

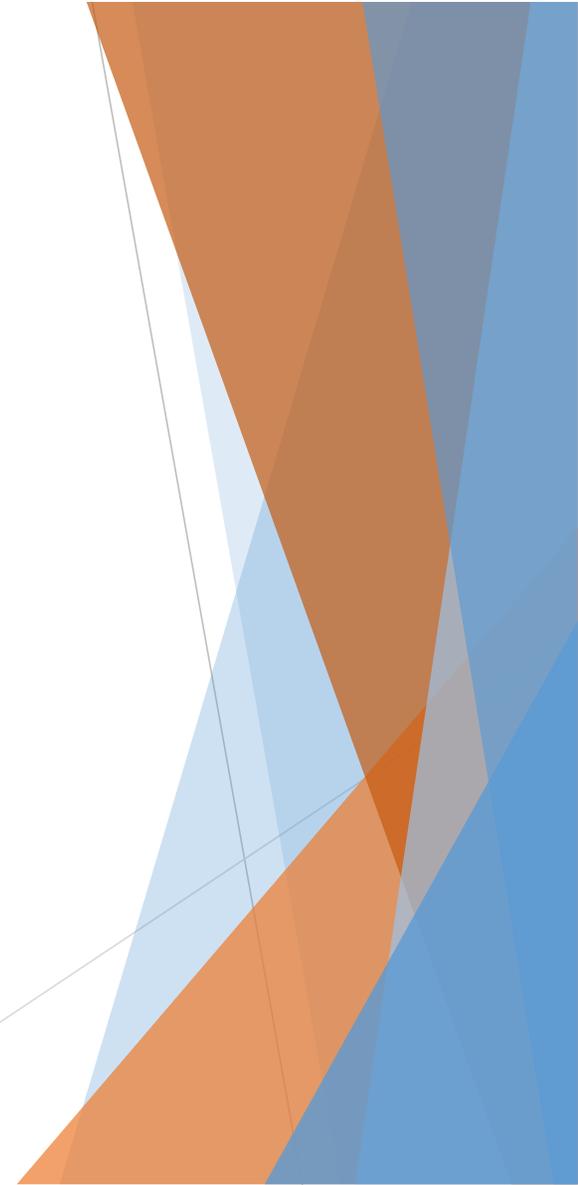


FACULTY OF ENGINEERING  
DEPARTMENT OF CHEMICAL ENGINEERING

# ***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  $\text{CaCO}_3$  in the suspension.

Mass of the slurry =  $565 \text{ g} - 65 \text{ g} = 500 \text{ g}$

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

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

Density of the suspension =  $500 \text{ g} / 455 \text{ ml} = \mathbf{1.099 \text{ g/ml}}$

Mass of the calcium carbonate =  $215 \text{ g} - 65 \text{ g} = 150 \text{ g}$

Mass of the water in the suspension =  $500 - 150 \text{ g} = 350 \text{ g}$

Mass fraction of the calcium carbonate in the suspension =  
 $150 \text{ g} / 500 \text{ g} = \mathbf{0.3}$

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;

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

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;

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

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

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

Mass flow rate of the methyl acetate

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

Mass flow rate the mixture;

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