Some basic terms…...

- Momentum transfer (mass x velocity)
- Heat transfer
- Mass transfer
- Rate = Driving force / resistance
- Flux = Rate / area
- Gradient

- In molecular transport processes concern with transfer or movement of a given property or entity by molecular movement through a system or medium which can be a fluid (gas or liquid) or a solid.

- Each molecule of a system has a given quantity of the property mass, thermal energy, or momentum associated with it.

- When a difference of concentration of the property exists for any of these properties from one region to an adjacent region, a net transport of this property occurs.

- In dilute fluids such as gases where the molecules are relatively far apart, the rate of transport of the property should be relatively fast since few molecules are present to block the transport or interact

- In dense fluids such as liquids the molecules are close together and transport or diffusion proceeds more slowly.

- The molecules in solids are even more close-packed than in liquids and molecular migration is even more restricted.

General molecular transport equation

- All three of the molecular transport processes of momentum, heat or thermal energy, and mass are characterized in the elementary sense by the same general type of transport equation.

$$\boxed{\textbf{Rate of transfer process} = \frac{\textbf{Driving Force}}{\textbf{Resistance}}}$$

- This states what is quite obvious – that we need a driving force to overcome a resistance in order to transport a property.

- We'll be using FLUX also……

$$\boxed{\textbf{Flux of transfer process} = \frac{\textbf{Driving Force}}{\textbf{Resistance}}}$$

- The kinetic theory of gases gives us a good physical interpretation of the motion of individual molecules in fluids.
- Because of their kinetic energy the molecules are in rapid random movement, often colliding with each other.
- Molecular transport of a property such as momentum, heat, or mass occurs in a fluid because of these random movements of individual molecules.
- Each individual molecule containing the property being transferred moves randomly in all directions and there are fluxes in all directions
- Hence, if there is a concentration gradient of the property, there will be a net flux of the property from high to low concentration.
- This occurs because equal numbers of molecules diffuse in each direction between the high-concentration and low concentration regions.

Momentum transport & Newton's law

$$\textbf{Mometum Flux } \alpha \textbf{ Driving Force}$$

$$\Rightarrow \textbf{Mometum Flux } \alpha \frac{dv}{dx}$$

$$\Rightarrow \tau \, \alpha - \frac{dv}{dx}$$

$$\Rightarrow \tau = -\mu \frac{dv}{dx} - - - - - - - Newton's\ law\ of\ viscosity$$

- τ = shear stress or momentum flux
- = kg /m sec^2 or N/m2
- v = velocity, (m/sec)
- x = distance (m)
- μ = viscosity (kg /m sec)

Heat transfer & Fourier's law

$$\Rightarrow \textbf{Heat Flux} \ \alpha \ \frac{dT}{dx}$$

$$\Rightarrow \frac{q}{A} \alpha - \frac{dT}{dx}$$

$$\Rightarrow \frac{q}{A} = -k\frac{dT}{dx} ------ Fourier's\ law$$

- q = rate of heat transferred J/sec
- A = area (m^2)
- k = thermal conductivity (W/m K)
- T = temperature (K)
- x = distance (m)

Mass transport & Fick's law

$$\Rightarrow \textbf{Mass Flux} \; \alpha \; \frac{dC}{dx}$$

$$\Rightarrow J \; \alpha \; -\frac{dC}{dx}$$

$$\Rightarrow J = -D\frac{dC}{dx} ----(Fick's\ law\ of\ diffusion)$$

- J = mass flux or mol flux (kg/m^2 sec)
- C = concentration (kg/m^3)
- x = distance (m)
- ***D*** = diffusivity (m^2/sec)