→ Heterogenous reaction —

For a gas-solid phase reaction, the rate of reaction is expressed as no. of moles of reactants reacting per unit mass or area of the catalyst ($mol\ s^{-1}\ g^{-1}$ OR $mol\ s^{-1}\ m^{-2}$)

→ Homogenous reaction —

$$A \longrightarrow B$$

$$-\frac{d[A]}{dt} = [A]$$

Rate of reaction, $r_A = \frac{d[A]}{dt} = \frac{dC_A}{dt}$
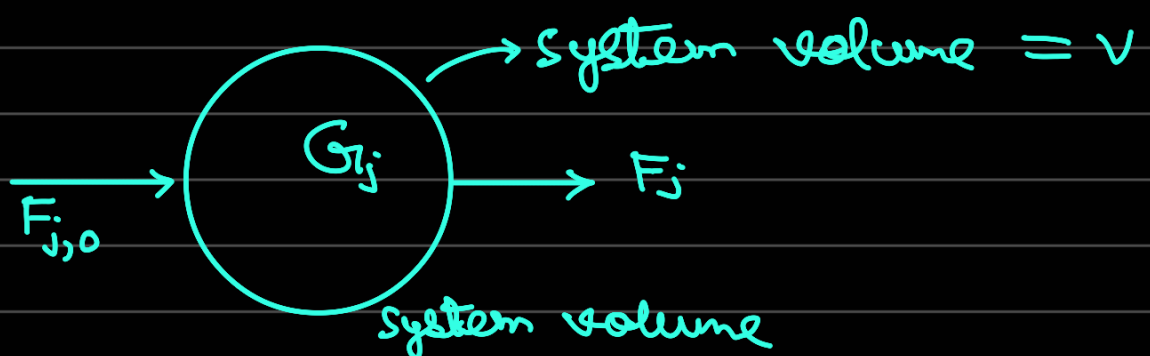
$C_A \longrightarrow$ conc^n of species A = moles/volume

For a continuous flow reactor operated at steady state,

Rate of reaction is moles/unit time/volume

(Ref. — Fogler (Ch:1)

→ General mole balance —

→ System volume = V

G_j

$F_{j,0}$ → → F_j

System volume

mole balance of a species j in the system volume, j represents a particular species of interest

$F_{j,0} \rightarrow$ Flow rate of j into the system (mol/time)

$F_j \rightarrow$ Flow rate of j out of the system (mol/time)

$G_j \rightarrow$ Generation rate of j by chemical reaction within the system (mol/time)

$N_j \rightarrow$ No. of moles accumulated within the system at any time t

mole balance of species j at any time, t is given by

$$F_{j,0} - F_j + G_j = \frac{dN_j}{dt}$$

Assuming all system variables to be uniform (T, conc^n of chemical species) Generation rate of species j:
$r_j \rightarrow$ Formation rate of species j.

$$G_j = r_j V$$

But if there is spatial variation within the system volume, the generation rate ΔG_{j_i} in terms of r_{j_i} and a subvolume ΔV_i:
$$\Delta G_{j_i} = r_{j_i} \Delta V_1$$

If the total system is sub-divided into m subvolumes, the total generation rate,

$$G_j = \sum_{i=1}^{m} \Delta G_{j_i} = \sum_{i=1}^{m} r_{j_i} \Delta V_i$$

If $\Delta V_i \rightarrow 0$, we write

$$G_j = \int r_j \, dV$$

So $F_{jso} - F_j + \int r_j \, dV = \dfrac{dN_j}{dt}$

(useful for reactor design)

This is the design equation for various type of industrial reactors.

→ Types of reactors –

- Batch Reactor
- Continuous flow reactor
  - → continuous stirred tank reactor/mixed (CSTR)
  - → Plug flow reactor (PFR)
  - → Packed bed reactor (PBR)

flow reactor