# CHE 205 MASS AND ENERGY BALANCES
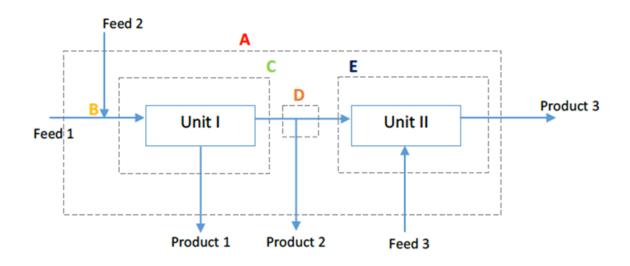
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**BALANCES ON MULTIPLE UNIT PROCESSES:**

**Usually industrial process involve more than one process unit. Chemical reactors are often present followed by a separation unit or two. The procedure for material balance calculations on such processes with multiple units is basically the same for single unit process systems. The main difference is that we have to isolate and define the subsystemsof the process and write the balances accordingly.**

The system boundary A shows the entire process where Feed streams 1, 2 and 3 and Product streams 1, 2 and 3 are given. Balances on this boundary are referred as OVERALL BALANCES.

Boundary B shows a mixing point where feed sterams 1 and 2 are mixed before entering Unit I. Here the output stream is the one that is entering Unit 1.
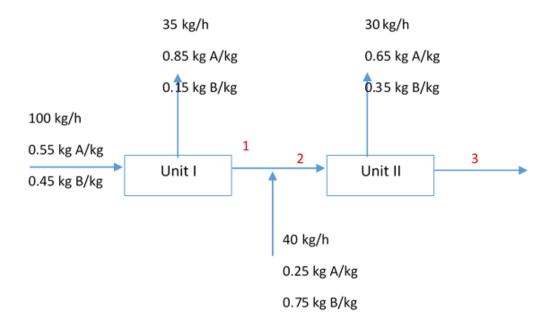
Boundary C encloses Unit I as a subsystem.

Boundary D is a stream splitting point where Product 2 is produced.

Boundary E is the subsystem for Unit II with Feed 3 as an input stream.

After you determine the number of unknown variables and independent equations, you can carry out an analysis called DEGREE OF FREEDOM ANALYSIS to determine whether you can solve the problem or not. If you have a zero degree of freedom, this means a slotion exists for the problem.

YOUR TURN:

1. Find out what an independent equation is.

2. A continuous steady state two-unit process is shown below: Components A and B are in different proportions for each stream. Calculate the unknown flow rates of 1, 2 and 3.

```
                35 kg/h                    30 kg/h

                0.85 kg A/kg               0.65 kg A/kg

                0.15 kg B/kg              ↑ 0.35 kg B/kg
100 kg/h             ↑

0.55 kg A/kg                    1        2            3
              ┌─────────┐         ┌─────────┐
──────────→   │ Unit I  │ ──────→ │ Unit II │ ──────→
0.45 kg B/kg  └─────────┘         └─────────┘
                                ↑

                           40 kg/h

                           0.25 kg A/kg

                           0.75 kg B/kg
```
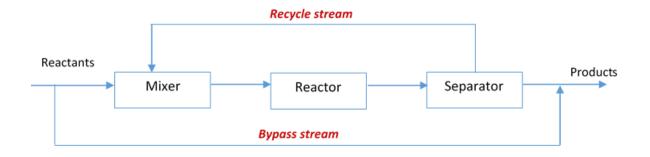
**RECYCLE AND BYPASS:**

**Recycle is commonly used to send unconverted raw materials leaving a process unit back to the unit again. This operation is useful to prevent the waste of reactants and also avoid the inpurity in the products. In a process involving recycle materials can circulate in a system without an accumulation of mass.**

**Recycle is useful for several reasons:**

**Recovery of catalyst**

**Dilution of the process stream**

**Controlling a process variable**

**Circulation of working fluid**

**In bypass, a portion of the feed to the process unit is diverted around the unit and combined with the product stream. Thecomposition and properties of the product can be varied by adjusting the fraction of the feed that is bypassed.**