

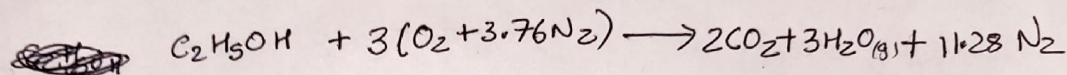
Pence Mataria

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Quiz-2 AE441

Q.1.  $\rightarrow$  for 21%  $O_2$  and 79%  $N_2$  by mass & by moles  
 $\frac{Z_{N_2}}{Z_{O_2}} = 3.76$

$\rightarrow$  at stoichiometric condition;



• air-fuel ratio on mass basis:

$$\frac{M_{air}}{M_{fuel}} = \frac{3(32 + 3.76(28))}{1(46)} = \boxed{8.953}$$

• air-to-fuel ratio on molar basis:

$$\frac{N_{air}}{N_{fuel}} = \frac{3(1 + 3.76)}{1} = \boxed{14.28}$$

$\rightarrow$  LHV and HHV at 298K

$$h_{f,C_2H_5OH}^\circ = -277690 \text{ kJ/kmol}$$

$$h_{f,O_2}^\circ = h_{f,N_2}^\circ = 0$$

$$h_{f,CO_2}^\circ = -393546 \text{ kJ/kmol}$$

$$h_{f,H_2O}^\circ = -241845 \text{ kJ/kmol}$$

$$h_{f,H_2O(g)}^\circ = h_{f,H_2O(l)}^\circ - 44010$$
$$= -285855 \text{ kJ/kmol}$$

$$\Delta H_c = H_{\text{React}} - H_{\text{Prod}}$$

• LHV

$$H_{\text{React}} = 1 \times h_{f,C_2H_5OH}^\circ + 3 \times (h_{f,O_2}^\circ + 3.76 h_{f,N_2}^\circ) = -277690 \text{ kJ}$$

$$H_{\text{Prod}} = 2 \times h_{f,CO_2}^\circ + 3 \times h_{f,H_2O(g)}^\circ + 11.28 (h_{f,N_2}^\circ)$$
$$= -1512627 \text{ kJ}$$

$$\therefore \Delta H_{c, \text{LHV}} = 1234937 \text{ kJ/kmol} = \boxed{26846.456 \text{ kJ/kg fuel}}$$

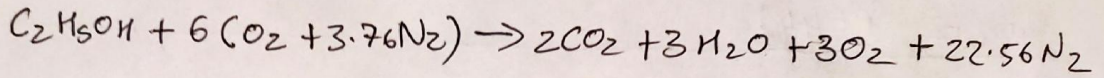
• HHV

$$H_{\text{React}} = 1 \times h_{f,C_2H_5OH}^\circ + 3 \times (h_{f,O_2}^\circ + 3.76 h_{f,N_2}^\circ) = -277690 \text{ kJ}$$

$$H_{\text{Prod}} = 2 \times h_{f,CO_2}^\circ + 3 \times h_{f,H_2O(l)}^\circ + 11.28 h_{f,N_2}^\circ = -1644657 \text{ kJ}$$

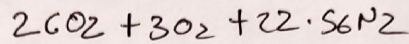
$$\therefore \Delta H_{c, \text{HHV}} = 1366967 \text{ kJ/kmol} = \boxed{29716.673 \text{ kJ/kg fuel}}$$

→ 2001. Stoichiometric air.



• after evaporating ~~the~~  $H_2O$  from product;

Product mixture consists of



$$\begin{aligned} M_{\text{Prod mix}} &= 2(44) + 3(32) + (22.56)(28) \\ &= 815.68 \text{ g} \end{aligned}$$

$$Y_{CO_2} = \frac{2(44)}{815.68} = \boxed{0.107}$$

$$Y_{O_2} = \frac{3(32)}{815.68} = \boxed{0.117}$$

$$Y_{N_2} = \frac{(22.56)(28)}{815.68} = \boxed{0.774}$$