CH365 Chemical Engineering Thermodynamics

Lesson 19
Heat Effects of Industrial Reactions

Download and open "Example_4-7_Cadet.nb"

CANVAS Modules, Lesson 19

Industrial Reactions

Review of Lesson 18

Today we will use these in the homework.

$$\Delta H^o = \Delta H^o_{298} + R \cdot \int_{T0}^{T} \frac{\Delta C^o_P}{R} dT = \Delta H^o_{298} + R \cdot IDCPH$$ Eq. 4.19

$$IDCPH = \int_{T_0}^{T} \frac{\Delta C^o_p}{R} dT = (\Delta A) \cdot (T - T_0) + \frac{\Delta B}{2} \cdot (T^2 - T_0^2) + \frac{\Delta C}{3} \cdot (T^3 - T_0^3) + \Delta D \cdot \left(\frac{T - T_0}{T \cdot T_0} \right)$$ 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!

$$\Delta H^o = \Delta H^o_{298} + R \cdot \int_{T0}^{T} \frac{\Delta C^o_P}{R} dT = \Delta H^o_{298} + R \cdot MDCPH \cdot (T - T_0)$$ Eq. 4.22

$$MDCPH = \frac{\langle \Delta C^o_p \rangle_H}{R} = \Delta A + \frac{\Delta B}{2} \cdot (T + T_0) + \frac{\Delta C}{3} \cdot (T^2 + T_0^2 + T \cdot T_0) + \frac{\Delta D}{T \cdot T_0}$$ Eq. 4.21

$$\int_{T_0}^{T} \frac{\Delta C^o_p}{R} dT = IDCPH(T_0, T, DA, DB, DC, DD)$$

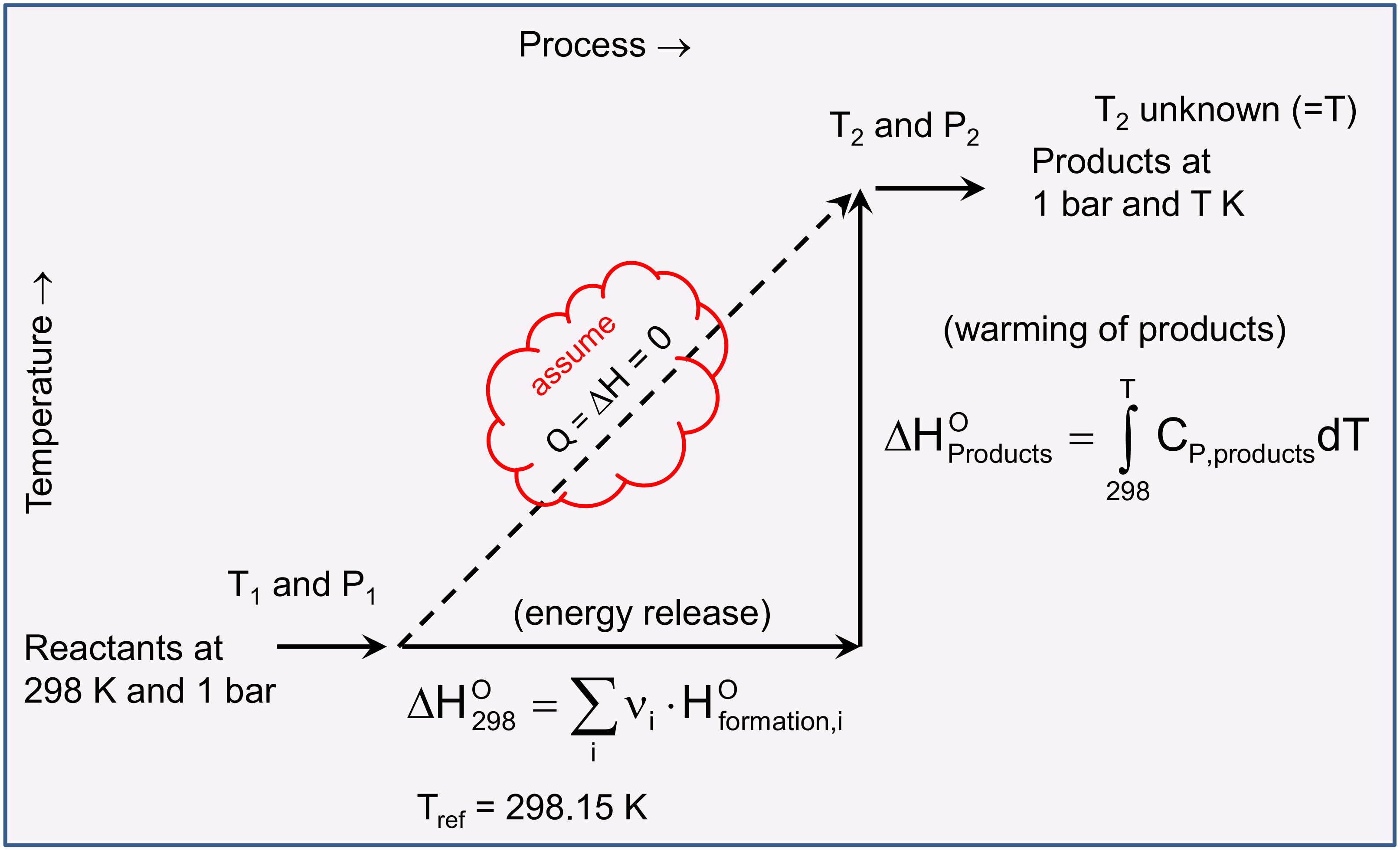
Functional nomenclature used in book, page 155

(no equation numbers)

$$\frac{\langle \Delta C^o_p \rangle_H}{R} = MDCPH(T_0, \underbrace{T, DA, DB, DC, DD}_{\text{These are “parameters;” all but } T_0 \text{ change}})$$

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 °C.


Process →
Temperature →
T_2 and P_2
T_2 unknown (=T)
Products at
1 bar and T K
assume
$Q = \Delta H = 0$
(warming of products)
$\Delta H^{O}_{Products} = \int_{298}^{T} C_{P,products} dT$
T_1 and P_1
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

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?