Fall 2015 Challenges

Upflow Anaerobic Sludge Blanket (UASB)

Big questions to answer

1. What is the rate limiting step for UASB reactors (mass transfer or specific biological processes) and how could that rate limiting step be accelerated?
2. How can the bacteria concentration in the UASB be increased to reduce the required residence time?
3. Can GSBRs be used effectively to further treat wastewater after a UASB process? (links with Aerobic GSBR team). Corresponding task: Determine relative reactor sizes assuming specific hydraulic retention time averages (~4-8 hours for UASB and ~4-6 hours for GSBR)
4. How effective are designs at capturing methane generated in UASB (minimizing losses in effluent and through leaks)
5. How robust are UASBs at handling rapid fluctuations in the strength of wastewater?
6. How well do the UASBs treat nitrogen, phosphorus and, possibly, fecal indicator bacteria (harmless E.coli)?
7. How sensitive are UASB cultures to oxygen stress and/or acid stress?
8. How many households should be treated by a single UASB (ie. what is the ideal scale for the reactors - whole towns, small enclaves of ~10 homes, individual homes?)
9. How much energy can be produced per household reactor and how does this compare with cooking needs (cookstoves can use biogas directly)?
10. In what scenarios would a community benefit from investing in a generator to burn methane for co-generation of heat and electricity
11. (both UASB and GSBR teams): For WW treatment in Honduras: are UASB and GSBR still promising? Which other processes/reactor types make sense? esp for blackwater treatment (corresponding tasks would include researching reports from Honduras about accepted technologies and going through the sswm.info website for WW treatment technologies for Blackwater)
12. (both UASB and GSBR teams): Social and public health questions: Is there a need for WW treatment in Honduras or is the widespread surface disposal of WW not a problem (corresponding tasks would involve researching fecal bacteria data in Honduras and/or prep for doing some fecal bacteria tests on the the trip to Honduras in January)

Tasks and goals

- Design a UASB reactor that has an upflow velocity in the bottom of the reactor that is higher than the sedimentation velocity of the anaerobic granules. Use tube or plate settler geometry to create a capture velocity above the bottom resuspension zone that will generate a high concentration of granules or flocs of bacteria. This will require a new geometry for the UASB. The goal is to maximize the difference between the hydraulic residence time and the solids retention time and to not create settled sludge dead zones. This reactor might be a 20 cm vertical section followed by a 45 degree elbow, a 30 cm long tube, a 90 degree elbow, a 60 cm long tube, etc to create a zigzag upward flow tube settler reactor.

- Design and fabricate a gas tight methane biogas measurement system (test with known amounts of air injected into a reactor filled with water)
- Startup UASBs (includes choosing influent recipe - start with Aiyuk et al recipe but strengthen to simulate blackwater)
- Maintain UASBs.
- Create protocol/procedure for degassing O_2 from influent water tank (to minimize O_2 coming in with WW)
- Analyze performance variables during experiments (COD, N, P, possibly *E. coli*) and photograph biomass
- Measure methane collected in biogas and lost in effluent to calculate captured methane compared to losses
- Collaborate with Aerobic GSBR team to combine the technologies for robust WW treatment that is energy neutral or energy positive.

Resources

- Past reports from Fall 2013 and Spring 2014 as well as datafiles from Summer and Fall 2014.
- Literature on UASBs