ChE-251: Chemical Process Calculations

Lab Session 2

1. Problem Statement

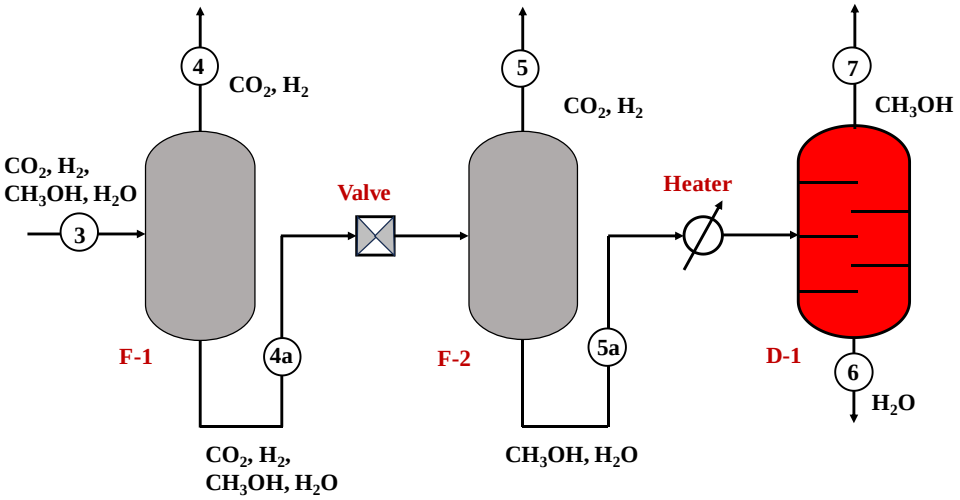

Figure 1. Separation network to obtain pure methanol.

A process flow diagram to purify methanol is shown in Figure 1. Read the description of the separation network given in the introduction of Practical 1. The mole fractions of streams 3, 4, 5, 6, and 7 are given in Table 1, and the total flow rate of stream 7 is 893.263 kmol/hr. The goals of the laboratory are to:

1. Determine the total molar flow rate of all the streams and the mole fractions of streams 4a and 5a. Ensure that the variables are determined by solving **linear** set of equations. Assume that the process is continuous and operating at a steady state.

2. Make a plot of the total capital cost of separation equipment as a function of methanol flow rate. Vary the methanol flow rate from 500 kmol/hr to 1500 kmol/kr. The capital costs of the three equipment as a function of the inlet flow rate are given by:

$$C_{F1} = \$182{,}100\left(\frac{F_3}{F_{3-base}}\right)^{0.6}$$

$$C_{F2} = \$171{,}200\left(\frac{F_{4a}}{F_{4-base}}\right)^{0.6}$$

$$C_{D1} = \$1{,}725{,}400\left(\frac{F_{5a}}{F_{5a-base}}\right)^{0.6}$$

where C_{F1}, C_{F2}, and C_{D1} are the capital costs of F-1, F-2, and D-1, respectively. F_3, F_{4a}, and F_{5a} are the molar flow rates of streams 3, 4a, and 5a, respectively. F_{3-base}, $F_{4a-base}$, and $F_{5a-base}$ are

the molar flow rates of streams 3, 4a, and 5a, respectively, for the base case corresponding to the molar flow rate of stream 7 of 893.263 kmol/hr. The figure should be labeled well.

Write a report with sections titled (1) Aim, (2) Method, (3) Results and Analysis, (4) Conclusion, and (5) Appendix. In the methods section, describe the methodology, define the variables, write, and explain the equations, and perform degree of freedom analysis. In the results section, report the results obtained using Matlab. The appendix section should contain the Matlab code with comments explaining the written code.

Table 1. Mole fraction of components in various streams.

Comp. mole fraction	Stream 3	Stream 4	Stream 5	Stream 6	Stream 7
CO_2	0.176	0.243	0.744	0	0.002
H_2	0.53	0.752	0.027	0	0
CH_3OH	0.147	0.004	0.188	0	0.987
H_2O	0.147	0.001	0.041	1	0.011