Answer on the question #56035 - Chemistry - Physical Chemistry

Question:

The enthalpies of the combustion of C2H4 (g) and C2H6 (g) are -1440 and -1560 kJ/mol respectively at a temperature at which volume per mol of the gas is 22.4 L. The percentage composition of ethene C2H4 (g) in 20 L mixture which on combustion releases 1340 kJ of heat:

Solution:

20 L of mixture contains the following number of the moles of gas:

$$n = \frac{V}{V_m} = \frac{20}{22.4} = 0.89\ mol.$$

The enthalpy of combustion of the mixture is:

$$\Delta H_{mixture} = -\frac{1340\ kJ}{0.89\ mol} = -1505.6\ kJ/\ mol.$$

Then, if the molar fraction of C2H4 is *x*:

$$\Delta H_{mixture} = x \cdot \Delta H_{C2H4} + (1-x) \cdot \Delta H_{C2H6}.$$

$$-1505.6 = x \cdot (-1440) + (1-x) \cdot (-1560)$$

$$x = 0.45$$

The molar fraction of C2H4 is 0.45. Hence, the number of the moles of C2H4 in 20 L of mixture is:

$$n(C2H4) = 0.89 \cdot 0.45 = 0.40\ mol.$$

The mass of C2H4:

$$m(C2H4) = n(C2H4) \cdot M(C2H4) = 0.40 \cdot 28.05 = 11.2\ g$$

The mass of C2H6:

$$m(C2H6) = \big(0.89 - n(C2H4)\big) \cdot M(C2H6) = 14.7g$$

Then, the mass percentage is:

$$\omega(C2H4) = \frac{11.2}{11.2 + 14.7} \cdot 100\% = 43\ \%$$

Answer: 43%