

Kem 100-120 Process Simulation I

Examination: 9.12.2004 Time: 9-12

Theory (max. 1 h) Answer in Finnish, Swedish or English

1. Explain shortly:
 - a) Utility bottleneck
 - b) Splitter module
 - c) Rating
2. Reactor types in a simulator
3. Variables and constraints in optimization

Simulation:

4. Citric acid solution is feed to a continuous crystallizer, where 50 wt-% water is removed by evaporation. Evaporation operating temperature is at 100 °C and pressure 1 bar. Residence time of the crystallizer is 5 h and the yield is 98%. The crystals product is filtrated in a vacuum filter. 850 kg/h water is feed in the filter. 98% of the crystals are separated and the cake dryness (LOD) is 30%. The filter cake is dried in a drum dryer, where 98 wt-% water is removed. In addition 1 wt-% crystal is also removed with water.

Guidance: Make a user defined crystal component. Specify in crystallizer that citric acid crystallizes as this user defined crystal component.

Feed to the crystallizer is at 25 °C and 1 bar:

Calcium Citrate:	9.7 kg/h
Citric Acid:	1490.0 kg/h
Sulfuric Acid:	57.0 kg/h
Water:	11608.0 kg/h

Simulate the process. Determine the unit production costs. The citric acid crystals selling price is 2.5 \$/kg. The cost of the liquid waste stream from filter is 0.01 \$/kg. The purchased cost of citric acid is 1.75 \$/kg.

5. Vapor containing 10 mol-% hexane and 5 mol-% heptane and 85 mol-% of air at 30 °C is cooled to recover the hydrocarbons. In which outlet temperature 90 mol-% of hydrocarbon vapors is removed as liquid in atmospheric pressure?

Maximum points: theory:	1-3	2p/each
Simulation	4	5p
	5	3p
Exercises:		4p (100% attendance)
TOTAL:		18p