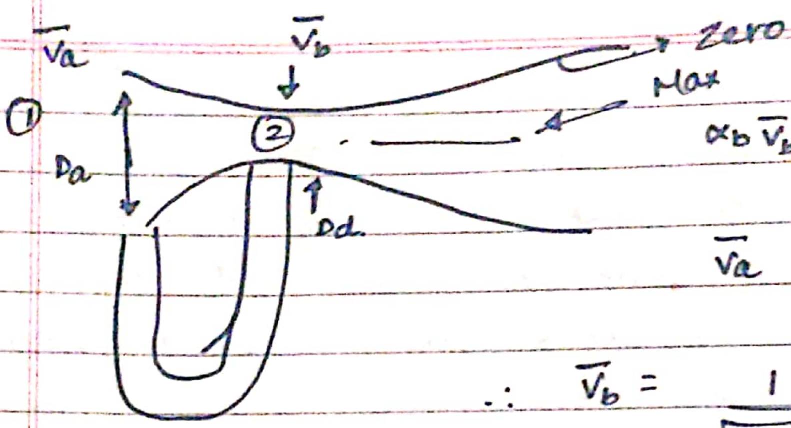

$$\alpha_b \bar{V}_b^2 - \alpha_a \bar{V}_a^2 = \frac{2(P_a - P_b)}{\rho}$$

$$\bar{V}_a = \left(\frac{D_b}{D_a}\right)^2 \bar{V}_b$$

$$\therefore \bar{V}_b = \frac{1}{\sqrt{\alpha_b - \left(\frac{D_b}{D_a}\right)^4 \alpha_a}} \sqrt{\frac{2(P_a - P_b)}{\rho}}$$

$$= \frac{C_v}{\sqrt{1-\beta^4}} \sqrt{\frac{2(P_a - P_b)}{\rho}}$$

Given by manufactures

If $C_v = 1$, there is no loss of energy

K.E of an element of cross section area ds, the mass flow rate $= \rho u ds$

$$dE_k = (\rho u \, ds) \frac{u^2}{2}$$

For entire cross-section

$$E_k = \frac{\rho}{2} \int_s u^3 ds$$

$$\frac{E_k}{\dot{m}} = \frac{\frac{1}{2}\int u^3 ds}{\int u \, ds} = \frac{1}{2} \frac{\int u^3 ds}{\bar{V} s}$$

↳ Approx $\alpha \frac{\bar{V}^2}{2}$

α can be obtained by equating these

Turbulent $\alpha = 1$

laminar $\alpha > 1$

$= \frac{P_2}{\rho} +$ $\sqrt{2(250 \times}$

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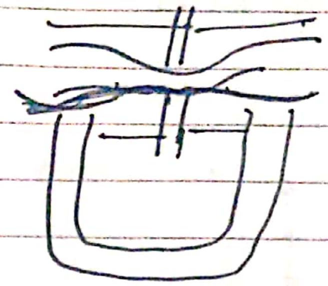
Orificemeter

$$u_0 = \frac{c_0}{\sqrt{1-\beta^4}} \sqrt{\frac{2(P_a - P_b)}{\rho}}$$

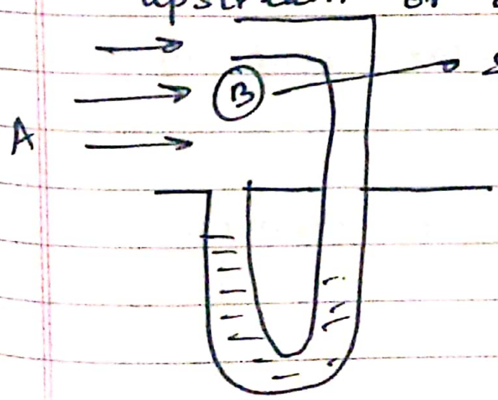


$c_0 = 0.61$ for

$$Re_0 = \frac{D_0 u_0 \rho}{\mu} > 30k$$

Vena contracta - When there flow, if we see the streamline, they are forced to converge at oriface. We see that they cont. to converge upto certain downstream and then start expanding. The point where the streamlines are closest to each other, not at the orifice but close to the orifice, that point is vena contracta. Generally, vena contracta is located little downstream of orifice.

→ Significant energy loss at orifice
→ Availability of st. pipe required at upstream or down stream.



→ stagnation point

AB terminates at B

$\frac{u_0^2}{2}$ is converted to

pressure head $\left(\frac{P_s - P_0}{\rho}\right)$

$$\Rightarrow u_0 = \sqrt{\frac{2(P_s - P_0)}{\rho}}$$

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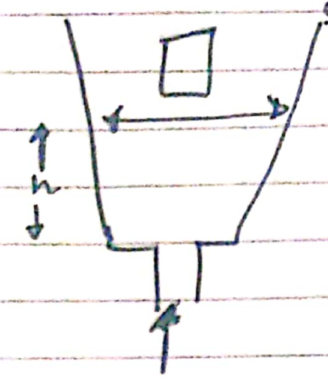
DRAG

cylindrical



$D_t = D_f + ah$

Balance of forces

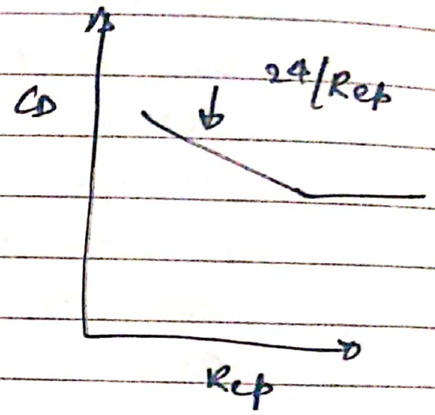
weight of float
$= (\text{vol. of float})(\rho)\, g$

Buyancy $= V(\text{fluid } \rho)\, g$

Drag $= A_f C_D \rho \frac{u^2}{2}$

$Re_p = \frac{d V \rho}{\mu}$
↳ Reynold's no of particle

Buyancy + Drag = Weight.



Flow rate

$= u \frac{\pi}{4} (D_t^2 - D_f^2)$

$\approx u \frac{\pi}{2} D_f \, ah$

Dia of float

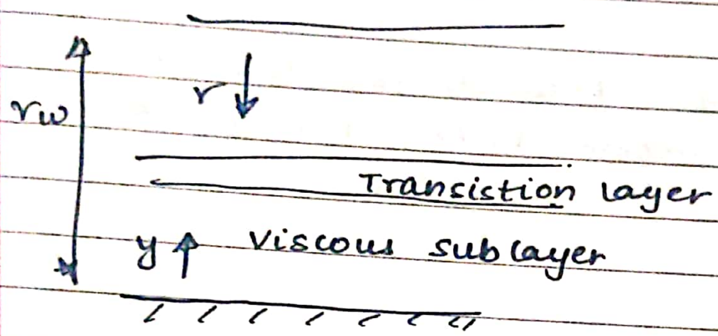
D_t inner dia of linearly tapered tube $= D_f + ah$

Rotometer has linear relationship b/w flow rate and reading

In case of venturimeter/ orificemeter, flowrate $\propto \sqrt{\text{reading}}$.

NPSH is defined as diff b/w absolute stagnation pressure in the flow at the pump suction and liquid vapor pressure, expressed as head of flowing liq.

Turbulent flow and universal velocity Distribution



u^* (friction velocity) $= \bar{V}\sqrt{\frac{f}{2}} = \sqrt{\frac{\tau_w}{\rho}}$

Dimenonless vel. $u^+ = \frac{u}{u^*}$

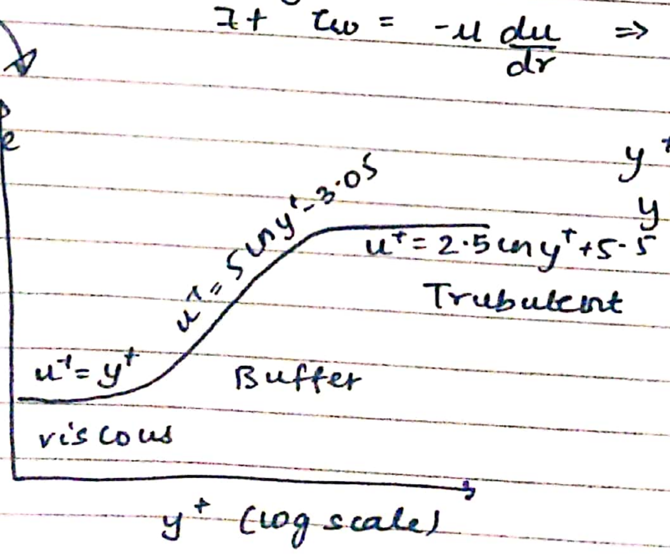
Dimenoless distance $y^+ = \frac{y u^* \rho}{\mu}$

For viscous sublayer

$r_w = r + y \approx r$

At $\tau_w = -\mu \frac{du}{dr} \Rightarrow \frac{du^+}{dy^+} = 1$

Followed irrespective of fluid, channel etc.



y^+ (0 to 5) vis.

y^+ (5 to 30) Buff

30 to center → Turbl

At center of pipe $u_c^+ = 2.5 \ln y_c^+ + 5.5$

$$\bar{V} = \frac{1}{\pi r_w^2} \int_0^{r_w} u \,(2\pi r)\, dr$$

$$\Rightarrow \quad \frac{1}{\sqrt{f/2}} = 2.5 \ln\left(Re \sqrt{\frac{f}{8}}\right) + 1.75$$

This eqn. predicts friction factor for smooth tube for $10^4 < Re < 10^6$ with 2% accuracy.

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