Application of first law of thermodynamics in Isothermal process:-

Isothermal process:-

When a change in pressure & volume of a substance takes place but the temprature remains constant, the change (process) is said to be isothermal.

When a gas is compressed suddenly then 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

$$\delta Q = dU + \delta W$$

$$\therefore \quad \delta Q = 0 + \delta W$$

or $$\delta Q = \delta W$$

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

For a perfect gas, an isothermal change is represented by Boyle's law given by equation $PV = \text{Constant}$.

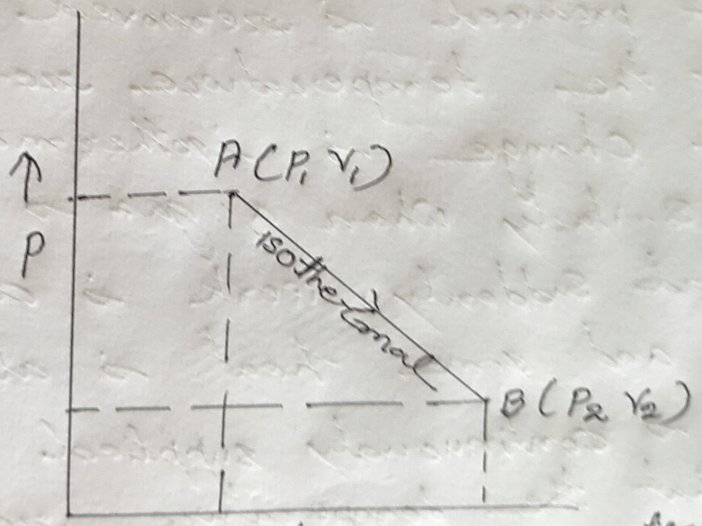

fig-1: isothermal

Suppose the working substance undergoes expansion, starting from point A having initial pressure P_1 and volume V_1.

Pressure is decreased in going from A to B and work is done by the working substance at the cost of its internal energy and suffers a fall in temperature.

But the system is perfectly conducting to the surroundings. It absorbs heat from the surroundings and maintains a constant temperature.

Thus, from A to B, the temperature remains constant. The curve AB is called the isothermal curve or isothermal. But in going back from B to A, the system gives out extra heat to the surroundings and maintains the temperature constant.

Thus, during isothermal process, the temperature of the working substance remains costant. It can absorb heat or give heat to the surroundings.

The equation for isothermal process is

$PV = RT$ = constant., for $n=1$

& $PV = nRT$, for n gram molecules of a gas.

For an ideal gas undergoing isothermal process.

$$(U_2 - U_1) = 0$$

∴ From the first law of thermodynamics we have $Q = W$

i.e in an isothermal process the heat supplied to an ideal gas is equal to the work done by the gas.

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