02

IDEAL FLOW

BASIC PATTERNS OF FLOW

- LINEAR
- SOURCE
- SINK
- VORTEX

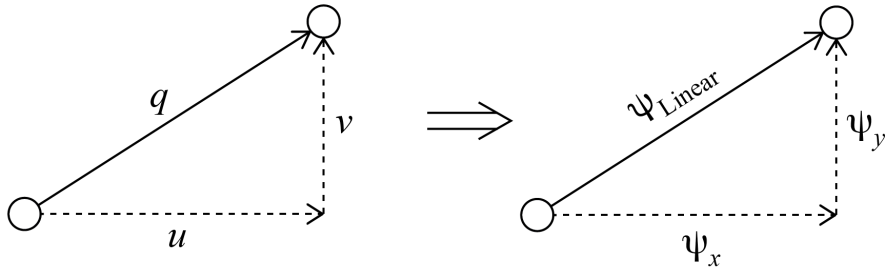
BASIC PATTERNS OF FLOW

Terdapat 4 basic flow pattern yang perlu diketahui iaitu:

1. Linear atau uniform flow
2. Source
3. Sink
4. Vortex

LINEAR OR UNIFORM FLOW

q = Resultant velocity

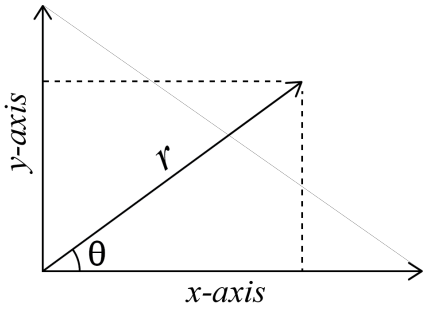


$$\psi_{Linear} = \psi_x + \psi_y$$

$$\psi_L = \psi_x + \psi_y$$

$$\psi_L = uy - vx$$

$$\psi_L = u(r \cdot \sin\theta) - v(r \cdot \cos\theta)$$



$y = r \cdot \sin\theta \quad , \quad x = r \cdot \cos\theta$

$$\psi_{\text{Linear}} = ur \cdot \sin\theta$$

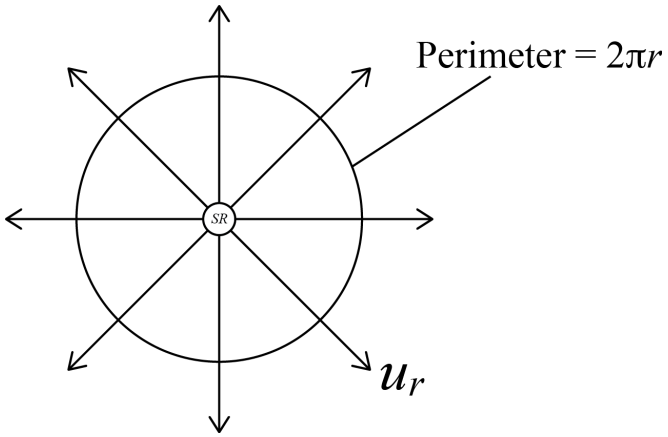
$$\phi_{Linear} = \phi_x + \phi_y$$

$$\phi_L = ux + vy$$

$$\phi_L = u(r \cdot \cos\theta) + v(r \cdot \sin\theta)$$

$$\phi_{\text{Linear}} = ur \cdot \cos\theta$$

SOURCE



Source flow has a strength, called "strength of source". It symbol is "m".
The strength of a source is the total volume rate of flow from it.

$$u_r = \frac{\text{Volume rate of flow}}{\text{Area perpendicular to velocity}}$$

$$u_r = \frac{m}{2\pi r} = \frac{d\psi}{r d\theta}$$

$$u_\theta = -\frac{d\psi}{dr} = 0$$

$u_\theta = 0$ kerana tiada halaju yang berpusing mengelilingi paksi bulatan.

$$\frac{d\psi}{r d\theta} = \frac{m}{2\pi r}$$

$$d\psi = \frac{m}{2\pi r} \cdot r \cdot d\theta$$

$$= \frac{m}{2\pi} \cdot d\theta$$

$$\int d\psi = \frac{m}{2\pi} \int 1 \cdot d\theta$$

$$\psi = \frac{m\theta}{2\pi}$$

$$\psi_{\text{Source}} = \frac{m\theta}{2\pi}$$

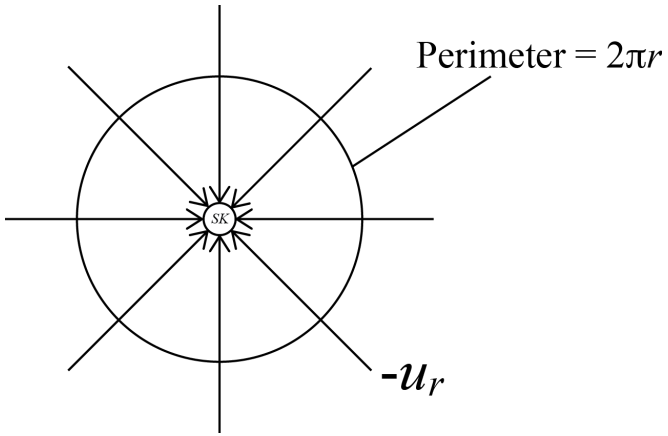
$$u_r = \frac{m}{2\pi r} = \frac{d\phi}{dr}$$

$$d\phi = \frac{m}{2\pi r} dr$$

$$\int d\phi = \frac{m}{2\pi} \int \frac{1}{r} \cdot dr$$

$$\phi_{\text{Source}} = \frac{m}{2\pi} \ln r$$

SINK



m = Strength of sink

$$-u_r = \frac{m}{2\pi r} = \frac{d\psi}{r d\theta}$$

$$\psi_{\text{Sink}} = -\frac{m\theta}{2\pi}$$

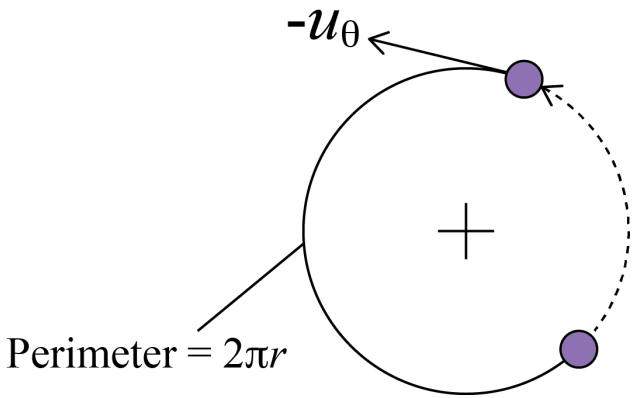
$$-u_r = \frac{m}{2\pi r} = \frac{d\phi}{dr}$$

$$d\phi = -\frac{m}{2\pi r} dr$$

$$\int d\phi = -\frac{m}{2\pi} \int \frac{1}{r} \cdot dr$$

$$\phi_{\text{Sink}} = -\frac{m}{2\pi} \ln r$$

VORTEX



It is similar with circulation.
Vortex has strength of vortex, denoted by, Γ .

$$\Gamma = u_\theta \cdot 2\pi r$$

$$u_\theta = \frac{\Gamma}{2\pi r} = -\frac{d\psi}{dr}$$

$$d\psi = \frac{-\Gamma}{2\pi} \cdot \frac{1}{r} \cdot dr$$

$$\int d\psi = \frac{-\Gamma}{2\pi} \int \frac{1}{r} \cdot dr$$

$$\psi = \frac{-\Gamma}{2\pi} \ln r + C$$

If $r = A$ and $\psi = 0$,

$$0 = \frac{-\Gamma}{2\pi}\ln A + C$$

$$C = \frac{\Gamma}{2\pi}\ln A$$

Masukkan nilai C

$$\psi = \frac{-\Gamma}{2\pi}\ln r + \frac{\Gamma}{2\pi}\ln A$$

$$\psi = -\left(\frac{\Gamma}{2\pi}\ln r - \frac{\Gamma}{2\pi}\ln A\right)$$

$$\psi = -\frac{\Gamma}{2\pi}\ln\left(\frac{r}{A}\right)$$

$$\psi_{\text{Vortex}} = -\frac{\Gamma}{2\pi}\ln\left(\frac{r}{A}\right)$$

$$u_\theta = \frac{\Gamma}{2\pi r} = \frac{d\phi}{r d\theta}$$

$$d\phi = \frac{\Gamma}{2\pi r} r d\theta$$

$$\phi = \frac{\Gamma}{2\pi} \cdot \theta$$

$$\phi_{\text{Vortex}} = \frac{\Gamma \cdot \theta}{2\pi}$$

RINGKASAN

	ψ	ϕ
Linear	$\psi_{\text{Linear}} = ur \cdot \sin\theta$	$\phi_{\text{Linear}} = ur \cdot \cos\theta$
Source	$\psi_{\text{Source}} = \frac{m\theta}{2\pi}$	$\phi_{\text{Source}} = \frac{m}{2\pi}\ln r$
Sink	$\psi_{\text{Sink}} = -\frac{m\theta}{2\pi}$	$\phi_{\text{Sink}} = -\frac{m}{2\pi}\ln r$
Vortex	$\psi_{\text{Vortex}} = -\frac{\Gamma}{2\pi}\ln\left(\frac{r}{A}\right)$	$\phi_{\text{Vortex}} = \frac{\Gamma \cdot \theta}{2\pi}$