10.3 Calculate the partial pressure and gas-phase concentration (in ppm) of n-octane[1] in air when the air is saturated at 100°F. The total pressure is 1 atm.

First look at Figure B.1

- octane @ 100°F (x axis + labelled line)
- 0.5 psi vapor pressure (y axis)

We know that in general $P_i \leq P_{vi}$, unless liquid is present. However, in this case we are at saturation. In these problems, you want to look up the vapor pressure, but then you may need to check other conditions (especially pressure, temperature, and presence of liquid) to determine *what relationships between partial pressure and vapor pressure are valid.*

The system is **saturated** when the system is at equilibrium with both vapor and liquid present, and when saturated, the partial pressure is equal to the vapor pressure

$$P_i = P_{vi} \text{ at saturation}$$

Therefore P_i **= 0.5 psi**

To find the concentration in ppm, first we will find the mole fraction: Use eq 10.2 from the text (remember 1 atm = 14.7 psi, and we know we are at equilibrium because we're at saturation)

$$\begin{aligned} P_i = y_i P &= P_{vi} \text{ at equilibrium} \\ 0.5 \text{ psi} &= y_i 14.7 \text{ psi} \\ y_i &= 0.034 \end{aligned}$$

If you recall from Section 1.5

$$ppm = \frac{V_{pol}}{V_{tot}} \times 10^6$$

and here we will assume the volume fraction = mole fraction so

$$ppm = \frac{V_{pol}}{V_{tot}} \times 10^6 = 0.034 \times 10^6 = \mathbf{34{,}014\ ppm}$$

[1] n-octane is one of the possible structures of C_8H_{18}, which can be structurally arranged in many ways, but this is the simplest arrangement (a straight line) and what is referred to on the chart.