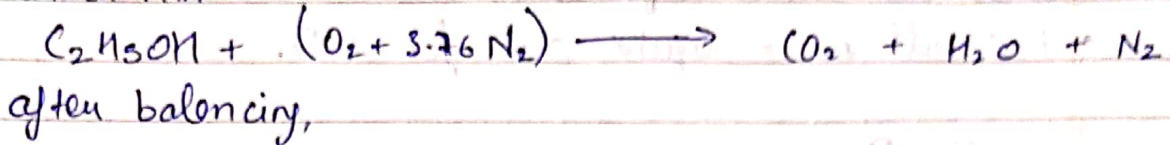


Name: Aditya Raghunwshi

Roll: 170052

Given rxn:



① $\frac{A}{F}_s = \frac{\text{mass of air}}{\text{mass of fuel}} = \frac{3(11.28 \times 28)}{1(24 + 6 + 16)}$
 $= \frac{3(32 + 3.76 \times 28)}{1(24 + 6 + 16)} = \boxed{8.95}$ Ans (Mass basis)

② $h_{f,C_2H_5OH} = -277690 \text{ KJ/Kmol}$
 $h_{f,O_2} = 0 \text{ KJ/Kmol}$
 $h_{f,N_2} = 0 \text{ KJ/Kmol}$

$\frac{A}{F}_s = \frac{\text{moles of air}}{\text{moles of fuel}} = \frac{3 \times 4.76}{1} = \boxed{14.28}$ Ans (Molar basis)

$$H_{\text{reac}} = 1(-277690) + 3(0) + 3.76 \times 3(0)$$

$$= -277690 \text{ KJ/Kmol}$$

$$h_{f,H_2O(g)} = -241845 \text{ KJ/Kmol (gas)}$$

$$h_{f,CO_2} = -393546 \text{ KJ/Kmol}$$

$$h_{f,N_2} = 0 \text{ KJ/Kmol}$$

$$H_{\text{prod}} = 2(-393546) + 3(-241845) + 11.28(0)$$

$$= -1512627 \text{ KJ/Kmol}$$

$$\underline{LHV} = H_{\text{reac}} - H_{\text{prod}}$$

$$= -277690 - (-1512627)$$

$$= 1234937 \text{ KJ/Kmol}$$

$$= (1234937/46) \text{ KJ/Kg of } C_2H_5OH$$

$$= \boxed{26846.45 \text{ KJ/Kg}}$$

- H_{reac} will be same for HHV
- H_2O will be in liquid state for HHV.

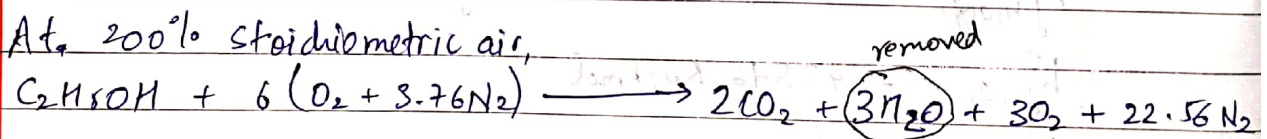
$$\begin{aligned}
 \cancel{H_{\text{prod}}} \\
 h_{f,H_2O}^o(l) &= h_{f,H_2O}^o(g) - h_{H_2O}^o(\text{vap}) \\
 &= -241845 - (44010) \\
 &= -285855 \text{ KJ/Kmol}
 \end{aligned}$$

$$h_{f,CO_2}^o = -393546 \text{ KJ/Kmol}$$

$$h_{f,N_2}^o = 0 \text{ KJ/Kmol}$$

$$\begin{aligned}
 H_{\text{prod}} &= 2(-393546) + 3(-285855) \\
 &= -1644657 \text{ KJ/Kmol}
 \end{aligned}$$

$$\begin{aligned}
 HHV &= H_{\text{reac}} - H_{\text{prod}} \\
 &= -277690 - (-1644657) \\
 &= 1366967 \text{ KJ/Kmol} \\
 &= (1366967/46) \text{ KJ/Kg of } C_2H_5OH \\
 \boxed{HHV} &= \boxed{29716.67 \text{ KJ/Kg}}
 \end{aligned}$$



Mass of CO_2 in product side,

$$\text{Mass of } CO_2 = 2(12 + 32) = 88$$

$$\text{Mass of } O_2 = 3(32) = 96$$

$$\text{Mass of } N_2 = 22.56(28) = 631.68$$

$$Y_{CO_2} = \frac{88}{88 + 96 + 631.68} = \boxed{0.107}$$

$$Y_{O_2} = \frac{96}{88 + 96 + 631.68} = \boxed{0.117}$$

$$Y_{N_2} = \frac{631.68}{88 + 96 + 631.68} = \boxed{0.774}$$