Separation Processes, ChE 4M3, 2014

Assignment 1

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Separation Processes can be viewed from a number of perspectives: what is the mechanism being used to separate? what phases are being separated from each other; and separating agents are being added to the system?

Let's take a look at these, as well as get into details about the first topic covered so far: sedimentation.

Question 1 [10]

1. Identify the mechanism (principle of separation) by which the components are being separated in the following instances. For example, when concentrating orange juice in an evaporator, we are exploiting the difference in *volatility* between water, and the complex aqueous compounds that make up the juice.

   Unit operations to consider:

   - Ion exchange
   - Brewing coffee in hot water (focus on the brewing step, not the separation of coffee grounds from the brew)
   - Flash drum
   - Hemodialysis
   - Venturi scrubber

2. Also identify the separating agent in each case, and state whether it is an MSA or ESA.

Question 2 [5]

Give actual example(s) of where the following mechanism (principle of separation) could be used to split components from a given feed stream. State the name of a unit operation that exploits this mechanism to cause the separation. *For example*, the first answer could be "a sequence of sieves".

- Difference in particle sizes
- Difference in molecule sizes (not particle size)
- Difference in liquid densities
- Difference in particle's surface charge
- Difference in relative solubility
- Difference in relative volatility

Question 3 [8]

Describe what the following separators do (be a bit more adventurous than just using Wikipedia in your research)

- mechanical deboner
- flotation cell
- pressure swing adsorption
- fluidized bed

Question 4 [10]

List five ways you can think of to separate dust from a fluid stream. The methods must be physically possible. Use sketches in your answers.

Question 5 [10]

1. Spherical particles of ion-exchange resin of 100 μm diameter and density of $\rho = 1200\,\text{kg.m}^{-3}$ are settling in an glycerol solution ($\rho = 1100\,\text{kg.m}^{-3}$ and $\mu = 0.05$ Pa.s) under gravity.

   What is the terminal settling velocity?

2. We have however a complete distribution of particle sizes: the smallest particle size is 50 μm and the largest is 140 μm. In general, should we plan our design for the separation unit based on the larger size or smaller size particles?

Question 6 [4]

In this flowsheet for converting sugar cane to raw sugar from King's textbook, *Separation Processes*, identify 2 separation unit operations.

For each unit operation, describe:

1. the principle being exploited to create the separation
2. the ESA and/or MSA being added.

Also, watch the video on the sugar process again [http://www.youtube.com/watch?v=ZBOou6cahtw] to visualize the size of these units.

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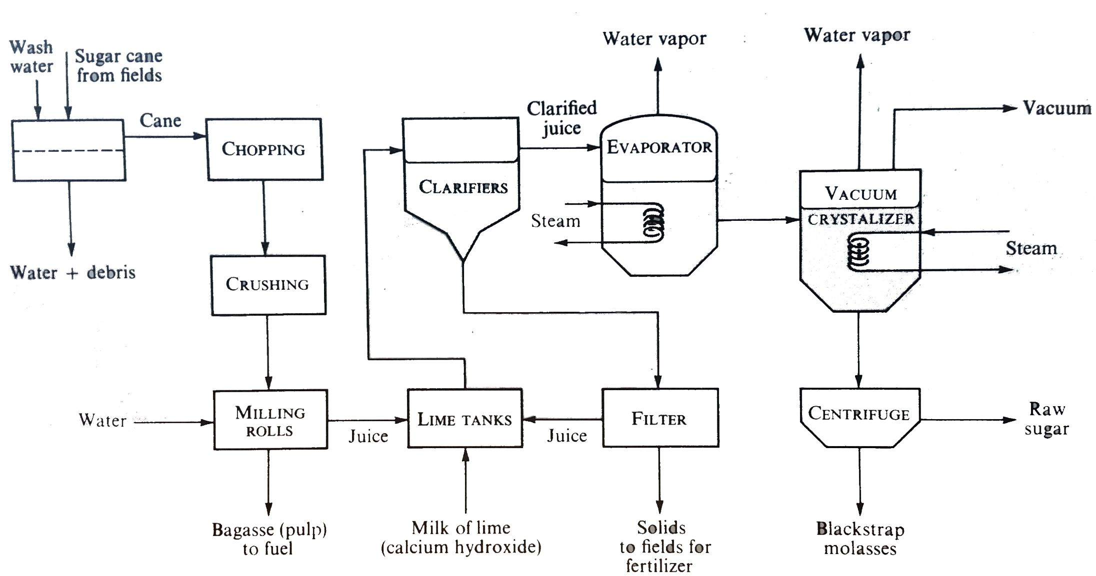

Figure 1-1 Processing steps for producing raw sugar from sugar cane.

Figure 1: See King, "Separation Processes", 2nd edition, p 3.