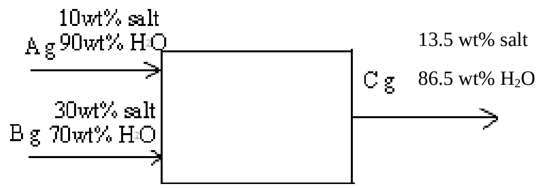
Tutorial 4 – Solutions

1.

Schematic diagram:



Input + generation = output + consumption

A g × 90 wt% H_2O + B g × 70 wt% H_2O= C g × 86.5wt% H_2O

A g × 10 wt% salt + B g × 30 wt% salt = Cg × 13.5 wt% salt

A g + B g = C g

Degress of Freedom analysis:

3 unknowns (A g, B g, C g)- 2 species (Salt, H_2O) = 1 degree of freedom

Basis of Calculation: set A = 100g, degrees of freedom now = 0

Solution:

Overall Balance: A g + B g = C g

100 g +B g = C g ----------------------------①

Balance on A: 100 g × 10wt% + B g × 30wt%= C g × 13.5wt%----------------②

So you have two unknowns and two equations:

B=21.21g C=121.21 g

2.

$pV = nRT \Rightarrow$

$1500 \times 10^3 Pa \times 0.03 m^3 = n \times 8.314 \times (273 + 25) K$

$n = 18.16 mol$ (O_2 moles in cylinder)

$pV = nRT \Rightarrow$

$200 \times 10^3 Pa \times 1m^3 = n \times 8.314 \times (273 + 25)K$

$n = 80.72mol$ (moles of air in closed tank)

$\therefore$ moles of oxygen in closed tank=$80.72mol \times 21\% = 16.95mol$

Total moles of oxygen = 16.95 mol + 18.16 mol = 35.11mol

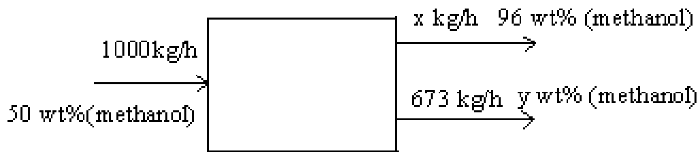
Total moles of nitrogen= 80.72mol×79% = **63.76 mol**

Mole fraction of oxygen=$\frac{35.11}{18.16 + 80.72} \times 100\%$ = 35.51%

$pV = nRT \Rightarrow$

$p = \frac{nRT}{V} = \frac{98.88 \times 8.314 \times 298}{1.03} = 237846.912Pa$

3.



Total mass balance without reaction:

1000 kg/h = 673 kg/h + x kg/h

x=327 kg/h

Methanol balance:

1000 kg/h × 0.5 = 327 kg/h × 96% + 673 kg/h × y wt%

y= 27 .65 wt%

4.

$250kg - \frac{250kg \times (1 - 15\%)}{1 - 3\%} = 31kg$

5.

a) Using NaOH balance around evaporator

5000 lb/h×2%=x lb/h×20%

x=500 lb/h

b) Using water balance around evaporator

$5000\ lb/h \times (1\text{-}2\%) = y\ lb/h + 500\ lb/h \times (1\text{-}20\%)$

$y = 4500\ lb/h$

$$\therefore \frac{4500\ lb/h}{5000\ lb/h \times 2\%} = 45\ lb/h$$