MSC – II Unit IV

Speed of Sound (Accoustic) waves in media

Speed of Longitudinal wave Motion :—

(1) In a solid medium

$$v = \sqrt{\left(k + \frac{4}{3}\eta\right)\rho} \quad \text{——— (1)}$$

where k = bulk modulus
η = modulus of rigidity
ρ = density of the material of the solid.

When the solid is in the form of a long bar, the speed of longitudinal waves through the bar is given by

$$v = \sqrt{Y/\rho} \quad \text{——— (2)}$$

where Y = young's modulus of the material of the bar

(2) In liquids, the velocity of longitudinal waves is given by

$$v = \sqrt{K/\rho} \quad \text{——— (3)}$$

When Sound waves are propagated through it, are isothermal. The amount of heat produced during compression is lost to the surroundings & Similarly the amount of heat lost during rarefraction is gained from the surroundings so, as to keep the temperature constant. Using co-efficient of isothermal elasticity i.e K_i in eqn (6) Newton's formula becomes

$$v = \sqrt{\frac{K_i}{\rho}} \qquad \text{---(7)}$$

Calculation of K_i :-

$\because pV = \text{const}$

$\therefore p\,dv + v\,dp = 0$

$\Rightarrow p = -\frac{v\,dp}{dv}$

$= -\frac{dp}{dv/v} = K_i$ (By definition)

$\therefore v = \sqrt{\frac{p}{\rho}}$ ---(8)

[from eqn (7)]

Error in Newton's Formula

As $p = h\,dy$

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$$v = \sqrt{\frac{K_i}{\rho}} \qquad \text{---(7)}$$

Calculation of K_i :-

$\because pV = \text{const}$

$\therefore p\,dV + V\,dp = 0$

$\Rightarrow p = -\frac{V\,dp}{dV}$

$= -\frac{dp}{dV/V} = K_i$ (By definition)

$\therefore v = \sqrt{\frac{p}{\rho}}$ ---(8)

[from eqn (7)]