~~Law of Corresponding State~~:→

Reduced equation of state & law of Corresponding State:→

Reduced equation state:

There are two constants in Vanderwaal equation i.e 'a' & 'b', the value of these constants changes with change in gas. or we can say as gas changes the value of vanderwaal constant 'a' & 'b' also changes. In this condition we should have different equations for different gases. If we write the relative values in terms of critical constants (P_c, V_c & T_c respectively) for actual pressure, volume, & temperature then we have an equation free from any such constants and so it can be applied for all the gases.

Let. $\frac{P}{P_c} = P_r$, $\frac{V}{V_c} = V_r$ & $\frac{T}{T_c} = T_r$.

Where P_r, V_r & T_r are also called reduced values of Pressure, volume & temperature respectively which are pure numbers & dimensionless also.

By vanderwaal eqn $\left(P+\frac{a}{V^2}\right)(V-b) = RT$ for 1 mol of gas

When we use Critical Constant in the vanderwaal equation

$$\left(P + \frac{3P_c \times V_c^2}{V^2}\right)\left(V - \frac{V_c}{3}\right) = \frac{8}{3} \cdot \frac{P_c V_c}{T_c} \cdot T \quad \text{—I}$$

Devide both side by $P_c V_c$ we have

$$\left[\frac{P + \frac{3P_c V_c^2}{V^2}}{P_c}\right]\left[\frac{V - \frac{V_c}{3}}{V_c}\right] = \frac{\frac{8}{3}\frac{P_c V_c T}{T_c}}{P_c \times V_c}$$

$$\left[\frac{P}{P_c} + 3\left(\frac{V_c}{V}\right)^2\right]\left[\frac{V}{V_c} - \frac{1}{3}\right] = \frac{8}{3}\frac{T}{T_c}$$

$$\left(P_r + \frac{3}{V_r^2}\right)\left(V_r - \frac{1}{3}\right) = \frac{8}{3}T_r$$

or $$\boxed{\left(P_r + \frac{3}{V_r^2}\right)\left(3V_r - 1\right) = 8T_r} \quad \text{—II}$$

The above equation II is called reduced equation of state or reduced vanderwaal equation of state. If the value of P_r, V_r & T_r are appropriate then it hold good for all gases without any constant values.

Teacher's Signature: ____________

If the two or more than two gases reduced pressure & reduced tempera-
ture values are same then they
Should have same reduced volume
also. This statement is also called
Law of corresponding state.

By plotting compressibility factor
Z $\left(\frac{PV}{RT}\right)$ against reduced pressure (P_r)
the law of corresponding state can be
checked experimentally for different
gases at same reduced temperature (T_r)
The value of Z for different gases
seems to be same curve, this proves
all gases in corresponding state deviation
almost same from ideal behaviour.

Boiling point of all liquids
are approximately two third of their ~~critical~~
critical temperature. It proves the liquid
at their boiling point are in correspon-
ding states. Hence we can say
when we study the physical properties
of liquids and their chemical consti-
tution then their properties are determined
at their boiling point.