

[tex197] Joule coefficient of Dieterici gas

The cooling of a gas via free expansion is described by the Joule coefficient

$$\left(\frac{\partial T}{\partial V}\right)_U = \frac{1}{C_V} \left[p - T \left(\frac{\partial p}{\partial T}\right)_V \right].$$

(a) Determine the Joule coefficient for 1 mol of the Dieterici gas specified by the following thermodynamic equation of state:

$$p = \frac{RT}{V-b} \exp\left(-\frac{a}{RTV}\right),$$

where $a, b > 0$ are empirical constants.

(b) For a situation of high temperature, we can assume that $e^{-a/RTV} \simeq 1$ and $C_V \simeq \text{const}$ hold in good approximation. Under these assumptions, calculate the temperature drop, $\Delta T \doteq T_f - T_i$, when the Dieterici gas is freely expanded from V_i to $V_f > V_i$.

Solution: