CH365 Chemical Engineering Thermodynamics

Lesson 19
Heat Effects of Industrial Reactions

Open "Example_4-7_Cadet" mma file in CANVAS

Find it in Modules, Lesson 19

Industrial Reactions

Review of Lesson 18

Today we will use these in the homework.

$$\Delta H^{\circ} = \Delta H^{\circ}_{298} + R \cdot \int_{T0}^{T} \frac{\Delta C^{\circ}_{P}}{R} dT = \Delta H^{\circ}_{298} + R \cdot IDCPH \qquad \text{Eq. 4.19}$$

$$IDCPH = \int_{T_0}^{T} \frac{\Delta C^{\circ}_{p}}{R} dT = (\Delta A) \cdot (T - T_0) + \frac{\Delta B}{2} \cdot (T^2 - T_0^2) + \frac{\Delta C}{3} \cdot (T^3 - T_0^3) + \Delta D \cdot \left(\frac{T - T_0}{T \cdot T_0} \right) \qquad \text{Eq. 4.20}$$

$$\Delta A = \sum_i \nu_i \cdot A_i, \quad \Delta B = \sum_i \nu_i \cdot B_i, \quad \text{etc.}$$

This only works when T is the same for reactants and products. (see L18 Slide 5) Not explained in book!

$$\Delta H^{\circ} = \Delta H^{\circ}_{298} + R \cdot \int_{T0}^{T} \frac{\Delta C^{\circ}_{P}}{R} dT = \boxed{\Delta H^{\circ}_{298} + R \cdot MDCPH \cdot (T - T_0)} \qquad \text{Eq. 4.22}$$

$$MDCPH = \frac{\left\langle \Delta C^{\circ}_{p} \right\rangle_H}{R} = \Delta A + \frac{\Delta B}{2} \cdot (T + T_0) + \frac{\Delta C}{3} \cdot (T^2 + T_0^2 + T \cdot T_0) + \frac{\Delta D}{T \cdot T_0} \qquad \text{Eq. 4.21}$$

$$\int_{T_0}^{T} \frac{\Delta C^{\circ}_{p}}{R} dT = IDCPH(T_0, T, DA, DB, DC, DD)$$
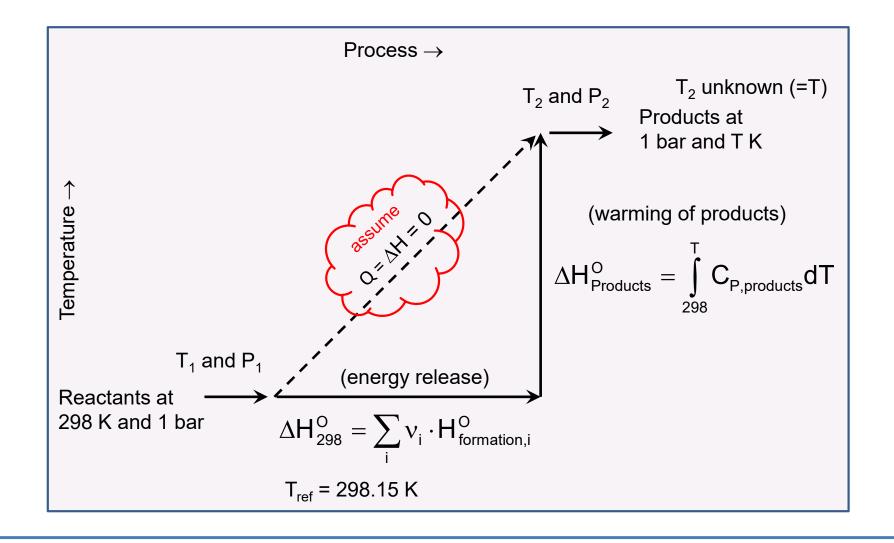
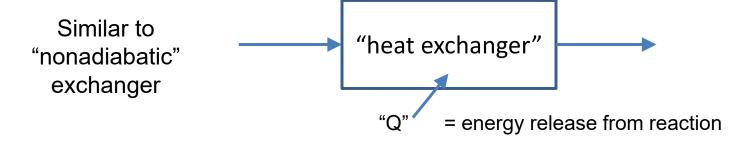Functional nomenclature used in book, page 155

(no equation numbers)

$$\frac{\left\langle \Delta C^{\circ}_{p} \right\rangle_H}{R} = MDCPH(T_0, T, DA, DB, DC, DD)$$

These are "parameters;" all but T_0 change

Example 4.7

What is the maximum temperature that can be reached by the combustion of methane with 20% excess air? Methane and air enter the burner at 25 deg C.

Process →

T_2 and P_2

T_2 unknown (=T)
Products at
1 bar and T K

assume $Q = \Delta H = 0$

(warming of products)

$$\Delta H^O_{Products} = \int\limits_{298}^{T} C_{P,products}\, dT$$

T_1 and P_1

Temperature →

Reactants at
298 K and 1 bar

(energy release)

$$\Delta H^O_{298} = \sum_i \nu_i \cdot H^O_{formation,i}$$

T_{ref} = 298.15 K

Similar to
"nonadiabatic"
exchanger

"heat exchanger"

"Q" = energy release from reaction

Example 4.7

What is the maximum temperature that can be reached by the combustion of methane with 20% excess air? Methane and air enter the burner at 25 deg C.

Solution:

Part (1) Calculate heat of reaction at 298:

Questions?