Lecture 8: Stoichiometry

The Lecture Contains:

Previous Next

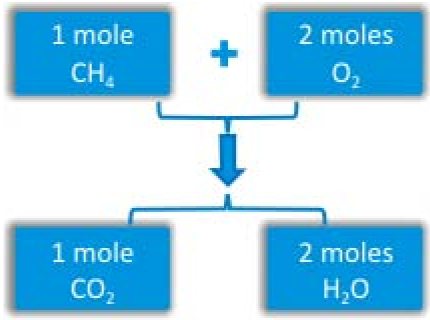
Stoichiometry

Stoichiometry: The elemental mass balance in a chemical reaction, describing exactly how much oxidizer has to be supplied for complete combustion of certain amount of fuel.

Example: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \Delta H_R$

$(16g) + (64g) \rightarrow (44g) + (36g)$

Mass is conserved



(Figure 8.1)

Lean Mixture:

Quantity of oxidizer > Stoichiometric quantity

Rich Mixture:

Quantity of oxidizer < Stoichiometric quantity

Previous Next

Stoichiometry Calculation

Problem: Gasoline + Dry air → Products (10.02% CO_2 ; 5.62% O_2 ; 0.88% CO ; 83.48% N_2)

Determine (i) A/F Ratio; (ii) Equivalence Ratio; (iii) Stoichiometric Air Used

Solution

Equation: C_8H_{18} + 16.32 (O_2 + 3.76 N_2) → 7.37 CO_2 + 0.65 CO + 4.13 O_2 + 61.38 N_2 + 9H_2O

$(F/A)_{actual} = m_{fuel}/m_{air}$ = ((12 × 8) + 18)/(16.32(32 + (3.76 × 28))) = 0.05089

Stoichiometric Equation:

C_8H_{18} + 12.5(O_2 + 3.76 N_2) → 8CO_2 + 9H_2O + 47N_2

$(F/A)_{stoic} = m_{fuel}/m_{air}$ = ((12 × 8) + 18)/(12.5(32 + (3.76 × 28))) = 0.06643

Equivalence ratio $(\Phi) = \{(F/A)_{actual}\}/\{(F/A)_{stoic}\}$ = 0.766

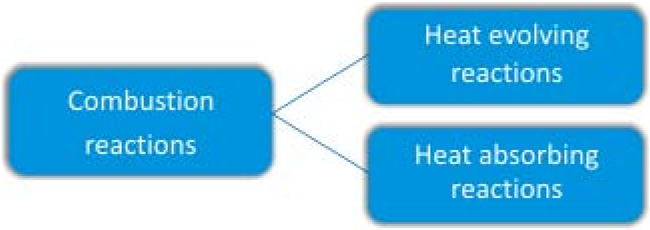
Since Φ <1 ; The mixture is lean

Stoichiometric Air Used:

Stoichiometric air = 100 / Φ = 100/ 0.766 = 130.5%

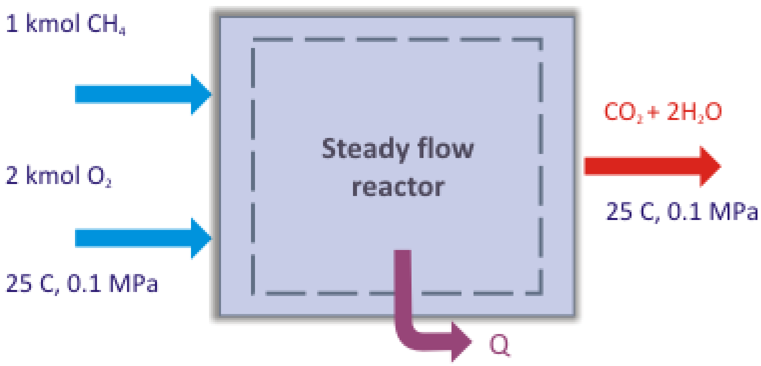
Previous Next

Thermochemistry



(Figure 8.2)

Consider the burner as shown below:



(Figure 8.3)

Assumption: (i) Negligible change in K.E. & P.E., (ii) No shaft work

Previous Next

Thermochemistry

$$Q = dH = H_P - H_R = \sum_{iP} n_{iP} h_{iP} - \sum_{iR} n_{iR} h_{iR} = \Delta H^o_{R,298}$$

Where, H_R – Total enthalpy of reactants; H_P – Total enthalpy of products

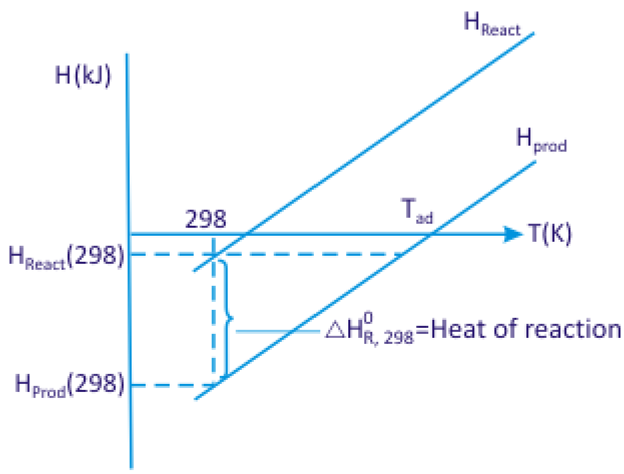
n_{iR} – No of moles of ith reactant; n_{iP} – No of moles of ith product

h_{iR} – Enthalpy of formation per unit mole of ith reactant

h_{iP} – Enthalpy of formation per unit mole of ith product

$\Delta H^o_{R,298}$ – Standard heat of reaction

Heat of reaction depends on temperature



(Figure 8.4)

Previous Next