Design Project
Fall 2006

Acetone is typically produced in commercial quantities as a by-product during the formation of phenol. However, acetone manufactured thus generally contains small amounts of the reactant benzene and the desired product phenol. In the past, these impurities were deemed to be within allowable limits. However, recent downward revisions of these limits by the US Food and Drug Administration has made alternative processes (which do not involve benzene) more attractive. We wish to begin the design of one such alternative process to produce 10,000 metric tons of acetone per year with a purity of 99.9%.

Consider the following reactions involved in making acetone.

$$\begin{aligned} (CH_3)_2CHOH &\longrightarrow (CH_3)_2CHO + H_2 \\ 2(CH_3)_2CHOH &\longrightarrow (CH_3)_2CH - O - CH(CH_3)_2 + H_2O \end{aligned} \tag{1}$$

The first reaction produces the desired product, acetone (AC) and hydrogen (H) while the second reaction produces undesired product, di-isopropyl ether (DE) and water (WA). The reaction proceeds at 2 *atm* and a temperature range of 300 ^oC to 360 ^oC.

1. Utilize the Douglas Hierarcy to describe the rationale for using the BFD shown in Figure 1. Convert this BFD into a skeleton PFD.

2. *Assuming* that there is no recycle, compute the mass balances necessary to get the desired product specification. Use the following conversion information.

Team	Temperature	Conversion	moles DE/moles AC
1	300	46.3	0.0100
2	310	55.4	0.0095
3	320	64.6	0.0090
4	330	73.4	0.0080
5	340	81.3	0.0070
6	350	87.8	0.0060
7	360	92.7	0.005

3. Now compute the mass balances *with* recycle.

   This part of the project is done *without* using CHEMCAD. You are allowed to use a spread-sheet to do calculations. Please note that many details have been left out in Figure 1 and some of the information in the figure may not be *correct*.

4. Utilize the BFD that you used in Part II and compute the molar flowrate of each stream in the flowsheet using CHEMCAD.

5. Compute the energy balance using CHEMCAD and determine the heating/cooling requirements for each unit.

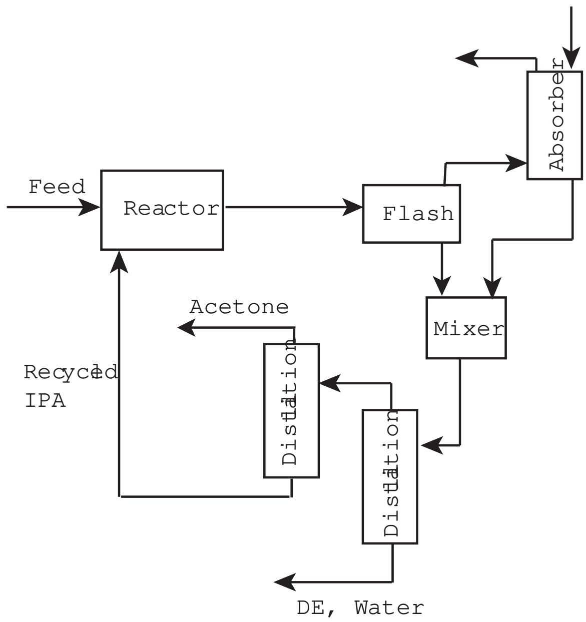

Figure 1: Block Flow Diagram

6. Compare your CHEMCAD results with hand calculations done in Part II and comment on the differences (if any).

7. Specify which heuristics you used from TBWS to set pressure and/or temperature levels in the BFD.

8. Determine the size of each equipment in your BFD. Specify which heuristic you used from TBWS for sizing each unit.

9. Specify which type of equipment you are using and its material of construction.

10. Determine the total capital cost of your process by using CAPCOST.

11. Determine the total manufacturing cost of your process by using CAPCOST.

Final Design Project Format

Write a design report using the instructions given in TBWS that include all the questions asked above. You need to back up all your results and conclusions with appropriate calculations and/or references to heuristics. The report should be readable by any faculty member of the Department of Chemical Engineering who has read the problem statement. TBWS Chapter 27 provides example tables and figures. Include a page defining all nomenclature.