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Lec. 6

PHYSICS 1

1ST LEVEL 2020 - 2021

ENGINEERING CAMP

SCAN FOR FACEBOOK GROUP

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"Fluid Dynamics"

A Fluid Flow: سريان المائع

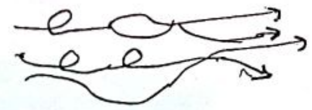
(1) Laminar flow: سريان هادئ

- Steady flow سريان مستقر
  * السرعة لا تتغير بمرور الوقت
- Each Particle (جسيم) of the fluid follows a smooth path. مسار سهل
- The path called stream lines. خطوط التدفق
- at a given point the velocity is the same.

stream lines

(2) Turbulent flow: سريان دوامي (مضطرب)

- An irregular flow.



- occurs when the particles goes above critical speed.

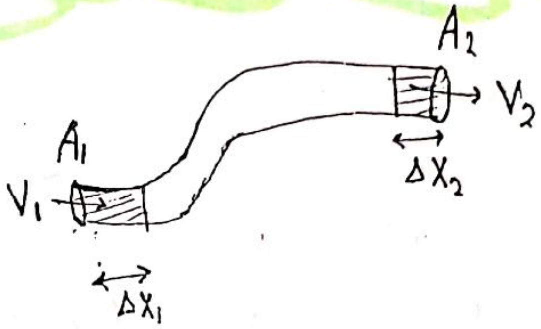
يحدث عندما تتعدى سرعة الجزيئات السرعة الحرجة

$m_1 = m_2$ شرحها: انه حجم المائع الداخل يساوي حجم المائع الخارج 2

B Continuity equation:

معادلة الإستمرارية

→ Because the flow is steady



$\therefore \dot{m}_1 = \dot{m}_2$

$\therefore \rho_1 A_1 V_1 = \rho_2 A_2 V_2$

غير قابل للإنضغاط

because the fluid incompressible

$\therefore \rho_1 = \rho_2$

$\therefore \boxed{A_1 V_1 = A_2 V_2}$ Continuity equation

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$\therefore AV = \text{Constant}$

The product of the cross-section area and velocity at any point is constant.

Q → Volume Flow Rate — حجم الماء الذي يعبر الماسورة خلال ثانية

Note: حجم — وحدتها $\frac{m^3}{s}$ — معدل التدفق الحجمي

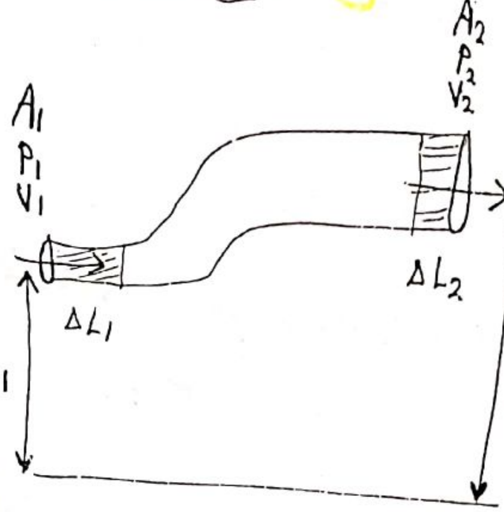
$AV = \frac{V}{t} = Q$ "Flow rate"

$P + \frac{1}{2}\rho v^2 + \rho g h = Cont$ مقدار ثابت في اي جزء من الماسورة

Derive Bernoulli's equation:

$\underline{3}$

the Work-energy theorem states the the work done on a system equal the change in kinetic energy of the system.



$$W_{net} = \Delta K.E$$

$F_1 = P_1 A_1 \quad F_2 = P_2 A_2$

$W_1 = F_1 \Delta X_1 = P_1 A_1 \Delta X_1 = P_1 Vol_1$

$W_2 = F_2 \Delta X_2 = -P_2 A_2 \Delta X_2 = -P_2 Vol_2$

→ the work done by the pressure force

داخل $+$ خارج $-$

$$P_1 A_1 \Delta L_1 - P_2 A_2 \Delta L_2 = (P_1 - P_2)\frac{\Delta m}{\rho}$$

where $\Delta V = A_1 L_1 = A_2 \Delta L_2$ $\quad \Delta V_1 = \Delta V_2$

الشغل المبذول في الماسورة $W = \Delta V (P_1 - P_2) \rightarrow (2)$

→ the work done by gravity force

$$\Delta m\, g\, (y_2 - y_1)$$

طاقة حركة $\quad$ طاقة وضع

$(P_1 - P_2)\Delta V = (\Delta KE + \Delta PE)$

$= (\frac{1}{2} m V_2^2 - \frac{1}{2} m V_1^2) + (\Delta m g y_2 - \Delta m g y_1)$

$\div \Delta V$

$(P_1 - P_2) = \frac{1}{2}\rho V_2^2 - \frac{1}{2}\rho V_1^2 + \rho g y_2 - \rho g y_1$

$(P_1 - P_2) = \frac{1}{2}\rho (V_2^2 - V_1^2) + \rho g (y_2 - y_1)$

→ the net work $\quad W = (P_1 - P_2)\frac{\Delta m}{\rho} - \Delta m g (y_2 - y_1)$

$P_1 + \frac{1}{2}\rho V_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$

→ change in kinetic energy $\quad \Delta K = \frac{1}{2}\Delta m (V_2^2 - V_1^2)$

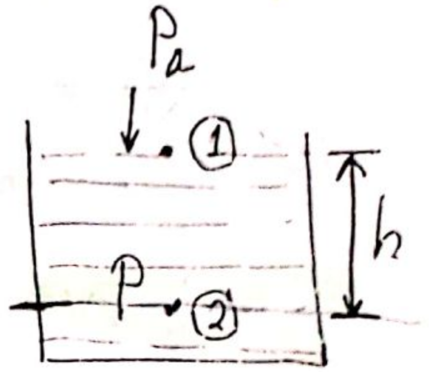
$$\therefore (P_1 - P_2)\frac{\Delta m}{\rho} - \Delta m g (y_2 - y_1) = \frac{1}{2}\Delta m (V_2^2 - V_1^2)$$

$$\therefore P_1 - P_2 = \rho g (y_2 - y_1) + \frac{1}{2}\rho (V_2^2 - V_1^2)$$

$$\therefore P_1 + \rho g h_1 + \frac{1}{2}\rho V_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho V_2^2 \Rightarrow \boxed{P + \rho g h + \frac{1}{2}\rho v^2}$$

"Bernoulli's applications"

1 Hydrostatic pressure:



$$P_1 = P_a \qquad V_1 = 0 \qquad h_1 = h$$

$$P_2 = P \qquad V_2 = 0 \qquad h_2 = 0$$

$$\because P_1 + \rho g h_1 + \frac{1}{2}\rho V_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho V_2^2$$

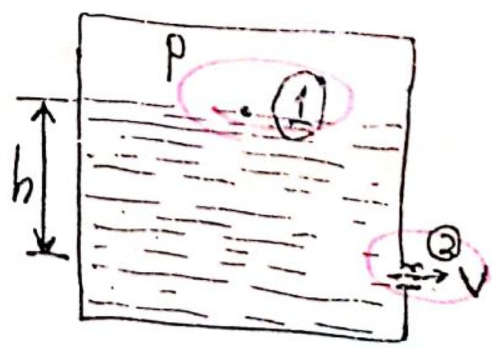
$$\therefore P_a + \rho g h + 0 = P + 0 + 0$$

$$\therefore \boxed{P = P_a + \rho g h}$$

2 Torricelli's theorem:

نظرية
تورشيلي

(i) closed tank



$$P_1 = P \qquad V_1 \simeq 0 \qquad h_1 = h$$

$$P_2 = P_a \qquad V_2 = V \qquad h_2 = 0$$

$$\because P_1 + \rho g h_1 + \frac{1}{2}\rho V_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho V_2^2$$

$$\therefore P + \rho g h + 0 = P_a + 0 + \frac{1}{2}\rho V^2$$

$$\therefore P - P_a + \rho g h = \frac{1}{2}\rho V^2$$

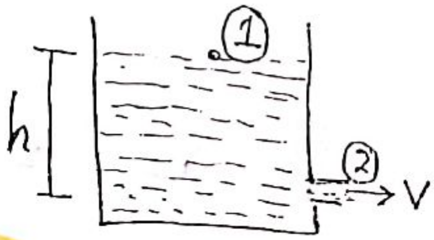
$$\therefore \frac{2(P - P_a + \rho g h)}{\rho} = V^2$$

$$\therefore \boxed{V = \sqrt{\frac{2(P - P_a + \rho g h)}{\rho}}} \quad m/s$$

(ii) <u>open tank</u>: تستخدم في قياس سرعة خروج الماء

$P_1 = P_a \quad V_1 = 0 \quad h_1 = h$

$P_2 = P_a \quad V_2 = V \quad h_2 = 0$



$$\therefore P_1 + \rho g h_1 + \frac{1}{2}\rho V_1^2 = P_2 + \rho g h_2 + \frac{1}{2}\rho V_2^2$$

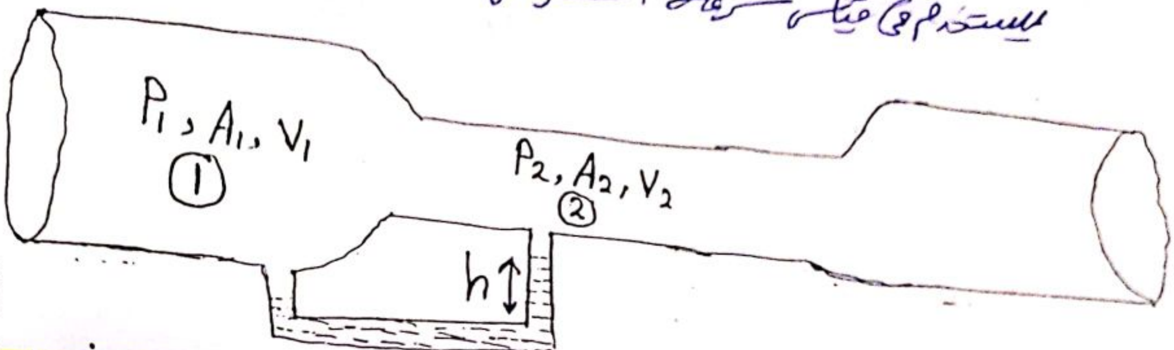
$$\therefore \cancel{P_a} + \rho g h + 0 = \cancel{P_a} + 0 + \frac{1}{2}\rho V^2$$

$$\therefore \frac{1}{2}\cancel{\rho} V^2 = \cancel{\rho} g h$$

$$\therefore \boxed{V = \sqrt{2gh}} \quad m/s$$

3 Venturimeter: مقياس فينتشوري

يستخدم في قياس سرعة السوائل



أفقية

→ Horizontal tube $\therefore h_1 = h_2$

$$\therefore P_1 + \cancel{\rho g h_1} + \frac{1}{2}\rho V_1^2 = P_2 + \cancel{\rho g h_2} + \frac{1}{2}\rho V_2^2$$

$$\therefore P_1 - P_2 = \frac{1}{2}\rho V_2^2 - \frac{1}{2}\rho V_1^2$$

$$\therefore P_1 - P_2 = \frac{1}{2}\rho\left[V_2^2 - V_1^2\right] \longrightarrow (1)$$

$$\therefore A_1 V_1 = A_2 V_2 \quad \text{"Continuity"}$$

$$\therefore V_1 = \frac{A_2 V_2}{A_1} \longrightarrow (2)$$

From (2) into (1)

$$\therefore P_1 - P_2 = \frac{1}{2}\rho\left[V_2^2 - \frac{A_2^2 V_2^2}{A_1^2}\right]$$

$$\therefore \boxed{V_2 = \sqrt{\frac{2(P_1 - P_2)}{\rho\,(1 - A_2^2 \ldots)}}\ m/s}$$

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