2.13 Joule-Thomson: adiabatic + isenthalpic expansion

Performing an experiment as illustrated in Fig. 2.9, one typically observes a temperature change when pressing gas through a throttle.

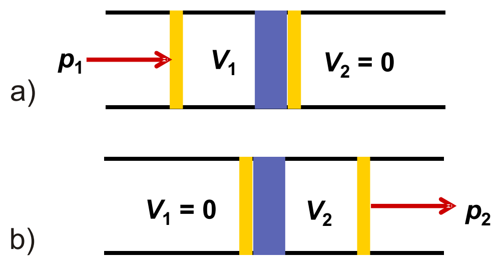

Figure 2.9: Illustration of isenthalpic expansion: a) at beginning of experiment, b) after finishing the experiment.

- Gas becomes cold / warm during expansion by counteracting attractive / repulsive forces, thus reducing / increasing U.
- Sign of ΔT depends on the Joule-Thomson coefficient which depends on p and T. Being adiabatic, we find

$$\Delta U = \Delta q + \Delta w = \Delta w \tag{2.38}$$

According to Fig. 2.9 a) we find for system 1 (left of diaphragm)

$$\Delta U_1 = 0 - U_1 = -U_1 = -p_1\,(0 - V_1) = p_1\,V_1 \tag{2.39}$$

According to Fig. 2.9 b) we find for system 2 (right of diaphragm)

$$\Delta U_2 = U_2 - 0 = U_2 = -p_2\,(V_2 - 0) = -p_2\,V_2 \tag{2.40}$$

$$\begin{aligned} \text{Thus the total change is} \quad & \Delta U_1 + \Delta U_2 = -U_1 + U_2 = p_1\,V_1 - p_2\,V_2 \\ \Rightarrow \quad & U_2 + p_2\,V_2 = U_1 + p_1\,V_1 \quad \Rightarrow \quad H_2 = H_1 \end{aligned} \tag{2.41}$$

So the Δ in the above equation means state (after change) minus state (before change). Eq. (2.41) implies that the adiabatic expansion is also isenthalpic, and of course it is an irreversible process, because a tiny change in p_1 will not change the gas flow direction.