$$\rho c = \rho c - \rho v + d\rho c - d\rho \cdot v$$

$$d\rho c = \rho v + \underline{v} \cdot d\rho$$

neglect $\underline{v \cdot d\rho}$.

$$\boxed{c = \frac{\rho v}{d\rho}} \quad * \quad \text{——— (1)}$$

According to linear momentum equation in x dir$^n$:

<u>Force on fluid</u> = Rate of change of momentum = $\dot{m}$ [change in velocity]

$$(P + dP)A - PA = \frac{\rho A dL (V - 0)}{dt}$$

$$dP \cancel{A} = \rho \cancel{A} \cdot \frac{c \cancel{dt}}{\cancel{dt}} (v).$$

$$dP = \rho \cdot c \cdot V$$

$$c = \frac{dP}{\rho V} \quad \text{——— (ii)}$$

$t = 15^\circ C$

from eqⁿ (I) & (II).

$$c^2 = \frac{\rho V}{d\rho} \times \frac{dP}{\rho V}$$

$$c = \sqrt{\frac{dP}{d\rho}}$$

Bulk modulus (K) $= \dfrac{dP}{-\left(\dfrac{dV}{V}\right)}$ —— (I)

mass of fluid is constant so that

$$\rho V = \text{constant}$$

differentiating the above eqn

$$\rho\, dV + V\, d\rho = 0$$

$$\rho\, dV = -V\, d\rho,$$

$$\left(\frac{-dV}{V}\right) = \frac{d\rho}{\rho} \quad \text{—— (II)}$$

Put the value $\left(-\dfrac{dV}{V}\right) = \dfrac{d\rho}{\rho}$ in (I) eqn

$$K = \frac{dP \cdot \rho}{d\rho} \Rightarrow \frac{K}{\rho} = \frac{dP}{d\rho}$$

we know that $C = \sqrt{\dfrac{dP}{d\rho}}$

$$C = \sqrt{\frac{dP}{d\rho}} = \sqrt{\frac{K}{\rho}}$$

velocity of sound in isothermal process:-

$$\frac{P}{\rho} = \text{Const.}, \quad P \cdot \rho^{-1} = \text{constant}$$

differentiating the above eqn

$$P(-1)\rho^{-2}\, d\rho + \rho^{-1}\, dP = 0$$

divided by $\rho^{-1}$

$$\frac{dP}{d\rho} = \frac{P}{\rho} = RT.$$

$$c = \sqrt{\frac{P}{\rho}} = \sqrt{RT.}$$

## Velocity of sound for adiabatic process!-

$$\frac{P}{\rho^K} = \text{Const.} \Rightarrow P.\rho^{-K} = \text{Const.}$$

$$P.(-K)\rho^{-K-1}.d\rho + \rho^{-K}dP = 0$$

divide by $\rho^{-K}$.

$$-PK\rho^{-1}d\rho + dP = 0. \quad , \quad dP = \frac{P.K}{\rho}d\rho.$$

$$\frac{dP}{d\rho} = \frac{P}{\rho}.K. = RT.K$$

$$\boxed{c = \sqrt{\frac{dP}{d\rho}} = \sqrt{K.R.T}}$$

Mach number!- $M = \sqrt{\frac{\text{Inertia force.}}{\text{Elastic force}}} = \sqrt{\frac{\rho AV^2}{KA}} = \sqrt{\frac{V^2}{K/\rho}}$

$$= \frac{V}{C} \qquad \boxed{C = \sqrt{\frac{K}{\rho.}}} \ (*)$$