Separation Processes, ChE 4M3, 2013

Assignment 2

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Questions related to sedimentation, centrifuges and particle size distributions.

Question 1 [15]

A waste stream at a peak rate of 500 m^3 per hour is to be treated. The company's *rectangular* settling basin has length of 15 meters and width of 23 meters.

These are latex particles with approximately the following sizes present: 30μm, 40μm, 50μm and 90μm and these particles have a density of 1200kg.m^{-3}.

1. Which particle sizes will be completely separated out?
2. What will happen with the other particle sizes?
3. Prove in a clear manner (i.e. using equations and step-by-step logic) that the depth of the sedimentation vessel has no bearing on the problem.

Question 2 [8]

A company is treating a given wastewater stream, contaminated with fine solids. The municipal waste system will not allow this waste to be dumped untreated. The problem however is that the solids take too long to settle, about 1.0 mm.s^{-1} in a lab test. A small amount of cheap flocculant triples the settling time, to almost 3 mm.s^{-1}.

What will be the multiple of capital cost saving by using flocculant? (e.g. your answer should be something like: "capital cost will be reduced N times")

Question 3 [12]

1. In a test on a given centrifuge, particles of density 2800 kg.m^{-3} and of size 5 μm equivalent spherical diameter, were separated from suspension in water fed at a volumetric throughput rate of 0.25 m^3.s^{-1}. Calculate the value of the capacity factor, Σ.
2. What will be the corresponding size cut for a suspension of coal particles in oil fed at the rate of 0.04 m^3.s^{-1}? The density of coal is 1300 kg.m^{-3} and the density of the oil is 850 kg.m^{-3} and its viscosity is 0.01 N.s.m^{-2}.
3. Is Stokes' law applicable?

Question 4 [6]

A thickener is operating at the designed feed rate of 180 m^3hr^{-1} but needs to be operated at 225 m^3hr^{-1} due to increased upstream production. It is the last step before discharging the overflow stream to municipal

treatment. Since your company is under investigation from government authorities already, there can be absolutely no risk of discharging additional solids in the overflow.

Clearly explain at least 3 options you can realistically investigate to handle the increased flow; and be as creative as possible. Also, be clear on the expected magnitude of your effect: is it linear or some other function?

Question 5 [3 + 3]

A student in the class pointed out this article from the Toronto Star.

Describe the various separation units used by this technology. A 3 mark bonus if you can provide credible references as to the flocculant used.

Question 6 [10]

Plot the differential and cumulative analysis (only show the percent retained curve) for the following sieve test results:

Mesh number	Mass retained [g]
6	0.0
8	12.8
12	28.3
16	148.6
20	251.3
30	192.3
40	79.6
50	49.2
70	24.7
140	12.6
170	8.4
230	12.8
Pan	11.2

END