

13. cvičení

1. HRW, kapitola 20, 14Ú

$$p = \frac{AT - BT^2}{V}$$

$$p = \text{konst}, \quad T_1 \rightarrow T_2$$

$$W = \int_{V_1}^{V_2} p \, dV = p \int_{V_1}^{V_2} dV = p(V_2 - V_1)$$

$$\frac{p}{V_1} = \frac{p}{V_2}$$

$$\frac{AT_1 - BT_1^2}{V_1} = \frac{AT_2 - BT_2^2}{V_2}$$

$$V_2 = \frac{AT_2 - BT_2^2}{AT_1 - BT_1^2} V_1$$

$$V_2 - V_1 = \left(\frac{AT_2 - BT_2^2}{AT_1 - BT_1^2} - 1 \right) V_1$$

$$V_2 - V_1 = \left(\frac{AT_2 - BT_2^2 - AT_1 + BT_1^2}{AT_1 - BT_1^2} \right) V_1$$

$$W = p(V_2 - V_1) = \frac{AT_1 - BT_1^2}{V_1} \left(\frac{AT_2 - BT_2^2 - AT_1 + BT_1^2}{AT_1 - BT_1^2} \right) V_1$$

$$W = AT_2 - BT_2^2 - AT_1 + BT_1^2$$

$$W = A(T_2 - T_1) - B(T_2^2 - T_1^2)$$

2.

Stavy:

1. p_1, V_1, T_1
2. p_2, V_2, T_1
3. p_3, V_2, T_2
4. p_4, V_1, T_2

1→2 izotermický

$$\Delta U_{12} = 0$$

$$W_{12} = nRT_1 \ln \frac{V_2}{V_1} = Q_{12} > 0 \quad (V_2 > V_1)$$

2→3 izochorický

$$W_{23} = 0$$

$$\Delta U_{23} = C_V(T_2 - T_1) = Q_{23} < 0 \quad (T_2 < T_1)$$

3→4 izotermický

$$\Delta U_{34} = 0$$

$$W_{34} = nRT_2 \ln \frac{V_1}{V_2} = -nRT_2 \ln \frac{V_2}{V_1} = Q_{34} < 0$$

4→1 izochorický

$$W_{41} = 0$$

$$\Delta U_{41} = C_V(T_1 - T_2) = Q_{41} > 0$$

$$W_{\text{KD}} = W_{12} + W_{34} = nRT_1 \ln \frac{V_2}{V_1} - nRT_2 \ln \frac{V_2}{V_1} = nR(T_1 - T_2) \ln \frac{V_2}{V_1}$$

$$Q_{\text{KLADNE,KD}} = Q_{12} + Q_{41} = nRT_1 \ln \frac{V_2}{V_1} + C_V(T_1 - T_2)$$

$$\eta = \frac{W_{\text{KD}}}{Q_{\text{KLADNE,KD}}} = \frac{nR(T_1 - T_2) \ln \frac{V_2}{V_1}}{nRT_1 \ln \frac{V_2}{V_1} + C_V(T_1 - T_2)}$$

Mayerův vztah:

$$C_p = C_V + nR$$

$$\frac{C_p}{C_V} = 1 + \frac{nR}{C_V}$$

$$\frac{nR}{C_V} = \kappa - 1$$

Ve vztahu pro účinnost rozšíříme čitatele i jmenovatele $\frac{1}{C_V}$ a za $\frac{nR}{C_V}$ dosadíme $\kappa - 1$.

$$\eta = \frac{(\kappa - 1)(T_1 - T_2) \ln \frac{V_2}{V_1}}{(\kappa - 1)T_1 \ln \frac{V_2}{V_1} + T_1 - T_2}$$