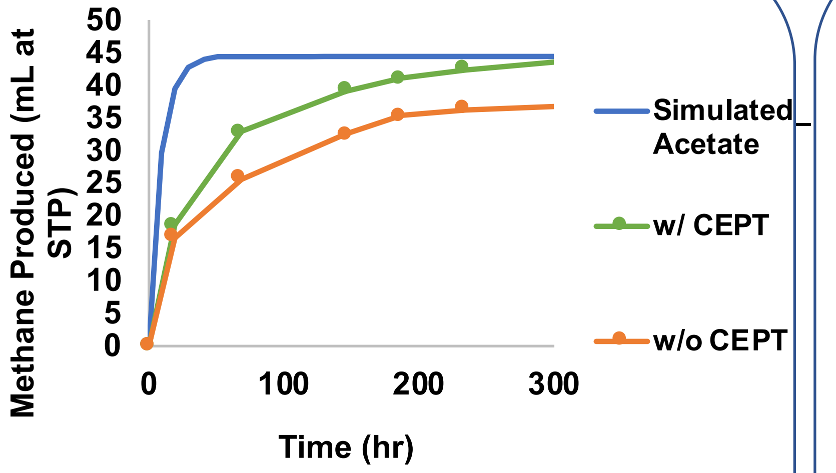

Figure 2. Methane production over time for BMP assay; lines represent different substrates

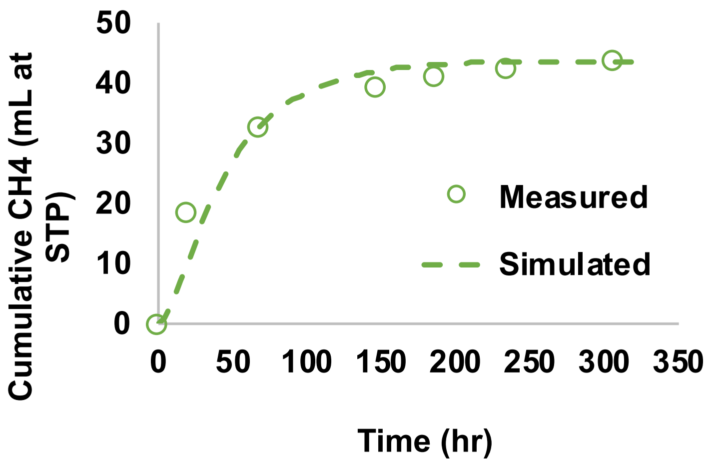

Figure 3. CEPT supernatant data modeled using consecutive reaction first order kinetics; rate constants were determined with this model

Table 1. Hydraulic retention time (HRT) required to achieve 90% hydrolysis efficiency

	Plug Flow Reactor	Continuously Stirred Tank Reactor
with CEPT	95 hours	360 hours
w/o CEPT	115 hours	430 hours

Conclusion: Membranes are needed to keep HRT low and SRT high within AFBR/SAF-MBR systems.

References

1 Shin, C., Mccarty, P. L., Kim, J., & Bae, J. (2014). Bioresource Technology Pilot-scale temperate-climate treatment of domestic wastewater with a staged anaerobic fluidized membrane bioreactor (SAF-MBR). *Bioresource Technology*, *159*, 95–103. https://doi.org/10.1016/j.biortech.2014.02.060