

Literature Review Compilation

Next to each idea/fact, include the superscript number corresponding to the number of the article (as assigned in our annotated bibliography document).

Startup Time

- Difficult to understand because it presents a lot of different solutions but highly recommend reading: Subramanyam, R., 2013. *Physicochemical and Morphological Characteristics of Granular Sludge in Upflow Anaerobic Sludge Blanket Reactors*. *ENVIRONMENTAL ENGINEERING SCIENCE* 30, 201–212.
<https://doi.org/10.1089/ees.2012.0347>
- A multistage biofilm reactor conducted startup in 3 phases each lasting 45 days: first with batch additions of wastewater, then a continuous flow of wastewater, and finally with an addition of CaCO_3 (9)

Methods

- Start testing pH in order to be able to measure the VFA output of the sludge blanket. This is a major cause of instability in a UASB system (12)
- Starting measuring temp
 - The lower the temperature, the higher the methane solubility and therefore an increase in energy loss

Design

- Holding tank to increase mixing before going into the reactor?
 - This can prevent the microbial community within the reactor from needing to deal with sudden changes within the influent
 - Septic tank to prevent odors
- Having a recycling stream
 - Faster velocity
 - More distributed organic loading?
- Different granule?
 - Improvements: Incorporation of the variation of density within the granule or diversity in the bacterial population distribution inside the granule in terms of the predominant species/groups
 - Different models: Multilayer model of granules, granule cluster structure, or non-layered structure model
- Can perform tracer tests to measure hydraulic performance on new systems
 - Mixing time or feed sludge dispersal time
 - <http://www.bhrgroup.com/Portals/5/Documents/Case%20Studies/SiteTracerTesting.pdf>

- UASB behavior resembles CSTR behavior

Talk to Ruth

- Consider microbial fuel cells as stabilizing the treatment process and yielding significantly higher methane yield and BOD treatment rates.
- Ask Professor Richardson about adding metal cations. How do we know which concentrations to add? Fe^{2+} , Mg^{2+} , etc. (8)
- Done during startup...add cations to get particles to stick together...it is not something you would do continuously
- We could reduce the flow a little bit, because they may not be able to work very well with the 8 hour residence time
- Fully operational, producing 60-70% methane biogas, the dissolved methane level is around 20 mg/L and we are currently at 15 mg/L
- Use the flocculator hopper in order to get some of the water out first so that we are not getting all of the water with the sludge at the bottom
- If we don't empty it all of the way (we could try and just take the top water out) we would need to seal up the top flange if we want to keep everything in there
- At half full the water inside will weigh around 200 pounds
- We are moving the reactors directly outside the room
- We need to buy buckets

Efficiency

- Temperature
 - Zeolites
 - Porous support, enables the reactor to retain high biomass concentrations and operate at significantly reduced hydraulic retention time
 - May further stimulate the growth of microcolonies
 - Higher temperatures are better for greater COD removal rates (comment on reading 1)
- pH
 - Maintaining a relatively neutral pH (6.3-7.8 required for methanogens) (1)

Future Consideration

- Consider sequential anaerobic-aerobic wastewater treatment (specifically UASB-Activated Sludge) and evaluate whether this is preferential to UASB and String Digester treatment currently being considered (11)
- Consider using hydrogen producing granules

- We could consider a holding tank that collects influent in order to prevent problems with either dilute water or high OLRs.

Recommended Readings for Everyone