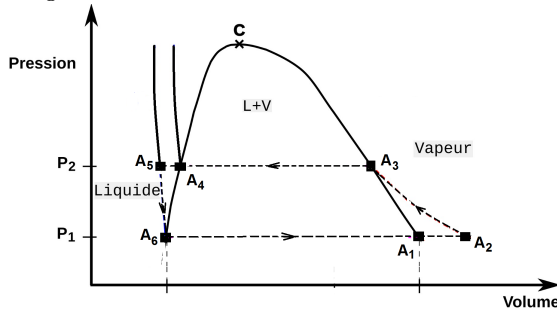


Exercice 1 :

1) Diagramme p-V



2) La vapeur d'eau se comportant comme un gaz parfait dans l'atmosphère, on a :

$$P_1 V_1 = RT_1 \Rightarrow V_1 = \frac{RT_1}{P_1} \quad V_1 = 0,0307 \text{ m}^3$$

$$A_1 A_2 : \text{réchauffement isobare} \Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$$V_2 = \frac{T_2}{T_1} V_1 \quad V_2 = 0,0373 \text{ m}^3$$

$$A_2 A_3 : \text{compression isotherme} \Rightarrow P_3 V_3 = RT_3 \text{ avec } P_3 = P_2 \text{ et } T_3 = T_2$$

$$V_3 = \frac{RT_2}{P_2} \quad V_3 = 0,0339 \text{ m}^3$$

$$3) A_1 A_2 : \text{réchauffement isobare} \Rightarrow Q_{12} = C_p (T_2 - T_1) \\ Q_{12} = C_g (T_2 - T_1) \quad Q_{12} = 2,616 \text{ kJ}$$

$$A_2 A_3 : \text{compression isotherme} \Rightarrow Q_{23} = RT \ln \frac{V_3}{V_2}$$

$$Q_{23} = RT_2 \ln \left(\frac{V_3}{V_2} \right) \quad Q_{23} = -9,04 \text{ kJ}$$

$$A_3 A_4 : \text{condensation (contraire à l'évaporation)}$$

$$\text{isotherme} \Rightarrow Q_{34} = -nL_2 \text{ et } T_3 = T_2$$

$$Q_{34} = -L_2 \quad Q_{34} = -36,6 \text{ kJ}$$

$$A_4 A_5 : \text{refroidissement (eau sous forme liquide) isobare}$$

$$\Rightarrow Q_{45} = C_f (T_5 - T_4) \text{ avec } T_4 = T_3 \text{ et } T_5 = T_1$$

$$Q_{45} = C_f (T_1 - T_2) \quad Q_{45} = -6,02 \text{ kJ}$$

$$A_5 A_6 : \text{détente (eau liquide) isotherme} \Rightarrow PV = \text{const} \\ \text{et } \frac{P}{T} = \text{const}$$

$$Q_{56} = C_f (T_1 - T_1) \quad Q_{56} = 0 \text{ kJ}$$

$$A_6 A_1 : \text{évaporation isotherme} \Rightarrow T_6 = T_1 \text{ et } L = L_1 \\ Q_{61} = L_1 \quad Q_{61} = 40 \text{ kJ}$$

$$4) W_{12} = R (T_2 - T_1) \quad W_{12} = 0,665 \text{ kJ} \\ W_{23} = -RT_2 \ln \left(\frac{V_3}{V_2} \right) \quad W_{23} = 9,04 \text{ kJ}$$

$$W_{34} = -P_3 (V_4 - V_3) = -P_2 (V_4 - V_3)$$

$$W_{34} = P_2 V_3 \quad W_{34} = 3,77 \text{ kJ}$$

$$W_{45} = 0 \text{ kJ} \text{ car } dV = 0 \text{ pour l'eau liquide}$$

$$W_{56} = 0 \text{ kJ} \text{ car } dV = 0 \text{ pour l'eau liquide}$$

$$W_{61} = -P_6 (V_1 - V_6) = -P_1 (V_1 - V_6)$$

$$W_{61} = -P_1 V_1 \quad W_{34} = -3,1 \text{ kJ}$$

$$5) \Delta H_{12} = Q_{12} \quad \Delta H_{12} = 2,616 \text{ kJ} \\ \Delta H_{23} = 0 \text{ kJ}$$

$$\Delta H_{23} = 0 \text{ kJ}$$

$$\Delta H_{34} = 0 \text{ kJ}$$

$$\Delta H_{45} = Q_{45} \quad \Delta H_{45} = -6,02 \text{ kJ}$$

$$\Delta H_{56} = 0 \text{ kJ}$$

$$\Delta H_{61} = 0 \text{ kJ}$$

$$6) \Delta S_{12} = C_g \ln \left(\frac{V_2}{V_1} \right) \quad \Delta S_{12} = 6,35 \text{ J} \cdot \text{K}^{-1} \\ \Delta S_{23} = R \ln \left(\frac{V_3}{V_2} \right) \quad \Delta S_{23} = -19,95 \text{ J} \cdot \text{K}^{-1}$$

$$\Delta S_{34} = -\frac{Q_{34}}{T_3}$$

$$\Delta S_{34} = \frac{Q_{34}}{T_2} \quad \Delta S_{34} = -80,77 \text{ J} \cdot \text{K}^{-1}$$

$$\Delta S_{45} = C_f \ln \left(\frac{T_1}{T_2} \right) \quad \Delta S_{45} = -14,6 \text{ J} \cdot \text{K}^{-1}$$

$$\Delta S_{45} = Q_{45} \quad \Delta H_{45} = -6,02 \text{ kJ}$$

$$\Delta S_{56} = \frac{Q_{56}}{T_5}$$

$$\Delta S_{56} = \frac{Q_{56}}{T_1} \quad \Delta S_{56} = 0 \text{ J} \cdot \text{K}^{-1}$$

$$\Delta S_{61} = \frac{Q_{61}}{T_6}$$

$$\Delta S_{61} = \frac{Q_{61}}{T_1} \quad \Delta S_{61} = 107,2 \text{ J} \cdot \text{K}^{-1}$$

Exercice 2 :

$$2) W_{12} = 0$$

$$W_{23} = -P_2 V_2 \ln \left(\frac{V_3}{V_2} \right) \Rightarrow W_{23} = -P_a V_a \ln \left(\frac{V_c}{V_a} \right)$$

$$W_{31} = -P_3 (V_1 - V_3) \Rightarrow W_{31} = -P_a (V_a - V_c)$$

$$Q_{12} = mc_v (T_2 - T_1)$$

$$Q_{23} = U_{23} - W_{23} \Rightarrow Q_{23} = P_a V_a \ln \left(\frac{V_c}{V_a} \right)$$

$$Q_{31} = mc_p (T_1 - T_3) = mc_p (T_1 - T_2)$$

$$2 \rightarrow 3 \text{ est isotherme}$$

$$Q_{31} = mc_p (T_1 - T_2)$$

$$2) W_{\text{cycle}} = -P_a V_a \ln \left(\frac{V_c}{V_a} \right) - P_a (V_a - V_c) \\ Q_{\text{cycle}} = -mc_v (T_1 - T_2) + mc_p (T_1 - T_2) \\ + P_a V_a \ln \left(\frac{V_c}{V_a} \right)$$

$$Q_{\text{cycle}} = m (c_p - c_v) (T_1 - T_2) + P_a V_a \ln \left(\frac{V_c}{V_a} \right)$$

$$Q_{\text{cycle}} = mr (T_1 - T_3) + P_a V_a \ln \left(\frac{V_c}{V_a} \right)$$

$$W_{\text{cycle}} + Q_{\text{cycle}} = -P_a (V_a - V_c) + mr T_1 - mr T_3$$

$$W_{\text{cycle}} + Q_{\text{cycle}} = -P_a (V_a - V_c) + P_a V_a - P_a V_c$$

$$W_{\text{cycle}} + Q_{\text{cycle}} = 0 \Rightarrow 1^{\text{er}} \text{ principe est vérifié.}$$