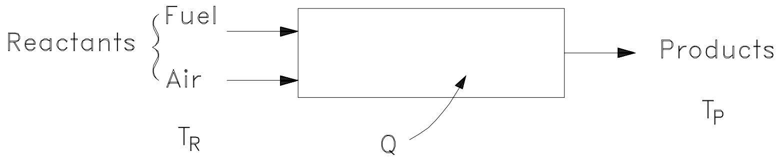
ME 354 Lecture Summary

Week 12: Lecture 2

Enthalpy of Combustion

- for various types of fuels the enthalpy of formation is not always known
  - the chemical composition of most fuels may vary from batch to batch
  - generally not tabulated
- enthalpy of combustion is an experimental alternative to enthalpy of formation
  - defined as the difference between the enthalpy of the products and the enthalpy of the reactants where complete combustion occurs at a given temperature and pressure

$$\begin{aligned} Q &= \sum (mh)_P - \sum (mh)_R = H_P(T_P) - H_R(T_R) \\ Q &= \sum (n\overline{h})_P - \sum (n\overline{h})_R = \underbrace{\overline{H}_P(T_P) - \overline{H}_R(T_R)}_{H_{RP}} \end{aligned}$$



- when enthalpy of formation data is available for all products and reactants the above equation can be used
- otherwise a calorimeter must be used to measure the enthalpy of combustion
- $+ve\ Q \Rightarrow$ endothermic reaction
- $-ve\ Q \Rightarrow$ exothermic reaction

Heating Value

- the heating value of a fuel is a positive value equal to the magnitude of the enthalpy of combustion

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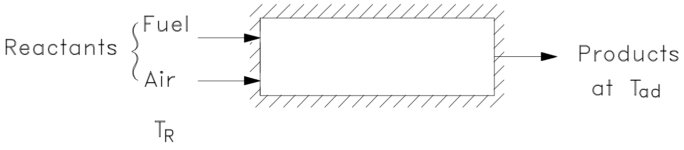
- two values are used
  - HHV: higher heating value - obtained when all the water formed by combustion is a liquid
  - LHV: lower heating value - obtained when all the water formed by combustion is a vapour
- the HHV exceeds the LHV by the energy required to vaporize the liquid formed

$$HHV = LHV + (mh_{fg})_{H_2O}$$

Adiabatic Flame Temperature

- under adiabatic conditions the maximum temperature attained by the products when combustion is complete is called the adiabatic flame or adiabatic combustion temperature



$$H_P(T_{ad}) = H_R(T_R)$$

$$\sum_P n_e(\overline{h}_f^o + \Delta\overline{h})_e = \sum_R n_i(\overline{h}_f^o + \Delta\overline{h})_i$$

$$\sum_P n_e(\Delta\overline{h})_e = \sum_R n_i(\Delta\overline{h})_i + \sum_R n_i\overline{h}_{f_i}^o - \sum_P n_e\overline{h}_{f_e}^o$$

where

n - obtained from reaction equation
$\overline{h}_{f_i}^o$ - from tabulated data
$\Delta\overline{h}$ - from tables or calculated knowing T_R

Therefore all terms on the right hand side can be evaluated. While the left hand side accounts for the change in enthalpy from T_{ref} to T_{ad}, which is unknown. The procedure requires iteration.

The temperature for the products is assumed. We then keep trying until we get agreement with the RHS. A typical value of $T_{ad} \approx 2300\ K$ for most hydro carbon fuels

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