

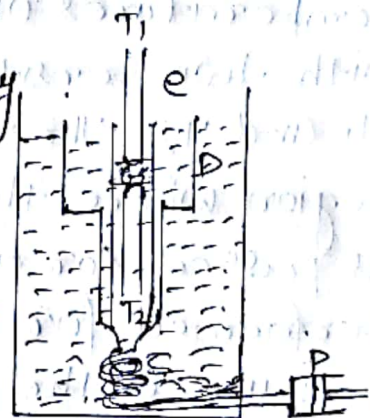
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B.Sc (Part-I) Hons
Paper - II

Joule - Thomson Effect:

The cooling produced when a gas is allowed to expand through a narrow orifice is called Joule-Thomson effect.

Joule and Thomson showed the above effect jointly with an experiment known as porous plug experiment. Through this experiment, they also established the existence of inter molecular attraction.



The apparatus used by them is shown in figure.

It consists of porous plug 'G' of silk or cotton wool kept in a position between two plates of perforated brass and enclosed in a cylinder made of non-conducting box-wood. A tin vessel 'D' filled with cotton, wool or asbestos surrounds the box-wood cylinder, and serves as a very good insulator and also protects the box-wood cylinder from coming in contact with water as the whole apparatus is placed in a water bath to ensure constant temperature.

The box-wood cylinder is fitted on both sides with copper tubes. The lower copper tube is connected to the compression pump 'P' by means of a long copper

Spiral S which is also immersed in the water bath as shown in figure, to maintain the gas at a steady constant temperature.

The compressed gas is allowed to suffer ~~that~~ throttle expansion through the porous plug, which serves to keep the velocity of flow small and thus prevents the formation of eddy current. Both these effects are spurious and must be avoided. The eddy currents however subside at a small distance from the porous plug. The temperatures on the two sides of the plug are measured with two sensitive platinum resistance thermometers T_1 and T_2 . The thermometer T_2 is placed outside the region where the eddy currents are formed. The gas is passed for about one hour and the experiment is performed for various differences of pressure. The pressure of the gas is noted, as it enters into the copper tube, by a manometer not shown in the figure. The experiment is repeated for various initial pressures, and temperatures.

Discussion! — (i) At sufficiently low temperatures all gases show a cooling effect.

(ii) At ordinary temperature all gases except hydrogen and helium show cooling effect. Hydrogen shows heating effect instead of cooling at room temperature.

(iii) The fall in temperature per atmosphere difference of pressure on the two sides of the porous plug.

(iv) The fall in temperature per atmosphere difference of pressure decreases as the initial temperature ~~higher than this temperature~~ of the gas is raised. It becomes zero at a particular temperature and at a temperature higher than this temperature instead of cooling, heating is observed. This particular temperature at which the Joule-Thomson effect changes sign is called the temperature of inversion.