SNS COLLEGE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

19MET201Engineering Thermodynamics

Mole and Mass Fraction

1. **A mixture of ideal gases consists of 7kg ofand 2kg ofat a pressure of 4bar and a temperature of 27°C. Determine:**

   i. **Mole fraction of each constituent,**

   ii. **Equivalent molecular weight of the mixture,**

   iii. **Equivalent gas constant of the mixture,**

   iv. **The partial pressure and partial volumes,**

   v. **The volume and density of the mixture**

Given data:

= 7kg

= 2kg p = 4bar T = 27°C

Solution:

i. Mole fraction of ,

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i. Mole fraction of N_2,

$$x_{N_2} = \frac{\left(\frac{7}{28}\right)}{\left(\frac{7}{28}\right)+\left(\frac{2}{32}\right)} = 0.8$$

Mole fraction of O_2,

$$x_{O_2} = \frac{\left(\frac{2}{32}\right)}{\left(\frac{7}{28}\right)+\left(\frac{2}{32}\right)} = 0.2$$

ii. Equivalent molecular weight of the mixture,

$$M = x_{N_2}M_{N_2} + x_{O_2}M_{O_2}$$

$$= (0.8\times28) + (0.2\times32) = 28.8\text{kg/kg mol}$$

$$\text{Total mass, m} = m_{N_2} + m_{O_2} = 7 + 2 = 9\text{kg}$$

iii. Equivalent gas constant of the mixture,

$$R = \frac{m_{N_2}R_{N_2} + m_{O_2}R_{O_2}}{m}$$

iv. The partial pressure and partial volumes,

$$p_{N_2} = x_{N_2}p = (0.8 \times 4) = 3.2bar$$

$$p_{O_2} = x_{O_2}p = (0.2 \times 4) = 0.8bar$$

$$V_{N_2} = \frac{m_{N_2}R_{N_2}T}{p} = \frac{7\left(\frac{8.314}{28}\right)\times300}{400} = 1.558m^3$$

$$V_{O_2} = \frac{m_{O_2}R_{O_2}T}{p} = \frac{2\left(\frac{8.314}{32}\right)\times300}{400} = 0.389m^3$$

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v. The volume and density of the mixture,

$$\text{Density of } N_2 = \frac{m_{N_2}}{V_{N_2}} = \frac{7}{1.558} = 4.492 \text{kg}/m^3$$

$$\text{Density of } O_2 = \frac{m_{O_2}}{V_{O_2}} = \frac{2}{0.389} = 5.141 \text{kg}/m^3$$