Pence Mataria
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Quiz-2 AE441

Q.1.

→ for 21% O_2 and 79% N_2 by mass & by moles

$$\frac{\%N_2}{\%O_2} = 3.76.$$

→ at stoichiometric condition;

$$C_2H_5OH + 3(O_2 + 3.76N_2) \longrightarrow 2CO_2 + 3H_2O_{(g)} + 11.28\,N_2$$

- 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:

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

→ LHV and HHV at 298K

$h^\circ_{f\,C_2H_5OH} = -277690$ KJ/Kmol

$h^\circ_{f\,O_2} = h^\circ_{f\,N_2} = 0.$

$h^\circ_{f\,CO_2} = -393546$ KJ/Kmol

$h^\circ_{f\,H_2O_{(g)}} = -241845$ KJ/Kmol

$h^\circ_{f\,H_2O_{(l)}} = h^\circ_{f\,H_2O_{(g)}} - 44010$

$= -285855$ KJ/Kmol

$\Delta H_c = H_{reac} - H_{prod}.$

- LHV

$H_{reac} = 1 \times h^\circ_{f\,C_2H_5OH} + 3 \times (h^\circ_{f\,O_2} + 3.76\,h^\circ_{f\,N_2}) = -277690$ KJ

$H_{prod} = 2 \times h^\circ_{f\,CO_2} + 3 \times h^\circ_{f\,H_2O_{(g)}} + 11.28(h^\circ_{f\,N_2})$

$= -1512627$ KJ.

$\therefore \Delta H_{c\,LHV} = 1234937$ KJ/Kmol $= \boxed{26846.456\ KJ/Kg_{fuel}}$

- HHV

$H_{reac} = 1 \times h^\circ_{f\,C_2H_5OH} + 3 \times (h^\circ_{f\,O_2} + 3.76\,h^\circ_{f\,N_2}) = -277690$ KJ

$H_{prod} = 2 \times h^\circ_{f\,CO_2} + 3 \times h^\circ_{f\,H_2O_{(l)}} + 11.28\,h^\circ_{f\,N_2} = -1644657$ KJ

$\therefore \Delta H_{c\,HHV} = 1366967$ KJ/Kmol $= \boxed{29716.673\ KJ/Kg_{fuel}}$

P.T.O.

→ 200% Stoichiometric air.

$$C_2H_5OH + 6(O_2 + 3.76N_2) \rightarrow 2CO_2 + 3H_2O + 3O_2 + 22.56N_2$$

- after evaporating H_2O from Product ;

Product mixture consists of

$$2CO_2 + 3O_2 + 22.56N_2$$

- $M_{Prod\,mix} = 2(44) + 3(32) + (22.56)(28)$

$$= 815.68\ g.$$

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

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

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