Answer on Question # 72738 - Chemistry - General Chemistry

Carbon tetrachloride, CCl4, was once used as a dry cleaning solvent, but is no longer used because it is carcinogenic. At 56.3°C, the vapor pressure of CCl4 is 53.5 kPa, and its enthalpy of vaporization is 29.82 kJ/mol. Use this information to estimate the normal boiling point (in °C) for CCl4.

Solution

The normal boiling occurs at a standard pressure, which is P_1 = 101.3 kPa. The vapor pressure (P_2 = 53.5 kPa) at another temperature (T_2 = 56.3°C = 329.45 K) is given in the problem statement. Using the enthalpy of vaporization (ΔH_{vap} = 29.82 kJ/mol) it is possible to apply the Clausius-Clapeyron equation:

$$\ln(P_1/P_2) = (-\Delta H_{vap} / R)\ (1/T_1 - 1/T_2)$$

$$\ln(101.3\ \text{kPa}\ /53.5\ \text{kPa}) = (-29.82\ \text{kJ/mol}\ /\ 0.008314\ \text{kJ/molK})\ (1/T_1 - 1/329.45\ \text{K})$$

$$1/T_1 = (0.008314\ /-29.82)\ \ln(101.3\ /53.5) + 1/329.45$$

$$T_1 = [(0.008314\ /-29.82)\ \ln(101.3\ /53.5) + 1/329.45]^{-1}$$

$$T_1 = 349.97\ \text{K} = 76.8\ °\text{C}.$$

Answer: 76.8 °C.