Week 11: Lecture 3

Reacting Mixtures and Combustion

Definitions

Combustion Process

- a fuel made up of hydrocarbons is said to have burned completely if:
  - all the carbon present in the fuel is burned to carbon dioxide
  - all the hydrogen is burned to water
- if the conditions are not fulfilled the combustion is incomplete

Combustion Reactions

reactants $\rightarrow$ products

or

fuel + oxidizer $\rightarrow$ products

- in all cases the mass is conserved
  mass of products = mass of reactants

Fuels

- fuel is simply a combustible substance
- hydrocarbon fuels exist as liquids, gases and solids

Combustion Air

- oxygen is required in every combustion reaction
- in most combustion reactions air provides the needed oxygen

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Air-Fuel Ratio

$$\frac{mass\ of\ air}{mass\ of\ fuel} = \frac{moles\ of\ air \times \tilde{M}_{air}}{moles\ of\ fuel \times \tilde{M}_{fuel}}$$

$$AF = \bar{AF}\left(\frac{\tilde{M}_{air}}{\tilde{M}_{fuel}}\right)$$

Theoretical or Stoichiometric Air

- the minimum amount of air that supplies sufficient oxygen for complete combustion of all carbon and hydrogen in the fuel
- no free oxygen would appear in the products
- normally the amount of air supplied is given as a percentage of the theoretical value i.e. 150% = 1.5 × the theoretical air
- the equivalence ratio is defined as

$$equivalence\ ratio = \frac{AF_{actual}}{AF_{theoretical}}$$

- if the equivalence ratio is:
  - $> 1 \quad \rightarrow$ lean mixture
  - $< 1 \quad \rightarrow$ rich mixture