FACULTY OF ENGINEERING
DEPARTMENT OF CHEMICAL ENGINEERING

INTRODUCTION TO CHEMICAL ENGINEERING
CEN 101

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SAMPLE PROBLEMS WITH SOLUTIONS

A suspension of calcium carbonate particles in water flows through a pipe. Your assignment is to determine both the flow rate and the composition of this slurry. You proceed to collect the stream in a graduated cylinder for **1 min**; you then weigh the cylinder, evaporate the collected water, and reweigh the cylinder. The following results are obtained:

Mass of empty cylinder: **65 g**
Mass of cylinder + collected slurry: **565 g**
Volume collected: **455 ml**
Mass of cylinder after evaporation: **215 g**

Calculate;
a) the **volumetric flow rate** and **mass flow rate** of the suspension.
b) the **density** of the suspension.
c) the **mass fraction** of $CaCO_3$ in the suspension.

Mass of the slurry = 565 g – 65 g = 500 g

Volumetric flow rate of the suspension = **455 ml /min**
Mass flow rate of the suspension = **500 g/min**

Density of the suspension = 500 g / 455 ml = **1.099 g/ml**

Mass of the calcium carbonate = 215 g – 65 g = 150 g
Mass of the water in the suspension = 500 – 150 g = 350 g

Mass fraction of the calcium carbonate in the suspension = 150 g/500 g = **0.3**

A mixture of methanol and methyl acetate contains **15.0 wt%** methanol.

a) Determine the ***kg-moles of methanol*** in **200 kg** of the mixture.

b) The flow rate of the methyl acetate in the mixture is to be **100 lbm/h**. What must be the ***mixture flow rate in lbm/h***?

a) The methanol-methyl acetate mixture contains 15 wt% methanol. The molecular weight of methanol is 32 kg / kmol.

Mass of methanol in the mixture = 200 kg x 0.15 = 30 kg metanol
Moles of methanol;

$$n = \frac{30\ kg}{32\ \frac{kg}{kmol}} = \mathbf{0.9375\ kmol}$$

b) The mixture contains 85% by weight of methyl acetate.

200 kg of the mixture contains 30 kg of methanol, 170 kg of methyl acetate. The molecular weight of methyl acetate is 74 kg / kmol. Molar amount of methyl acetate;

$$n = \frac{170\ kg}{74\ \frac{kg}{kmol}} = 2.3\ kmol$$

Molar flow rate of methyl acetate (is already given in the question).

$$100\ \frac{lbmol}{h} . \frac{1\ kmol}{2.2046\ lbmol} = 45.36\ \frac{kmol}{h}$$

Mass flow rate of the methyl acetate

$$\dot{m} = 45.36\ \frac{kmol}{h} . 74\ \frac{kg}{kmol} = 3357\ \frac{kg\ MA}{h}$$

Mass flow rate the mixture;

$$\dot{m} = 3357\ \frac{kg\ MA}{h} . \frac{1\ kg\ karışım}{0.85\ kg\ MA} . \frac{2.2046\ lbm\ karışım}{1\ kg\ karışım} = \mathbf{8707}\ \frac{\boldsymbol{lbm}}{\boldsymbol{h}}$$