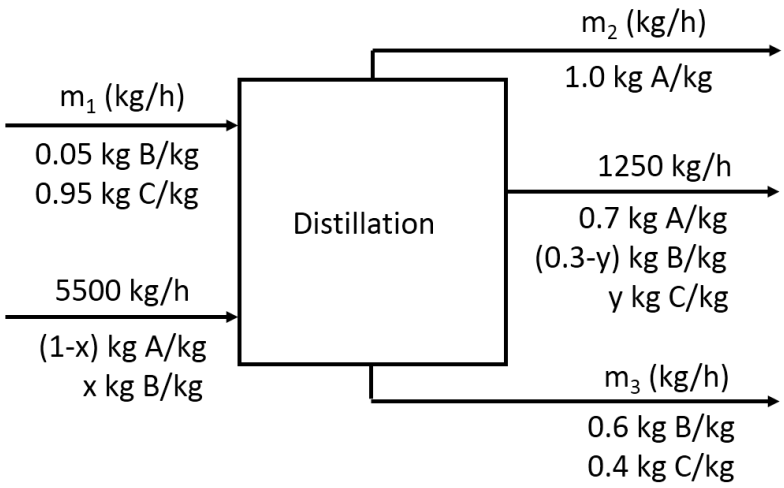
CHG 1125
QUIZ 3

Last Name: _____
First Name: _____
Student Number: _____

Duration: 30 minutes

The following labeled flowchart describes a steady-state single unit process. Calculate the degrees of freedom. State the balances that can be written for this system and the order in which you would write balances to determine unknown process variables. Then, proceed with the solution of all the unknown quantities.



Also know:

m_2 is half the flowrate of m_1

90% of C in m_1 exits in m_3

Find:

m_1 (kg/h)	
m_2 (kg/h)	
m_3 (kg/h)	
x (kg B/kg)	
y (kg C/kg)	

Unknowns :

m1 m2 m3 x y

Degrees of freedom :

Number of unknowns = 5

Number of equations = 3 species = 3 equations; $m_2 = 0.5\ m_1$; 90% of C in m_1 exists in m_3

Therefore, number of equations = 5

$n_{df} = n_{unknowns} - n_{equations} = 5\text{-}5 = 0$

Balances :

Overall balance:

$m_1 + 5500\ kg/h = m_2 + 1250\ kg/h + m_3$ ----------Eq. ①

B balance :

$0.05 * m_1 + x * 5500\ kg/h = (0.3-y) * 1250\ kg/h + 0.6 * m_3$ ----------Eq. ②

C balance :

$0.95 * m_1 = y * 1250\ kg/h + 0.4 * m_3$ ----------Eq. ③

Also,

$m_2 = 0.5m_1$ ----------Eq. ④

$0.9 * 0.95 * m_1 = 0.4 * m_3$ ----------Eq. ⑤

Step 1. By solving Eq. ①④⑤,

$m_2 = 0.5m_1$

$m_3 = 2.1375m_1$

$m_1 + 5500\ kg/h = 0.5m_1 + 1250\ kg/h + 2.1375m_1$

$m_1 = 2595\ kg/h$ $m_2 = 1298\ kg/h$ $m_3 = 5548\ kg/h$

Step 2. take m_1 and m_3 value into Eq. ③

$0.95 * 2595\ kg/h = y * 1250\ kg/h + 0.4 * 5548\ kg/h$

$y = 0.197\ kg\ C/kg$

Step 3. take m_1, m_3 and y value into Eq. ②

$0.05 * 2595\ kg/h + x * 5500\ kg/h = (0.3-0.197) * 1250\ kg/h + 0.6 * 5548\ kg/h$

$x = 0.605\ kg\ B/kg$