Separation Processes, ChE 4M3, 2014

Assignment 3

Kevin Dunn, kevin.dunn@mcmaster.ca **Due date: 14 October 2014**

Objectives: Consideration of centrifuges, filtration, and cyclones: not only the design of these units, but also operating them under different conditions.

Question 1 [6]

1. Find the specific cake resistance for pyrite pellets that are 100 μm.
2. Is the cake resistance higher or lower for particles that are 50 μm? (interpret this, and the prior answer)
3. If your particles are not spherical, which equivalent particle size would be suitable to calculate for the purpose of filtration calculations?

Question 2 [3]

Why might perlite (a type of volcanic glass) sometimes be added to filtration slurries? Describe the mechanism that makes this work to your advantage.

Question 3 [15]

Under your supervision is a continually operating process that has a disk-bowl centrifuge. You are producing a bacterial-product that has minimum monthly targets, and you are only just meeting those targets. The centrifuge is rated with a $\Sigma = 5256$ m^2 value when operated at $\omega = 5000$ rpm for separating bacteria from a bioreactor broth. The bacteria's density is 1050 kg.m^{-3} with average particle size of 30 μm; it is fed at a concentration of 20 kg.m^{-3}.

1. What is the interpretation of this Σ value?
2. Why is a disk-bowl centrifuge applicable in this company?
3. Your company wants to get better performance from the centrifuge. A colleague has suggested that if you dilute the feed you might get a higher recovery (separation factor) for the bacteria. So the plan is to install a holding tank before the centrifuge and dilute the feed 5-fold, down to a concentration of 4 kg.m^{-3}. What will be the *quantitative result* (i.e. numeric result) on protein recovery of doing this?
4. The operator wants to re-use this same centrifuge, but operated at 6200 rpm, for separating particles of density $\rho = 1250$ kg.m^{-3} and average particle diameter of 2μm. These particles were mistakenly added to a large quantity of liquid that has $\rho = 800$ kg.m^{-3} and $\mu = 0.3$ N.s.m^{-2}. Provide some guidance to the operator as to how long it will take to process this batch of 10 m^3 of liquid.

Question 4 [15]

You are evaluating a pilot-scale plate and frame filter press to filter limestone particles prior to entering a municipal discharge. The plate and frame press has plates which are 400mm by 400 mm (and note that the

active area is on both sides of each plate; see photos online, or in the course notes). The intention of these tests is to find the various resistances, so you can purchase a large scale unit.

The data you collect on the rental unit are posted as a spreadsheet; calculate the two resistances.

Question 5 [20]

A company is running a cyclone to remove valuable dust particulates from the air stream. The solids flow rate is 180 kg solids per hour, and so far they can recover most of the solids leaving in the underflow: 127 kg solids per hour. These two streams were sampled for a period of time and using screens, the following size analyses were performed:

Mesh number	Mass retained from feed [g]	Mass retained from coarse stream [g]
20	0	0
30	30	36
35	60	70
40	180	200
50	200	160
60	120	60
Pan	30	5

1. Plot the differential analysis curve for both streams, superimposed.
2. Calculate the total efficiency of the cyclone.
3. Calculate the cut size for this cyclone.
4. Describe one way you could **quantify** the cut's sharpness (interpret what the "sharpness" when describing cyclone performance).

END