1) (MASS BALANCE; NOT REACTIVE) Midterm 2019

A three-stage separation process including species A, B and C is shown in Figure 1. F, D1, D2 D3, P1, P2, P3 and E denotes the total mass for the indicated streams.

F (Feed) is 100 kg and composed of 50 wt % A 20 wt% B and the remaining is C.

D1 is composed of 50 wt% A, 23 wt% B and the remaining is C.

D2 is composed of 17 wt % A, 10 wt % B and the remaining is C.

D3 is 10 kg total and composed of only A and B.

P3 is composed of only A and B with 70 wt% A and 30 wt% B.

The ratio of P3/D3 is 3, the ratio of P2/D2 is 1, and the ratio of A and B in stream P2 is 4 to 1.

a) Perform degree-of-freedom analysis for each of 4 systems (Unit 1-2-3 and Overall)

b) Calculate all the unknown masses for the streams (D1, D2, P1, P2, P3 and E) and all the unknown compositions in the process and fill the Table 1. (an example is given for the stream F with the data provided in the question).

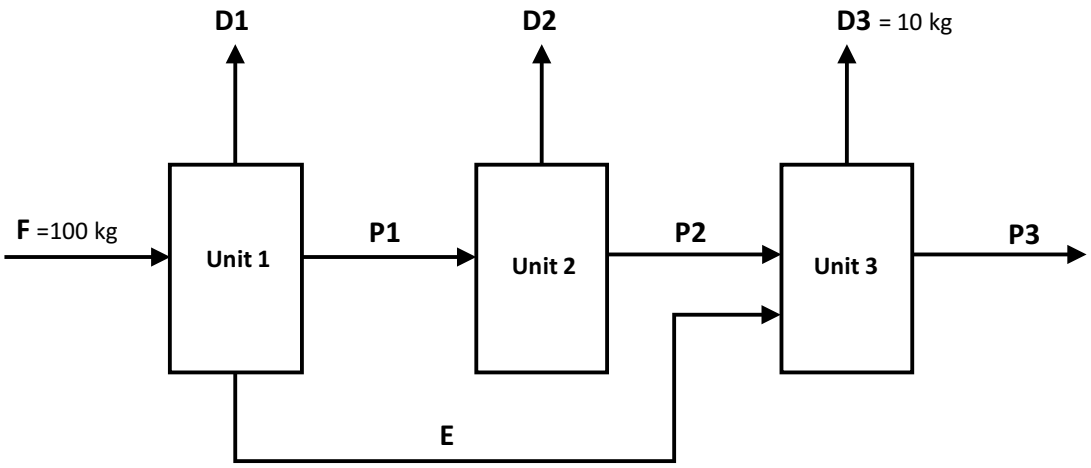


Figure 1. Three-stage separation process

Table 1 Mass and composition of all streams

F	100 kg	D1		D2		D3		P1		P2		P3		E	
x_A	0.50	x_A		x_A		x_A		x_A		x_A		x_A		x_A	
X_B	0.20	X_B		X_B		X_B		X_B		X_B		X_B		X_B	
X_C		X_C		X_C		X_C		X_C		X_C		X_C		X_C	

2) (**MASS BALANCE; REACTIVE) Midterm 2019**

Hydrogen can be produced by the shift reaction:

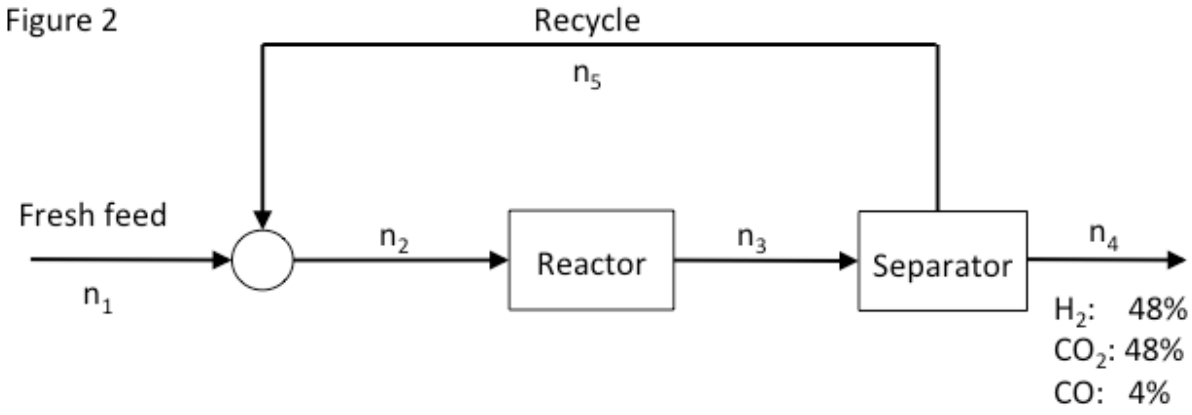
$$CO + H_2O \rightarrow CO_2 + H_2$$

In the reactor system shown in Figure 2, the conditions of conversion have been adjusted so that the H_2 content of the effluent from the reactor is 3%. The composition of the stream that enters in the reactor is 70% H_2O and 30% CO. The recycle stream contains only H_2O and CO. (All the stream compositions are in mole %). Basis: n_1 = 100 mol/h.

a) Calculate the flow and composition of all streams.

b) Calculate the moles of recycle per mole of hydrogen produced.

Figure 2



3) (MASS BALANCE; NOT REACTIVE) Midterm 2013

A mixture of two components, A and B, is fed at 100 kg/hr to a process unit (Unit 1) in equal parts by mass (F1). One stream, which contains 90 mass % A exits this unit at a rate of 40 kg/hr (F2). A second stream leaves Unit 1 (F3) and is mixed with a 30 kg/hr stream which is 70 mass % B (F4). This combined stream (F5) serves as the inlet for Unit 2. One of the two outlets from Unit 2, (F6) with the flowrate of 30 kg/hr, is analyzed and found to contain 60 mass % A. There is no data for the composition of the second stream exits unit 2 (F7).

a) Draw a flowchart of this process
b) How many systems you find for this process?
c) Perform the degree of freedom analysis for all the systems and calculate all the flowrates and their compositions if not given in the problem.