Quadrant II – Transcript and Related Materials

Programme : **Bachelor of Science (First Year)**

Subject : **Physics**

Paper Code : **PYC 102**

Paper Title : **Heat & Thermodynamics and Properties of Matter & Acoustics**

Unit 2 : **Behaviour of real gases**

Module Name : **Deviation from perfect gas behavior, Discussion of results of Andrew's experiments on CO2 and Amagat's experiment (Part-2)**

Module No : **10**

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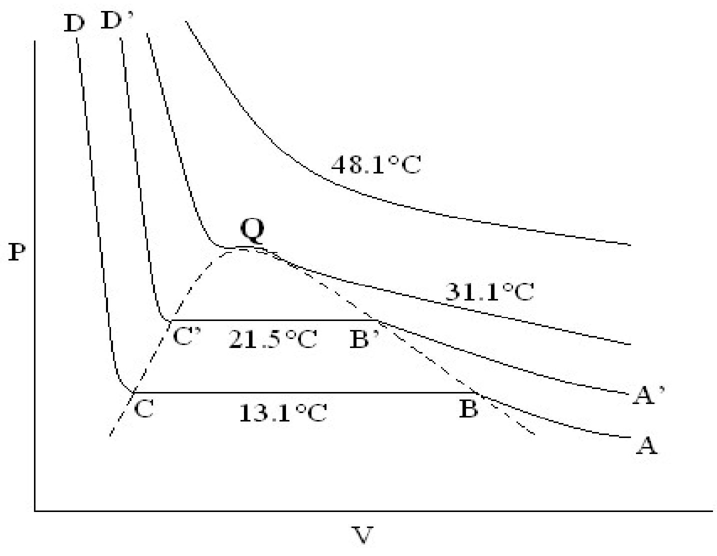
Notes

Results of Andrew's experiment:

The isothermals for CO_2 at various temperatures are shown in fig. below. Consider the curve ABCD corresponding to temperature 13.1°C



(i) In part AB, the substance is completely in the gaseous state, volume decreases as pressure increases.

(ii) At B the gas begins to condense. As the volume decreases from B to C more and more vapour becomes liquid. At C the entire substance is in the liquid state.

(iii) In the part CD, the pressure increases rapidly with no significant change in volume. This is because in this part the substance is completely in the liquid state and the liquid is highly incompressible.

The isothermals for higher temperatures 21.5°C etc. follow the same pattern but the horizontal portion decreases with increase in temperature. Finally at 31.1°C the horizontal portion completely disappears. At the point Q the liquid and vapour have the same density. Above 31.1°C the curves follow Boyle's law and the gas cannot be liquefied.

The temperature 31.1°C is called as the *critical temperature* of CO_2. The point Q is called *critical point.*

The critical temperature 'T_c' of a gas is defined as the maximum temperature above which the gas cannot be liquefied by application of pressure alone.

The critical pressure 'P_c' of a gas can be defined as the minimum pressure required to liquefy the gas at the critical temperature.

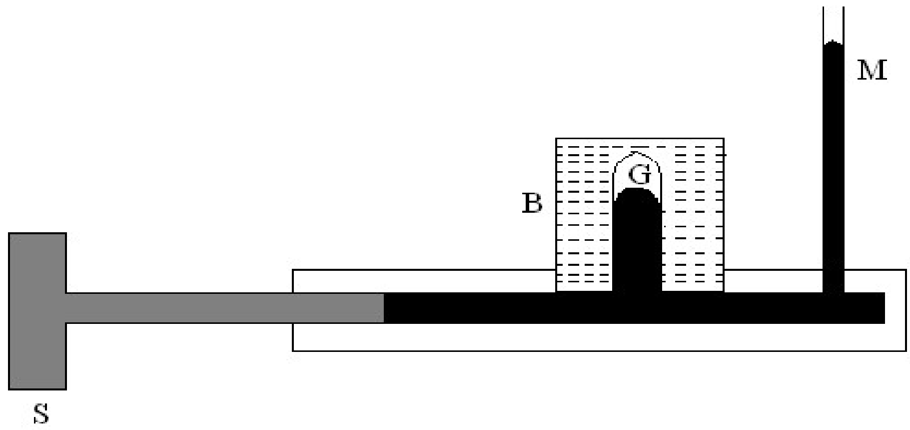
The critical volume 'V_c' of a gas can be defined as the volume of a unit mass of the gas at the critical temperature and pressure.

The critical temperature T_c, pressure P_c and volume V_c, are known as the critical constants of the gas.

If a (dotted) curve is drawn through the end points of the horizontal portions of the isothermals below T_c it shows maxima at the critical point Q. To the right of the curve outside the area enclosed by the dotted curve, the substance is unsaturated vapour and to the left it is in the liquid state.

Amagat's Experiment:

Amagat studied the behaviour of different gases at high pressures. The apparatus used is shown below.



It consists of metal cylinder containing mercury and fitted with a screw plunger S. A small quantity of the gas G was enclosed in a tube placed in a constant temperature bath B. This tube was connected to a steel manometer M placed at the bottom of a coal mine. The pressure on the gas could be increased upto about 400 atmospheres by moving the screw inwards and this pressure could be read on the manometer. The volume was read on the graduated tube containing the gas.

Amagat plotted graphs of PV against P.

The results are shown in fig. (a), (b) and (c) for H_2, N_2 and CO_2 respectively.

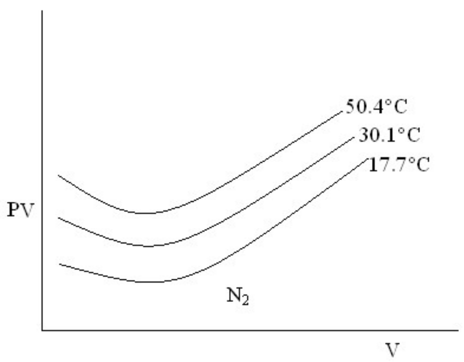


Fig. a

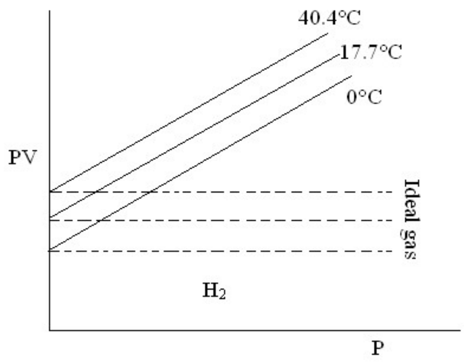


Fig. b

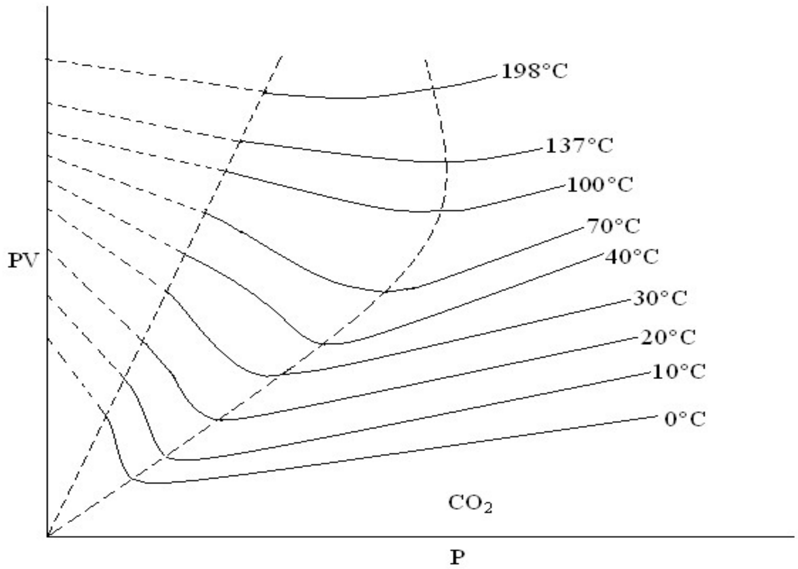


Fig. c

The following observations can be made from the graphs:

(i). In the case of H_2, the graph PV against P are straight lines, PV increasing with P.

(ii). In case of N_2, PV first decreases with the increase in V, reaches a minimum and then increases with P.

(iii). In the case of CO_2; below 30°C; the part of graph at low pressure is a straight line parallel to PV axis, this means the pressure remains constant while volume changes; this is due to the condensation of the vapour. The minima of the curves shift away from the origin as the temperature increases.