Prelim 2 Review
M-F of next week

With a focus on Flocculation and Sedimentation and beginning of Filtration

12 points - 3 multiple choice

18 points – 6 short answer

70 points – design challenges

Who can I talk with about what?

- No conversations (social media, discussion boards, etc.) with anyone* about CEE 4540 between Monday class and Friday class
  - *Except in class!
  - *You can ask questions to Juan or Monroe (email or in person)

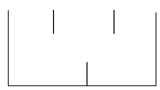
Flocculator Equation Summary

$$\nu\bar{G}^2 = \bar{\varepsilon} = K_e \frac{\bar{V}^2}{2}\frac{1}{\theta_e} = \frac{K_e\bar{V}^3}{2H_e} = \frac{K_e}{2H_e}\left(\frac{Q}{WS}\right)^3$$

Equations for average energy dissipation rate

$$W_{Min} = \frac{\Pi_{HS_{\min}} Q}{H_e}\left(\frac{K_e}{2H_e\nu\bar{G}^2}\right)^{\frac{1}{3}}$$

Minimum channel width to prevent



$$H_{e_{Max}} = \left[\frac{K_e}{2\nu\bar{G}^2}\left(\frac{Q\Pi_{HS_{Max}}}{W}\right)^3\right]^{\frac{1}{4}}$$

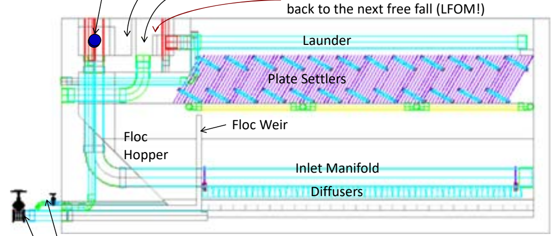
Maximum distance between expansions to ensure relatively uniform velocity gradients

$$S = \left(\frac{K_e}{2H_eG^2\nu}\right)^{\frac{1}{3}}\frac{Q}{W}$$

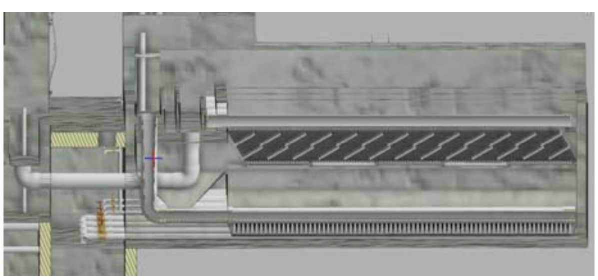
Baffle spacing

Distance between flow expansions

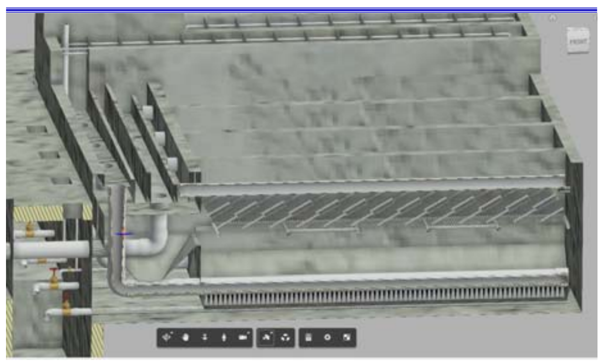
AguaClara Sedimentation Tank



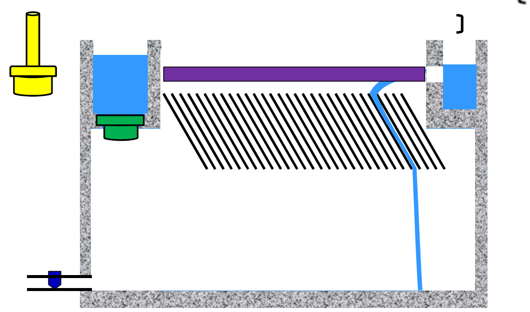
AguaClara Sed Tank Geometry



AguaClara Sed Tank Geometry



How can you drain and then refill a sedimentation tank?



Sedimentation: How do these velocities connect to design?

- Settle capture – determines the slowest terminal velocity floc that will settle to a surface
- Slide capture – determines the slowest terminal velocity floc that will slide down the plate. Function of velocity gradient at plate settler surface, angle, and floc density
- Upflow – set to obtain good performance of the floc blanket (ongoing research)
- Terminal – floc property set by maximum energy dissipation rate of the environment it is in AND by the previous collision potential

Settle Capture Velocity

- Which provides better removal of particles, a low settle capture velocity or a high settle capture velocity?
- Suppose you keep plate length constant and decrease spacing between plates. What happens to performance and cost?
- Could you design a sed tank with a floc blanket without plate settlers?

Performance ratio (conventional to plate/tube settlers)

- Compare the area on which a particle can be removed
- Use a single plate settler to simplify the comparison

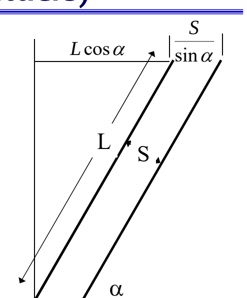
Plate/tube capture area

$$A_{plate} = W\frac{S}{\sin\alpha} + WL\cos\alpha$$

Conventional capture area

$$A_{conventional} = W\frac{S}{\sin\alpha}$$

$$\frac{A_{plate}}{A_{conventional}} = A_{ratio} = 1 + \frac{L}{S}\cos\alpha\sin\alpha = \frac{V_{Plate\uparrow}}{V_c}$$



Decrease the plate settlers spacing (and maintain the same up flow in the sed tank and the same capture velocity)

a) same amount of plastic needed for plates

b) increase the velocity gradient at the plate

c) increase the slide capture velocity

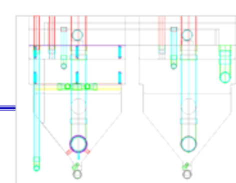
d) decrease the height of the plate settlers

e) increase the head loss through the plate settlers

f) decrease the Reynolds number for flow between the plates

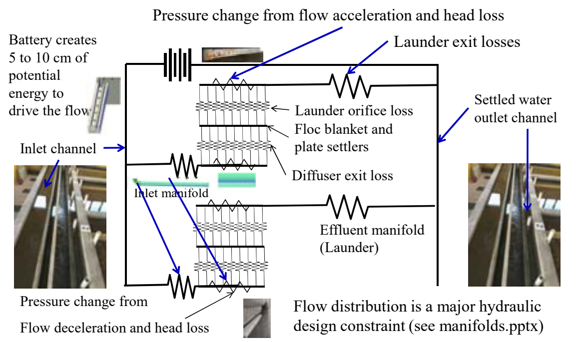
Quiz 11/5/14

Sed Questions



- What determines the depth of the sedimentation tank?
- What happens if you make the sedimentation tank 2 m wide or 50 cm wide?
- Why does the flow divide evenly between the sed tanks?

Anything that makes differences in parallel paths is bad!



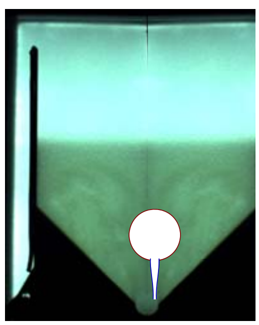
Flow Distribution

- Does high velocity in a sed tank inlet manifold help or hurt flow distribution?
  - Why?
- If you increase velocity in a manifold what else must you do to maintain uniform flow distribution?

$$\Pi_{DiffuserFlow} = \sqrt{\frac{hl_{ParallelPath} - \frac{\Delta H_{Manifold}}{2}}{hl_{ParallelPath} + \frac{\Delta H_{Manifold}}{2}}}$$

Floc Hopper Q's:

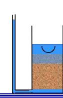
- What is in the floc hopper before it fills with flocs?
- Why do flocs flow over the floc hopper weir?
- Why does a floc blanket interface slowly rise?
- How fast are flocs settling unto the sloped bottom?



Floc Blanket

- Why would a floc blanket not work if AguaClara didn't use plate settlers?
- What mechanisms could explain why a floc blanket reduces the turbidity of the settled water?

Backwash Requirements – Head Loss (force balance)



Weight of water/Filter area   Weight of sand/Filter area

$$P_{Manometer} = \rho_{Water} g \left(H_{W_1} + H_{W_2} + \varepsilon_{FiSand} H_{FiSand}\right) + \rho_{Sand} g \left(1 - \varepsilon_{FiSand}\right) H_{FiSand}$$

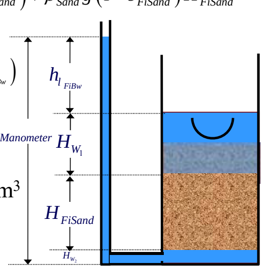
||

$$P_{Manometer} = \rho_{Water} g \left(H_{W_1} + H_{W_2} + H_{FiSand} + h_{l_{FiBw}}\right)$$

$$\boxed{h_{l_{FiBw}}} = H_{FiSand}\left(1 - \varepsilon_{FiSand}\right)\left(\frac{\rho_{Sand}}{\rho_{Water}} - 1\right)$$

For ε_{FiSand}=0.4 and ρ_{Sand}=2650 kg/m^3

$$\left(1 - \varepsilon_{FiSand}\right)\left(\frac{\rho_{FiSand}}{\rho_{Water}} - 1\right) = 0.99$$



Big picture: Prelim question that didn't make the cut…

An AguaClara plant that includes all of the latest in design innovations (flocculation, floc blanket, floc hopper, plate settlers, stacked rapid sand filter) is built for a community of 15,000 people with a per capita demand of 3 mL/s per person. The facility has 8 sed tanks and 2 filters. During a drought the flow rate through the plant is reduced by 50%. Which unit processes are affected negatively by a reduction in flow rate and what changes in operation would you advise?

$$G\theta_e = \sqrt{\frac{H_e K_e Q}{2\nu W S}}$$