## 2.12 Isenthalpic processes

As we will see soon, isenthalpic processes are the basis of most cooling systems. Before we describe experimental realizations we will do the necessary math. From the total differential $H(T, p)$ we get

$$\begin{aligned} dH &= \left(\frac{\partial H}{\partial T}\right)_p dT + \left(\frac{\partial H}{\partial p}\right)_T dp = 0 \\ \Rightarrow &- \left(\frac{\partial H}{\partial T}\right)_p dT = \left(\frac{\partial H}{\partial p}\right)_T dp \Rightarrow - \left(\frac{\partial H}{\partial T}\right)_p \left(\frac{\partial T}{\partial p}\right)_H = \left(\frac{\partial H}{\partial p}\right)_T \\ \Rightarrow &\left(\frac{\partial T}{\partial p}\right)_H = -\frac{\left(\frac{\partial H}{\partial p}\right)_T}{C_p} = \mu \end{aligned} \tag{2.37}$$

Here $\mu$ is the Joule-Thomson coefficient. According to its definition $\mu$ describes the temperature change due to a pressure change under isenthalpic condition. $\mu(T)$ could be zero, positive (e.g. for air at room temperature), or negative (e.g. for He at 27 K). Thus cooling as well as heating is possible during expansion, e.g. if cooling by adiabatic / isenthalpic expansion is found, $dp < 0$ as well as $dT < 0$, hence $\mu > 0$. The interpretation on a molecular scale of this expansion effect is

- $\mu > 0$ (cooling), attractive forces are dominant, thus a decrease of $U$ will occur.
- $\mu < 0$ (heating), repulsive forces are dominant, thus an increase of $U$ will occur.