Class: 2nd Stage
Subject: Thermodynamic 2
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Solution of problem 7.8

Problem (7.8): One kmol of ethane C_2H_6 is burned with an unknown amount of air during a combustion process. An analysis of the combustion products reveals that the combustion is complete, and there are 3 kmol of free O_2 in the products. Determine (a) the air-fuel ratio (b) the percentage of theoretical air used during this process. The molar masses of air and ethane are 29 and 30 kg/kmol, respectively.

Ans. (29.9 kg air/kg fuel, 186%)

1) Theo. Comb.

$$C_2H_6 + x\,O_2 + 3.76x\,N_2 \rightarrow y\,CO_2 + z\,H_2O + 3.76x\,N_2$$

2) balan Co

C: $2 = y$

H: $6 = 2z \Rightarrow z = 3$

O: $2x = 2y + z$

$2x = 4 + 3 \Rightarrow \frac{2x}{2} = \frac{7}{2}$

$x = 3.5$

3

3) $C_2H_6 + 3.5\,O_2 + 13.16\,N_2 \rightarrow 2\,CO_2 + 3\,H_2O + 13.16\,N_2$

Actual Comb.

$C_3H_8 + a\,O_2 + 3.76a\,N_2 \rightarrow 2CO_2 + 3H_2O + 3O_2 + 3.76a\,N_2$

5) balance

$O: 2a = 4 + 3 + 6$

$\frac{2a}{2} = \frac{13}{2} \Rightarrow a = 6.5$

6) $C_3H_8 + 6.5\,O_2 + 24.44\,N_2 \rightarrow 2CO_2 + 3H_2O + 3O_2 + 24.44N_2$

7) $AF = \frac{N_{air}}{N_{fuel}} \Rightarrow AF = \frac{6.5 + 24.44}{1} = 30.94 \frac{kmol_{air}}{kg}$

8) $P_{th\,air} = \frac{N_{air})_{act}}{N_{air})_{th}} = \frac{30.94}{3.5 + 13.16} \times 100\%$

$= 185.71\%$