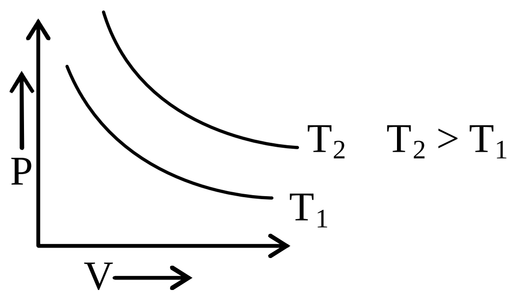
Isothermal Process

In this process, the pressure and volume of gas changes but temperature remains constant.

The system is in thermal equilibrium with the surroundings.
It is a slow process.

The internal energy of the system remains constant i.e, du = 0.

It obeys the Boyle's law i.e., PV=K.
Two isothermal curve for given mass never intersect each other.



If a system undergoes change from A to B, such that temperature remains constant i.e. in isothermal surface then,

$$A \xrightarrow[\text{Process}]{\text{Isothermal}} B$$

(P_1,V_1,T) (P_2,V_2,T)

$$P_1V_1 = P_2V_2 = nRT$$

(iv) Work done by the gas is given by,

$$\delta W = \int_{V_1}^{V_2} PdV$$

But, $PV = K$ (constant)

$$P = \frac{K}{V}$$

$$\therefore \quad \delta W = \int_{V_1}^{V_2} \frac{K}{V} dV$$

$$= K \ln \frac{V_2}{V_1}$$

$$= nRT \ln \frac{V_2}{V_1}$$

(v) The change in internal energy of a gas is zero i.e.

$$dU = 0$$

(vi) By first law of thermodynamics,

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

$$\delta Q = \delta W$$

Hence heat supplied in an isothermal process is used to do work against external surroundings.

(vii) Specific heat of isothermal process is infinity

(viii) Bulk modulus of isothermal process,

Since $PV = K$

On differentiating

$$PdV + VdP = 0$$

$$PdV = -VdP$$

$$P = \frac{-dP}{dV/V}$$

$\therefore$ Bulk modulus $B = \frac{-dP}{dV/V}$

(ix) Compressibility is given by, $K = \frac{1}{B} = \frac{1}{P}$

The work done during isothermal expansion at constant temperature is

$$W = 2.303RT\log_{10}\left(\frac{V_2}{V_1}\right)$$

$$= 2.303RT\log_{10}\left(\frac{P_1}{P_2}\right)$$