

# Separation Processes, ChE 4M3, 2013

## Assignment 3

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To use ideas and formulas related to mechanical separation units.

### Question 1 [8]

1. Prove that for a spherical particle,  $S = \frac{6}{d}$  = specific surface area of particle per volume of solid particle, with units of  $\text{m}^{-1}$ .
2. Calculate this value for spherical particles of  $50 \mu\text{m}$  and  $100 \mu\text{m}$ .
3. What is the theoretical value(s) of voidage for spheres?
4. Calculate  $\alpha$ , the specific cake resistance value in a filtration system for spherical particles of  $50 \mu\text{m}$  and  $100 \mu\text{m}$ , where the solids have a density of  $2500 \text{ kg}\cdot\text{m}^{-3}$ .

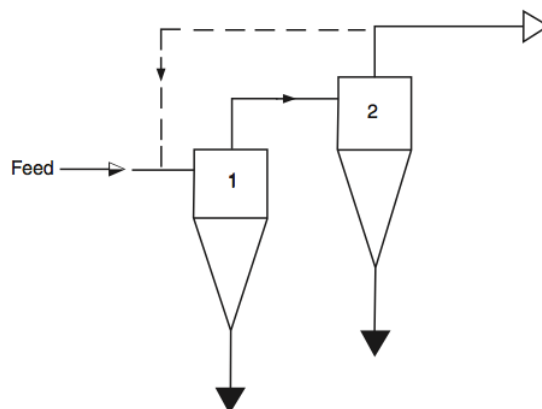
### Question 2 [4]

1. Under what assumptions do filtration data from lab equipment plot as a straight line for  $V$  versus  $\frac{t}{V}$  axes?
2. Look up the terms “precoat” and “filter aids” in the context of solid-liquid plate-and-frame or vacuum rotary-drum filtration. Explain in an unambiguous manner the purpose they serve.

### Question 3 [5]

Your sister company seems to have no problem at their site with particulate pollutant discharge. Your site however experiences continual problems, despite using a similar process.

You request their flowsheet and notice an arrangement of cyclones as shown below (your flowsheet does not have any cyclones). Explain what this sequence might do to help achieve pollutant reduction.



**Question 4 [20]**

The following filtration data are collected from a laboratory unit, using the same filter medium for all experiments. The objective is to determine the constants  $\alpha_0$  and  $f$  in the equation for specific cake resistance,  $\alpha = \alpha_0 (-\Delta P)^f$ , where  $\alpha$  and  $\alpha_0$  are in units of  $\text{m.kg}^{-1}$ , and  $-\Delta P$  is in Pascals.

Test 1 was run at 36 kPa, test 2 run at 128 kPa, and test 3 run at 370 kPa. All tests were run with a slurry concentration of 25 kg dry solids per cubic meter of filtrate, and the viscosity was around  $9.2 \times 10^{-4}$  Pa.s on a filter of  $0.08 \text{ m}^2$ .

Filtrate volume [L]	Test 1, Time [s]	Test 2, Time [s]	Test 3, Time [s]
0.25	20	13	4
0.5	39	29	9
1.0	99	70	26
1.5	175	123	53
2.0	276	207	83
2.5	–	365	128
3.0	–	399	182

Show all calculations made, including your assumptions. Work in a systematic manner.

**Question 5 [12]**

IGNORE THIS QUESTION

**Question 6 [8]**

After reading this article [on the course website](#), describe

1. what a venturi scrubber does
2. draw a sketch of how it looks
3. give an advantage relative to another separation unit that achieves a similar purpose
4. give a disadvantage relative to another separation unit that achieves a similar purpose.

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END