School of Engineering and Applied Science (SEAS), Ahmedabad University

Name: _____ Roll no.: _____

Chemical Engineering B.Tech: Semester III
Material and Energy Balance: Mid Term Exam (Monsoon:2023-2024); Marks: 30, Wt.: 30%
18th September 2023, Monday, 11.00 AM – 01:00 PM (Time duration: 1 hr 30 min)

Instructions:
1 All sections are compulsory.
2 Figures to right indicate full marks.
3 All acronyms carry their usual meaning.
4 Assume suitable data wherever necessary and specify it clearly in your answers.

Section A (Answer Any Three) (7×3 = 21 MARKS)

1. Octane (C_8H_{18}, Molecular weight 114 kg/mole) is burnt with 10% excess air. Calculate

   (a) Air/fuel ratio by weight,

   (b) Air/fuel ratio by volume,

   (c) Weight of dry exhaust gas formed per unit weight of fuel.

   (d) Moles of oxygen in the exhaust gas per unit weight of fuel,

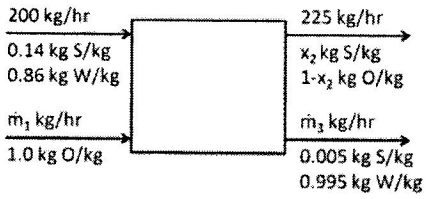
   (e) Moles of water vapor in the exhaust gas per unit weight of fuel

The specific gravity of octane may be taken as 0.7, air molecular weight 28.84 kg/mole)

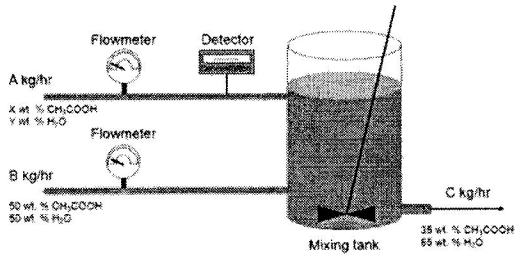
2. A liquid-liquid extraction vessel is used to separate a solute (S) from water (W). The solute is transferred to an organic solvent (O) that is immiscible in water. Given the process diagram below, calculate the following:

(a) The organic solvent required to produce a water product contain 0.5% solute.

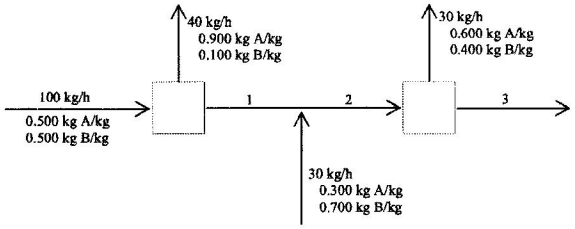
(b) The fraction of the solute in the feed that is recovered in the organic solvent product.



3. A mixing tank is used to prepare a solution for a reaction. The concentration and flow rate of stream A is variable thus a flow meter and a detector are used to ensure a specific concentration leaves the mixing tank. Use the schematic and information below to help an operator determine appropriate equations to use in their control operations for this process.

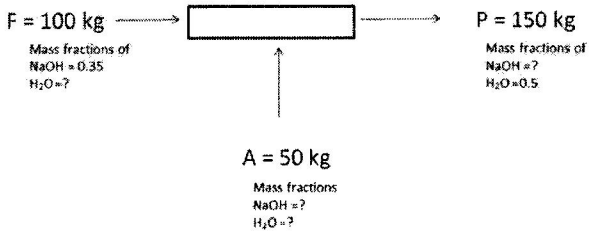


4. A labeled flowchart of a continuous steady-state two-unit distillation process is shown below. Each stream contains two components, A and B, in different proportions. Three streams whose flow rates and/or compositions are not known are labeled 1, 2 and 3. Calculate the unknown flow rates and compositions of streams 1, 2, and 3.



SECTION B (Answer all, 1 × 10 = 10)

For the given problem (for Q1-Q4)



1. What is the mass fraction for H_2O in feed and NaOH in product?
   a) 0.50 and 0.50
   b) 0.65 and 0.50
   c) 0.65 and 0.65
   d) 0.50 and 0.95
2. What is the mass in kg of H_2O in feed and NaOH in product?
   a) 65 and 50
   b) 95 and 50
   c) 65 and 75
   d) 50 and 50
3. What is the mass fraction of NaOH in A?
   a) 0.2
   b) 0.4

c) 0.6
d) 0.8

4. What is the mass fraction of H_2O in A?
   a) 0.2
   b) 0.4
   c) 0.6
   d) 0.8

Tank A contains 90% O_2 that is mixed with another tank B containing 30% of O_2 to get a Tank C containing 65% O_2 . for Q5-Q7

5. What is the ratio of the gas used from Tank A to that used from Tank B?
   a) 1.0
   b) 1.2
   c) 1.4
   d) 1.6
6. If A = 100 moles, what are the number of moles of B?
   a) 51.4
   b) 61.4
   c) 71.4
   d) 81.6
7. If A = 100 moles, what are the number of moles of C?
   a) 151.4
   b) 161.4
   c) 171.4
   d) 181.6
8. The number of variables whose values are unknown minus the number of independent equation is degree of freedom,
   The above given statement is
   a) True
   b) False
   c) It is not the definition of degrees of freedom
   d) None of the mentioned
9. Concept of material balance based upon?
   a) Conservation of mass
   b) Conservation of energy
   c) Conservation of momentum
   d) Conservation of Volume