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Adiabatic and isothermal changes

Q. Explain the terms adiabatic and isothermal changes.

Ans.- Isothermal change: When a change in pressure and volume of a substance takes place but the temperature remains constant, the change is said to be isothermal.

When the gas is compressed suddenly, some heat is produced but if the compression is slow and the heat produced is removed at once, so that the temperature remains constant, the change is isothermal.

Similarly when a gas is allowed to expand suddenly, work is done by the gas and some heat is absorbed. If heat is continuously supplied from outside so that the temperature remains constant, the change is isothermal.

Thus, in an isothermal change the temperature is kept constant by adding heat or taking it away from the substance. As there is no change in temperature, there is no change in internal

energy.

$\therefore dU = 0$

According to the first law of thermodynamics

$$dQ = dU + dW$$

$\therefore dQ = 0 + dW$

or $dQ = dW$

∴ In an isothermal change (or process or transformation) · Heat added (or subtracted) = External work done by (or on) gas.

For a perfect gas an isothermal change is represented by Boyle's law, given by the eqn

$PV =$ constant.

Adiabatic change: When a change in pressure and volume of a substance takes place but no heat is allowed to enter or leave it, the change is said to be adiabatic.

In the example given above; if no heat is taken away in the first case the temperature will rise and if no heat supplied in the second case, the temperature will fall.

Hence in an adiabatic change, the temp does not remain constant and no heat from outside is supplied to the system or taken away from it.

It does not mean that the heat content of the system remains constant. When a gas is allowed to expand, it does external work and energy for this purpose is drawn from the heat energy of the gas. The heat energy of the gas, therefore, decreases. When the gas is compressed, work is done on it and the energy gained appears as heat energy. The heat energy of the gas, therefore increases.

During an adiabatic process no heat enters or leaves the gas

$\therefore \quad dQ = 0$

According to the first law of thermodynamics

$$dQ = dU + dW$$

$$\therefore \quad 0 = dU + dW$$

$$\text{or} \quad dU = -dW$$

$\therefore$ In an adiabatic process

Increase (or decrease) in internal energy = External work done on (or by) the gas..