JQ.2.16.soln

September 19, 2014

(2.16) Determine the heat of combustion of toluene and express it in proper thermodynamic form. The heat of formation is 11.95 kcal/mole.

This is essentially the same type of analysis as problem 2.8.

Step 1: Balance the chemical reaction using elemental balances:

$$C_7H_8 + aO_2 \rightarrow bCO_2 + dH_2O$$

Find the stoichiometric coefficients a, b,& d.

C: $7 = b$

H: $8 = 2d$ or $d = 4$

O: $2a = 2b + d$ or $a = 7 + 2 = 9$

$$C_7H_8 + 9O_2 \rightarrow 7CO_2 + 4H_2O$$

Step 2: Use equation 2.25 to express the heat of combustion in terms of the heats of formation

$$\Delta\tilde{h}_c = \left(\sum_i \nu_i \Delta\tilde{h}^o_{f,i}\right)_{React} - \left(\sum_j \nu_j \Delta\tilde{h}^o_{f,j}\right)_{Prod}$$

$n_{C7H8} = 1.; n_{CO2} = 7.; n_{H2O} = 4.; \Delta h^o_{f,CO2} = -393.5kJ/\tilde{m}; \Delta h_{f,H2O_{lower}} = -241.8kJ/\tilde{m}; \Delta h_{f,C7H8} = 11.95 \times 4.2kJ/\tilde{m}$

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In [9]: n_C7H8=1.; n_CO2=7.; n_H2O=4.; hfC7H8= 11.95*4.2; hfCO2=-393.5; hfH2O_lower= -241.8;

In [10]: Dhcmol=hfC7H8 - (n_CO2*hfCO2 + n_H2O*hfH2O_lower); Dhcmol

Out[10]: 3771.89
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The molar heat of combustion for toluene is $3772kJ/mole$. We divide by the molecular weight to get the heat of combustion on a mass basis. We divide by the mass of oxygen to get this on a oxygen basis.

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In [10]:
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