* (1) EGL always drops in the direction of flow because of loss of head

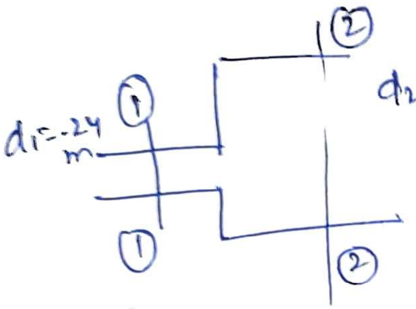
(2) HGL may rise or fall depending upon the pressure change.

(3) HGL is always below the EGL

(4) For a uniform cross section the slope of the HGL is equal to the slope of EGL.

Q- At a certain enlargement of water pipe line from a diameter of 0.24m to 0.48m. The hydraulic gradient line rises by 10mm. Find the discharge.

Sol$^n$




$A_1 V_1 = A_2 V_2$

$\frac{\pi}{4} d_1^2 \times V_1 = \frac{\pi}{4} d_2^2 \times V_2$

$\frac{\pi}{4} \times (.24)^2 \times V_1 = \frac{\pi}{4} \times (.48)^2 \times V_2$

$\boxed{\frac{V_1}{V_2} = 4}$ —— (1)

Apply.
Bernoulli's eq$^n$ b/w (1) & (2)

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + Z_2 + \frac{(V_1 - V_2)^2}{2g} \quad ([illegible])$$

($h_{Le}$)

$$\frac{V_1^2}{2g} - \frac{V_2^2}{2g} - \frac{(V_1 - V_2)^2}{2g} = \left(\frac{P_2}{\rho g} + Z_2\right) - \left(\frac{P_1}{\rho g} + Z_1\right).$$

$$\frac{V_1^2 - V_2^2 - [V_1^2 + V_2^2 - 2V_1V_2]}{2g} = \frac{10}{1000}$$

$$\frac{2V_1V_2 - 2V_2^2}{2g} = .01$$

$$V_1V_2 - V_2^2 = .01 \times 2 \times 9.81$$

$$V_2 = .18 \text{ m/s.}$$

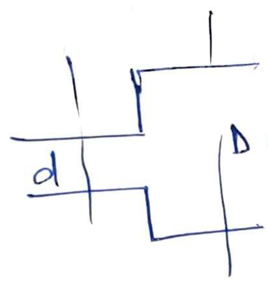
$$Q = A_2V_2 = \frac{\pi}{4} \times (.48)^2 \times .18$$

(x)

$$\boxed{Q = .032 \text{ m}^3/\text{s}}$$

Q:- A horizontal pipe of a given diameter d is suddenly enlarges to a diameter D. Find the ratio of $\frac{D}{d}$ such that the rise in pressure for a given discharge past the enlargement shall be maximum.

Solⁿ




$\frac{D}{d} = ?$

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + \frac{(V_1 - V_2)^2}{2g}$$

$$z_1 = z_2$$

$$\frac{V_1^2}{2g} - \frac{V_2^2}{2g} - \frac{(V_1 - V_2)^2}{2g} = \frac{P_2}{\rho g} - \frac{P_1}{\rho g}$$

$$\frac{V_1^2 - V_2^2 - (V_1^2 + V_2^2 - 2V_1V_2)}{2g} = \frac{P_2 - P_1}{w}$$

$$\frac{2V_1V_2 - 2V_2^2}{2g} = \frac{\Delta P}{w} = \frac{\Delta P}{\rho g}$$

$$\rho\left(V_1V_2 - V_2^2\right) = \Delta P.$$

For max^m discharge

$$\frac{d \Delta p}{d v_2} = 0$$

$$0 = \rho (V_1 - 2V_2)$$

$$V_1 = 2V_2.$$

$$A_1 V_1 = A_2 V_2.$$

$$\frac{\pi}{4} d_1^2 \times V_1 = \frac{\pi}{4} d_2^2 \times V_2. \qquad d_1 = d, \; d_2 = D.$$

$$d^2 \times 2V_2 = D^2 \times V_2$$

$$2d^2 = D^2$$

$$\frac{D^2}{d^2} = 2$$

(*)

$$\boxed{\frac{D}{d} = \sqrt{2}}$$