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Andrews' Experiment and Real Gas

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Abstract:-

This article is about Andrews's enhaustive experiment on the isotherm of carbon dioxide gas and formed the experimental base of real gas.

Deviation from ideal gas:-

The equation of state of ideal gas is given by PV=nRT. If this equation of state were valid, the graph of PV vs P would have straight line as the value of PV would be constant at constant T not vary with P. But the result is very different.

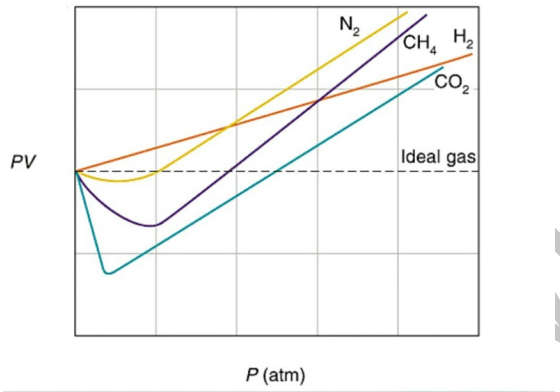

Image1:- Variation for PV vs P at high pressure

Thus all the gases differently from what was predicted by the ideal gas equation.

Andrew's experiment on carbon DI-oxide:-

A series of data of pressure and volume of CO_2. The experiment was done in a fixed temperature and was repeated under different temperatures. The isotherm i.e the graph between pressure and volume that was obtained is given below

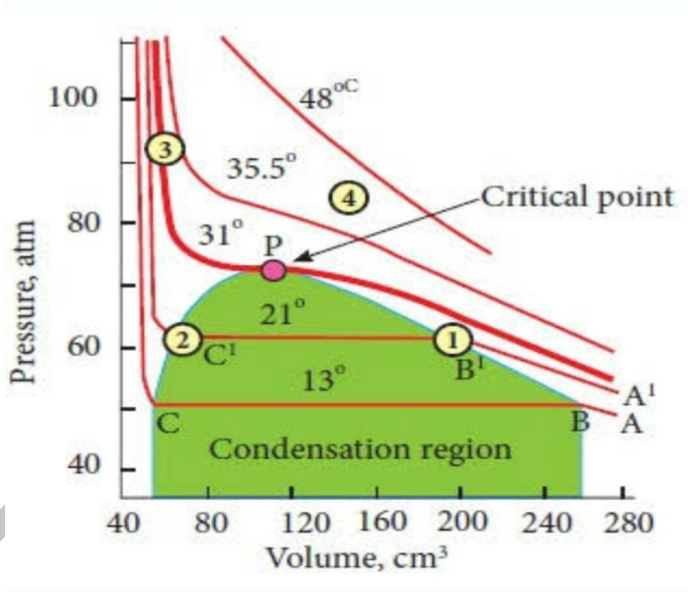

Image2:- isotherm of CO_2 by Andrews's experiment

Explanation of the isotherm:-

CO_2 is in the gaseous state at A, look at the isotherm at 13.1°C . Pressure increases volume decreases a bit till point B. There the process of liquefaction starts at constant pressure and decreasing volume till C. In the region BC, gaseous and liquid state coexists as the process of liquefaction continues. It is liquid at C and as liquid is highly in compressible, with increase in pressure, volume slightly decreases as it clear from CD.

Let's look the isotherms at higher temperatures. The form remains same but the pressure to liquefy increases and the horizontal portion of liquefaction decreases. At 31.4°C, the horizontal portion of the isotherm just decreases to zero or just disappears. This temperature is called critical temperature. And at temperature of higher than 31.4°C the horizontal portion is absent. This means, there is no process of

liquefaction going on at temperature 31.4°C or above no matter how high the pressure is. Or at or above critical temperature, keeping the temperature constant, gases can't be liquefied by increasing pressure. This experiment forms the basis of an important equation of state of real gas by van der Waal.

Real gas equation of state:-

Van der Waal attempted to modify the equation of state of real gas by questioning the two major assumption taken while forming the ideal gas equation. Those two assumption were, molecules are point masses with no volume and the molecules don't exert any force between themselves, taking only the kinetic energy of the gas. Van der Waal corrected it to finite size and introduced the inter molecular forces. The final form being

Where a and b are called van der Waal's constants. This was the first equation to understand vapour to liquid phase transition.

Reference:-

Thermal physics:- A.B Gupta
Image1:- brainly
Image 2:-brainkart