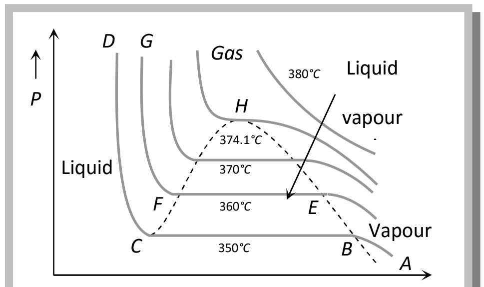
Andrews Curves.

The pressure (P) versus volume (V) curves for actual gases are called Andrews curves.



Andrews curve for water

(1) At 350°C, part AB represents vapor phase of water, in this part Boyle's law is obeyed $\left(P \propto \frac{1}{V}\right)$. Part BC represents the co-existence of vapor and liquid phases. At point C, vapors completely change to liquid phase. Part CD is parallel to pressure axis which shows that compressibility of the water is negligible.

(2) At 360°C portion representing the co-existence of liquid vapor phase is shorter.

(3) At 370°C this portion is further decreased.

(4) At 374.1°C, it reduces to point (H) called critical point and the temperature 374.1°C is called critical temperature (Tc) of water.

(5) The phase of water (at 380°C) above the critical temperature is called gaseous phase.

Critical temperature, pressure and volume

The point on the P-V curve at which the matter gets converted from gaseous state to liquid state is known as critical point. At this point the difference between the liquid and vapor vanishes i.e. the densities of liquid and vapor become equal.

(i) Critical temperature (Tc): The maximum temperature below which a gas can be liquefied by pressure alone is called critical temperature and is characteristic of the gas. A gas cannot be liquefied if its temperature is more than critical temperature.

CO_2 (304.3 K), O_2 (–118°C), N_2 (–147.1°C) and H_2O (374.1°C)

(ii) Critical pressure (Pc): The minimum pressure necessary to liquefy a gas at critical temperature is defined as critical pressure.

CO_2 (73.87 bar) and O_2 (49.7atm)

(iii) Critical volume (Vc): The volume of 1 mole of gas at critical pressure and critical temperature is defined as critical volume.

CO_2 (95×10^{-6} m^3)

(iv) Relation between Vander Waal's constants and Tc, Pc, Vc :

$T_c = \frac{8a}{27Rb}$, $P_c = \frac{a}{27b^2}$, $V_c = 3b$, $a = \frac{27R^2}{64}\frac{T_c^2}{P_c}$, $b = \frac{R}{8}\left(\frac{T_c}{P_c}\right)$ and

$\frac{P_c V_c}{T_c} = \frac{3}{8}R$