

4.8: The Enthalpy of an Ideal Gas is Independent of Pressure

How does pressure affect enthalpy H ? As we showed above we have the following relations of first and second order for G

$$\begin{aligned}\left(\frac{\partial G}{\partial T}\right)_P &= -S \\ \left(\frac{\partial G}{\partial P}\right)_T &= -V \\ -\left(\frac{\partial S}{\partial P}\right)_T &= \left(\frac{\partial V}{\partial T}\right)_P\end{aligned}$$

We also know that by definition:

$$G = H - TS \quad (4.8.1)$$

Consider an isothermal change in pressure, so taking the partial derivative of each side of Equation 4.8.1, we get:

$$\begin{aligned}\left(\frac{\partial G}{\partial P}\right)_T &= \left(\frac{\partial H}{\partial P}\right)_T - T\left(\frac{\partial S}{\partial P}\right)_T \\ \left(\frac{\partial H}{\partial P}\right)_T &= V - T\left(\frac{\partial V}{\partial T}\right)_P\end{aligned} \quad (4.8.2)$$

For an ideal gas

$$\frac{\partial V}{\partial T} = \frac{nR}{P}$$

so Equation 4.8.2 becomes

$$\left(\frac{\partial H}{\partial P}\right)_T = V - T\left(\frac{nR}{P}\right) = 0$$

As we can see for an ideal gas, there is no dependence of H on P .

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