Equations of an adiabatic process:-

Since we have derived

$$PV^{\gamma} = K \text{ (constant)} \quad \text{—(i)}$$

From ideal gas eqn we have

$$PV = RT \qquad \text{if } n = 1$$

$$\therefore \quad P = \frac{RT}{V}$$

putting this value of P in eqn (i) we get-

$$\frac{RT}{V} V^{\gamma} = K$$

$$TV^{\gamma-1} = \frac{K}{R}$$

$$\Rightarrow \quad TV^{\gamma-1} = \text{Constant} \quad \text{—(ii)}$$

again

$$PV = RT$$

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

putting the value of V in eqn (i) we get-

$$P\left(\frac{RT}{P}\right)^{\gamma} = K$$

$$\text{or} \quad P^{1-\gamma} T^{\gamma} = \frac{K}{R}$$

$$\Rightarrow \quad P^{1-\gamma} T^{\gamma} = \text{Constant} \quad \text{—(iii)}$$

Numerical

(i) A gas is suddenly compressed to $\frac{1}{4}$ the of its original volume. calculate the rise in temperature. If the original temp of the gas is $27^{\circ}C$ and $\gamma = 1.5$

Sol^n. Let $T_1 = 27 + 273 = 300\,K$

$V_1 = V$

then A/q $V_2 = \frac{V}{4}$

$\gamma = 1.5$

Since we have

$$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$$

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{\gamma-1}$$

$$T_2 = 300 \left(\frac{V}{\frac{V}{4}}\right)^{1.5-1}$$

$$T_2 = 300 \times (4)^{1/2}$$

$$T_2 = 300 \times 2$$

$$T_2 = 600\,K$$

$$T_2 = 600 - 273 = 327^{\circ}C$$

$\therefore$ Rise in temp i.e

$$\Delta T = T_2 - T_1$$

$$\Delta T = 327 - 27$$

$$\boxed{\Delta T = 300^{\circ}C}$$ Ans

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