CEN 3313

MASS TRANSFER

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Definitions of Concentration, Velocities and Fluxes

ρ_i *mass concentration* (*mass of species i per unit volume of mixture*)

$$m_i = \frac{\rho_i}{\rho} = \frac{\text{mass concentration of species } i}{\text{total mass concentration of mixture (density}}$$

$$\rho = \sum_{i=1}^{n} \rho_i$$

$$\sum_{i=1}^{n} m_i = 1$$

n: total # of species

Definitions of Concentration, Velocities and Fluxes

C_i *molar concentration* *(# of moles of species i per unit volume of mixture)*

$$x_i = \frac{C_i}{C} = \frac{molar\ concentration\ of\ species\ i}{total\ molar\ density\ of\ of\ mixture}$$

$$c = \sum_{i=1}^{n} c_i$$

$$\sum_{i=1}^{n} x_i = 1$$

n: total # of species

For ideal gases;

$$\rho_i = \frac{P_i}{R_i T} \qquad C_i = \frac{P_i}{RT}$$

R_i ; gas constant for species i

R ; universal gas constant

$$P = \sum_{i=1}^{n} P_i$$

$$x_i = \frac{C_i}{C} = \frac{P_i/RT}{P/RT} = \frac{P_i}{P}$$

VELOCITIES

v_i= velocity of ith species w.r.t. stationary coordinate axes for n species, local mass average velocity v *is* defined as*;*

$$v = \frac{\sum_{i=1}^{n} \rho_i v_i}{\rho_i}$$

ρv = local rate at which mass passes through a unit section ⊥ to the velocity

Local molar average velocity v^* *is* defined as*;*

$$v^* = \frac{\sum_{i=1}^{n} c_i v_i^*}{c_i}$$

cv^*= local rate at which moles passes through a unit section ⊥ to the velocity

In flow systems, one is interested in the velocity of given species i, w.r.t. v or v → **definition of diffusion velocities**;*

$v_i - v$ = ***diffusion velocity of species i w.r.t. v***

$v_i - v^*$ = ***diffusion velocity of species i w.r.t. v^****

diffusion velocities indicate the motion of species i relative to the local motion of the fluid stream

References

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