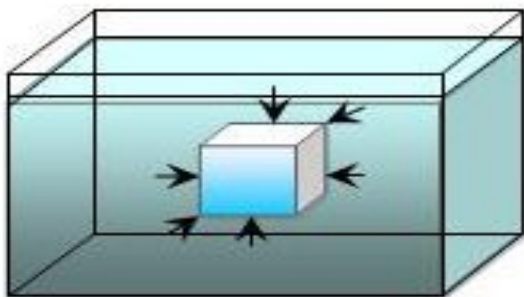


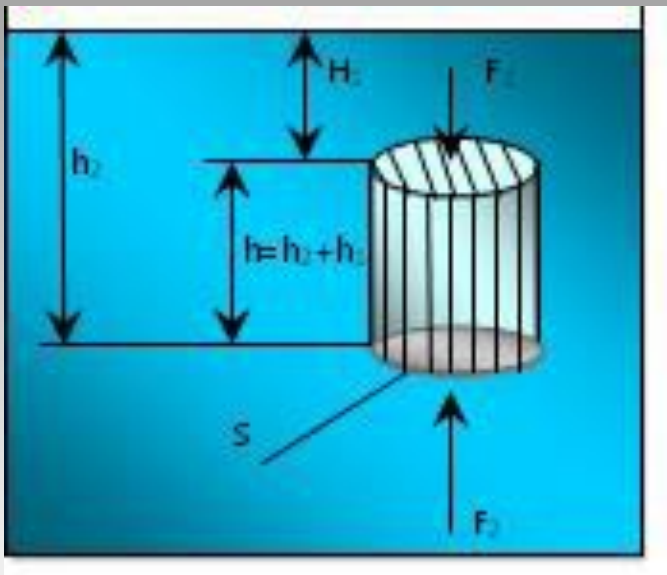
№7 лекция

Тұтас орталар механикасының элементтері



Лекция жоспары

- 1.Тұтас орта ұғымы**
- 2.Сұйықтар мен газдардың жалпы қасиеттері**
- 3. Идеал және тұтқыр сұйық**
- 4. Бернулли теңдеу**
- 5. Сұйықтардың ламинарлық және турбуленттік ағыны.**
- 6. Стокс формуласы.**
- 7. Пуазель формуласы.**



$$P = \frac{\Delta F}{\Delta S} \quad P = \lim_{\Delta S \rightarrow 0} \frac{\Delta F}{\Delta S} = \frac{dF}{dS}$$

$$P = \frac{H}{\text{м}^2} = \text{Па}$$

$$P = \frac{P}{S} = \frac{\rho g S h}{S} = \rho g h \quad - \text{гидростатикалық қысым}$$

$$P = mg; \quad m = \rho V = \rho g V = \rho g S h$$

$$F_A = \rho g V \quad - \text{Архимед күші}$$

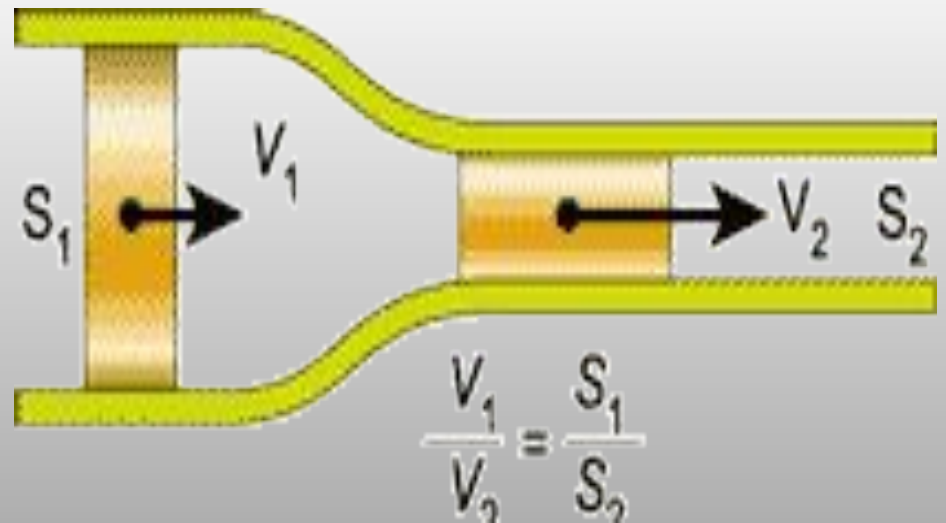
a)



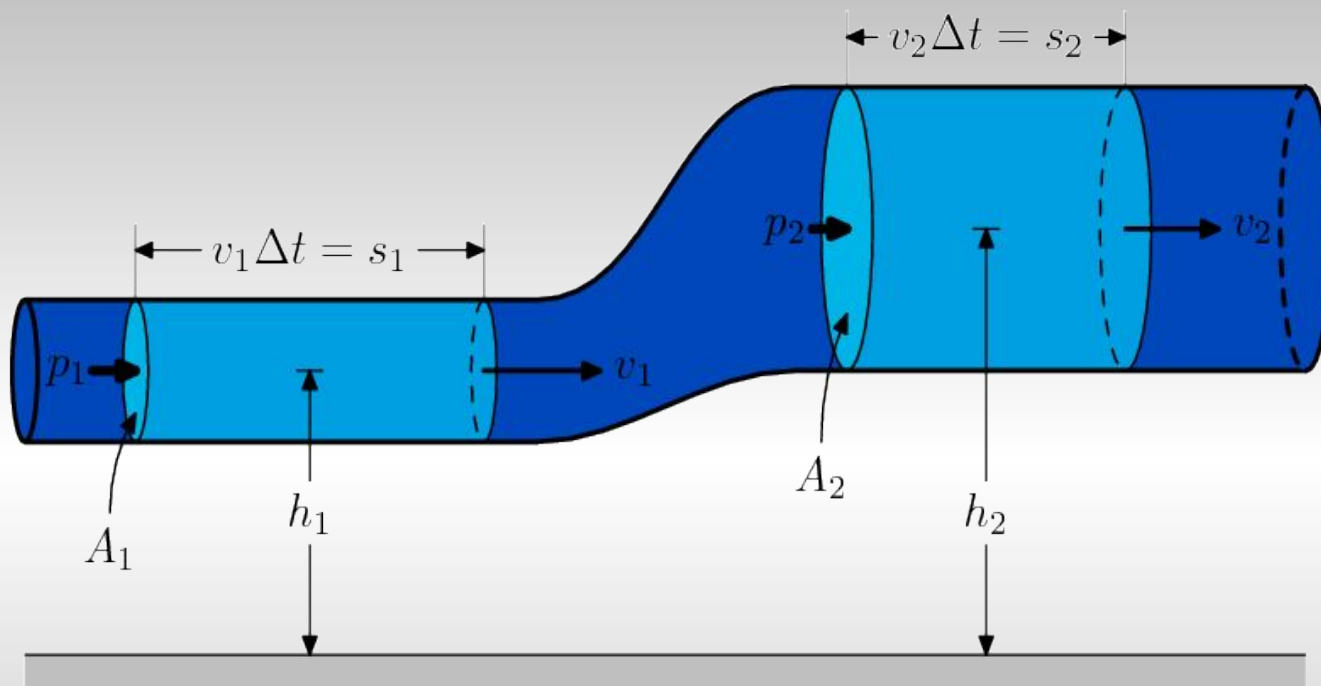
$$S_1 v_1 = S_2 v_2$$

$$S_1 v_1 = \text{const}$$

$$\frac{v_1}{v_2} = \frac{S_1}{S_2}$$



Бернулли тендеу



$$A = F\Delta t = pS\Delta t$$

$$A = p_1 S_1 \Delta t_1 - p_2 S_2 \Delta t_2 = (p_1 - p_2) \Delta V$$

$$\Delta E = \left(mgh_2 + \frac{mv_2^2}{2} \right) - \left(mgh_1 + \frac{mv_1^2}{2} \right) \quad m = \rho \Delta V$$

$$\Delta E = \left(\rho \Delta V gh_2 + \frac{\rho \Delta V v_2^2}{2} \right) - \left(\rho \Delta V gh_1 + \frac{\rho \Delta V v_1^2}{2} \right)$$

$$\Delta E = A$$

$$\left(\rho \Delta V gh_2 + \frac{\rho \Delta V v_2^2}{2} \right) - \left(\rho \Delta V gh_1 + \frac{\rho \Delta V v_1^2}{2} \right) = p_1 S_1 v_1 - p_2 S_2 v_2$$

$$\rho gh_1 + \frac{\rho v_1^2}{2} + P_1 = \rho gh_2 + \frac{\rho v_2^2}{2} + P_2$$

$$\rho gh + \frac{\rho v}{2} + P = const \quad \text{-Бернулли теңдеу}$$

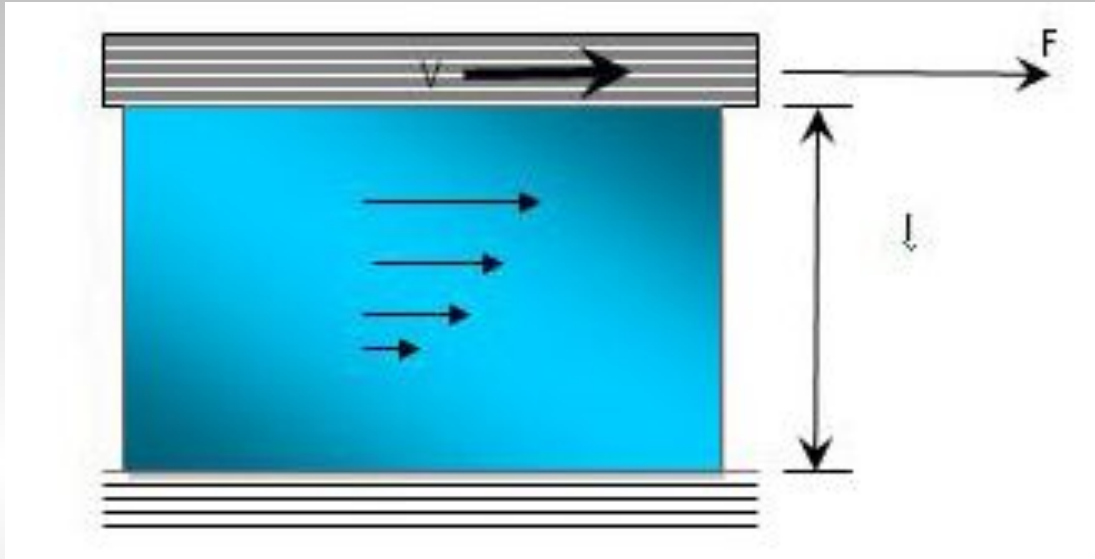
$$\text{Егер } h_1 = h_2 \quad \frac{\rho v_1^2}{2} + P_1 = \frac{\rho v_2^2}{2} + P_2$$

P – статикалық қысым

$$\frac{\rho v^2}{2} \quad \text{– динамикалық қысым}$$

$$v = \sqrt{2gh} \quad \text{– Торичелли формуласы}$$

Ішкі үйкеліс, тұтқырлық

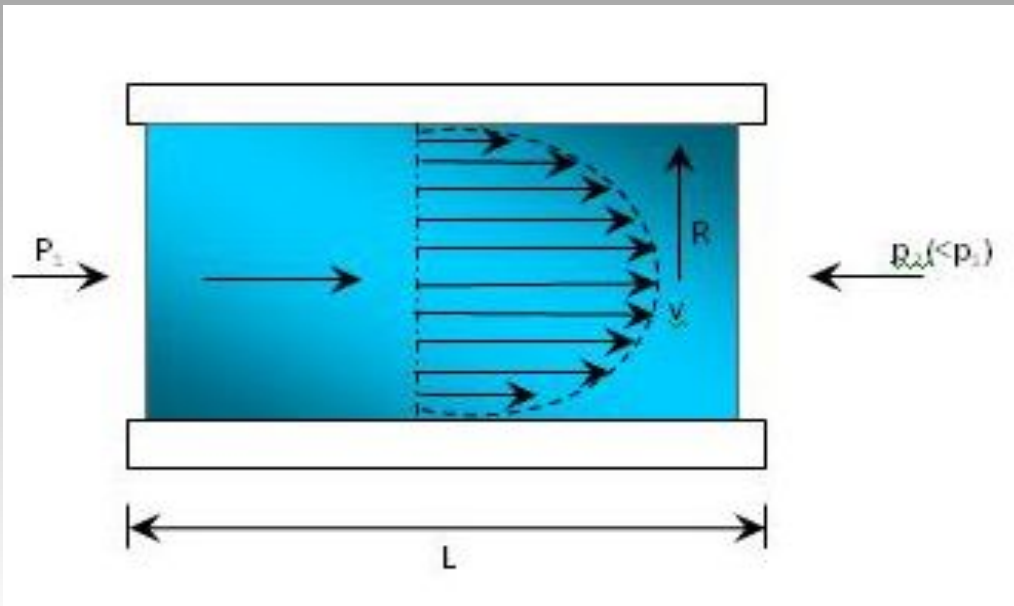


$$F = \eta \frac{dv}{dt} S$$

– Ньютон теңдеу

η – ішкі үйкеліс коэффициенті, динамикалық тұтқырлық

$\frac{dv}{dt}$ — жылдамдық градиенті



$$R_e = \frac{\rho v d}{\eta}$$

$$R_e \leq 1000$$

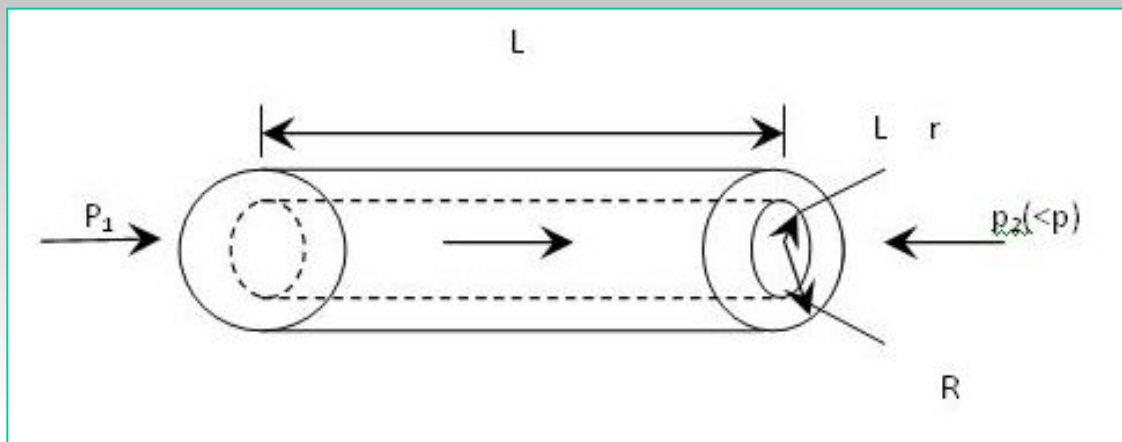
$$1000 < R_e < 2000$$

$$R_e \leq 2300$$

$$v = \frac{\eta}{\rho} \text{ — кинематикалық тұтқырлық}$$

$$R_e = \frac{v d}{\nu}$$

Пуазель формуласы



$$PS = P\pi r^2$$

$$F = (P_1 - P_2)\pi r^2$$

$$F = \eta \left| \frac{dv}{dr} \right| 2\pi r \Delta r = -\eta \frac{dv}{dr} 2\pi r \Delta r$$

$$2\pi r \Delta r$$

$$(P_1 - P_2)\pi r^2 = -\eta \frac{dv}{dr} 2\pi r \Delta r$$

$$dv = -\frac{P_1 - P_2}{2\eta \Delta r} r dr$$

$$v = -\frac{p_1 - p_2}{4\eta\Delta} r^2 + C$$

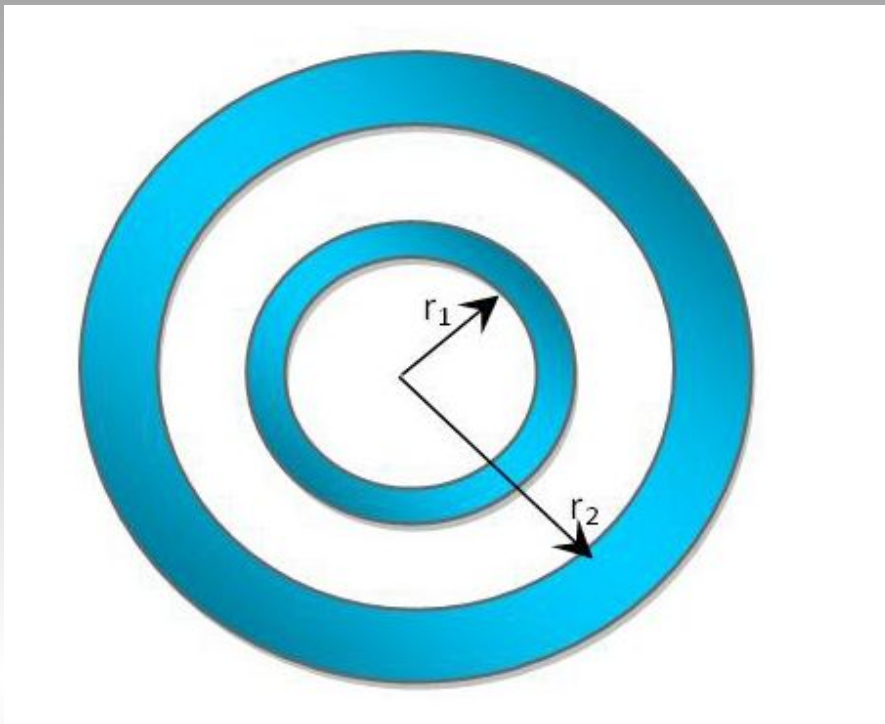
$$r = R, v = 0$$

$$C = \frac{P_1 - P_2}{4\eta\Delta} R^2$$

$$v(r) = -\frac{p_1 - p_2}{4\eta\Delta} (R^2 - r^2) = \frac{p_1 - p_2}{4\eta\Delta} R^2 \left(1 - \frac{r^2}{R^2}\right)$$

$$v_0 = v(0) - \frac{p_1 - p_2}{4\eta\Delta} R^2$$

$$v(r) = v_0 \left(1 - \frac{r^2}{R^2}\right)$$



$$dQ$$

$$2\pi r dr$$

$$v(r)$$

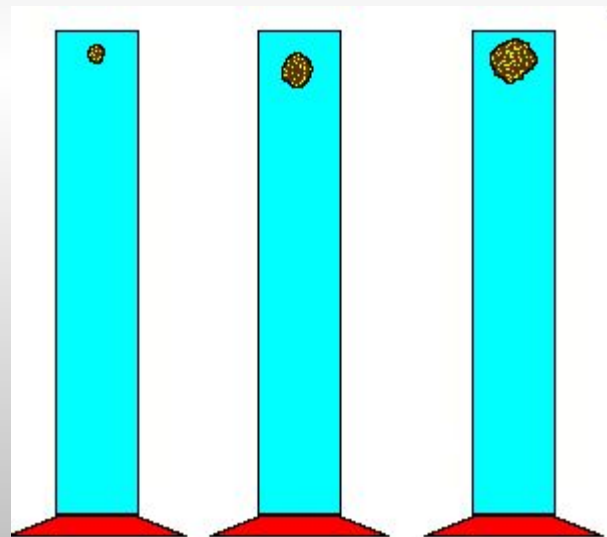
$$dQ = v_0 \left(1 - \frac{r^2}{R^2} \right) 2\pi r dr$$

$$Q = \int_0^R v_0 \left(1 - \frac{r^2}{R^2} \right) 2\pi r dr = \frac{1}{2} \pi R^2 v_0 = \frac{1}{2} S v_0$$

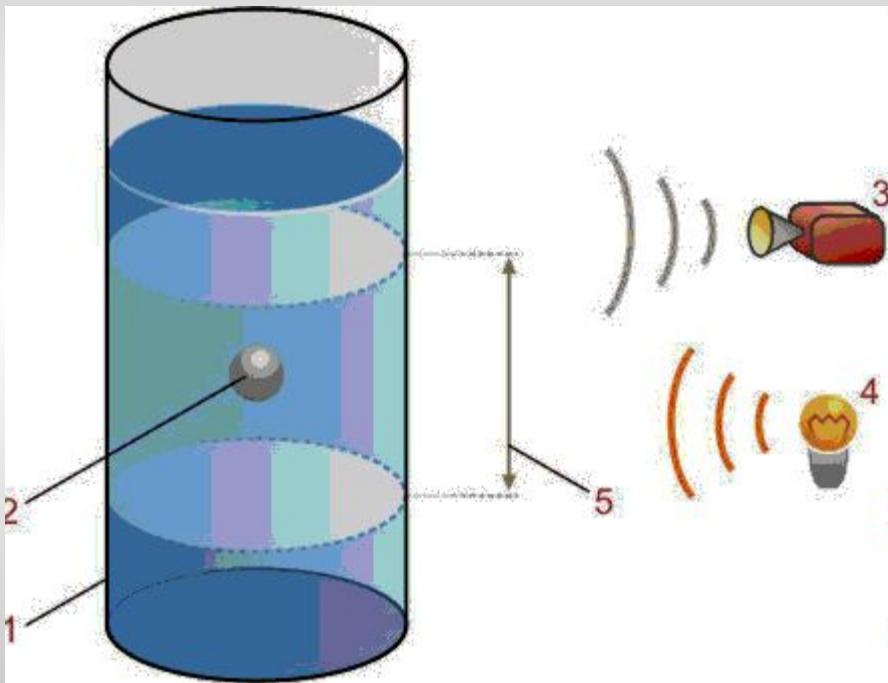
$$v_{op} = \frac{v_0}{2}$$

$$Q = \frac{(P_1 - P_2)}{8\eta l} \pi R^4$$

– Пуазель формуласы



Стокс заңы



$$F = 6\eta\pi r v$$

– Стокс формуласы

Көңіл аударғандарыңызға рахмет!