CHE 205 MASS AND ENERGY BALANCES

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FUNDAMENTALS OF MATERIAL BALANCES

General Procedure for Single-Unit Process Material Balance Calculations

1. **Choose as a basis of calculation an amount or flow rate of one of the process streams**

If an amount or flow rate is given, it is convinient to use it as the basis of calculations.

If there is no specified amount or flow rate, an arbitrary amount or flow rate should be taken as a basis. Usually a stream with a known composition is used.

2. **Draw and label the flowchart**

The process stream variables like total mass or mass flow rate, mass fractions of stream components, total moles, molar flow rates or molar compositions should be written on the flow chart. Also the unknown quantities should be labeled with proper notation.

3. **Define a system**

The system of interest where the material balance is to be solved should be specified. A system can be the total process, a single process unit or a part of a process with multiple units included.

4. **Evaluate the problem statement in terms of the labeled variables.**

Determine which unknowns you need to solve.

5. **Convert all numerical information into consistent units.**

Convert all quantities to same unit system.

6. **Define system variables for generation, consumption and accumulation**

7. **Write material balance equation**

Write the equations in efficient order, minimize simultaneous equations.

8. **Solve the equations**

Start with the equations involving only one unknown variable.

9. **Check your calculations.**

YOUR TURN:

A liquid mixture of benzene and toluene which contains 55.0% benzene by mass, is to be evaporated. The vapor product stream leaving the evaporator contains 85.0 % benzene and the liquid product stream contains 10.6 % benzene by mass. Draw and label the process flow chart. Calculate the mass flow rates of vapor product and liquid product, per hour.

Basis: 100 kg mixture => m_1=100 kg

Overall mass balance:

$m_1=m_v+m_L$ => m_v+m_L =100 kg

m_L =100 - m_v

Benzene balance:

$$100*0.55 = m_v * 0.85 + m_L * 0.106$$
$$55 = 0.85 * m_v + (100 - m_v) * 0.106$$
$$55 = 0.85 * m_v + 10.6 - 0.106 * m_v$$
$$44.4 = 0.744 * m_v$$
$$m_v = 59.7 kg$$
$$m_L = 40.3 kg$$