04

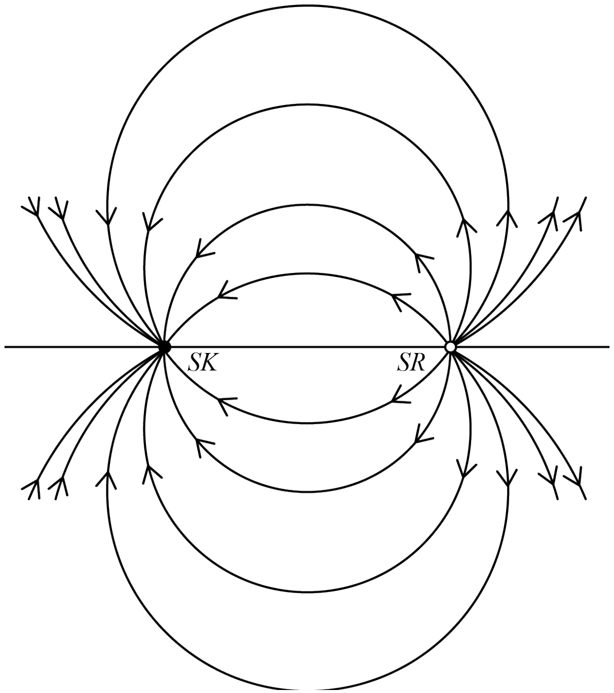
IDEAL FLOW

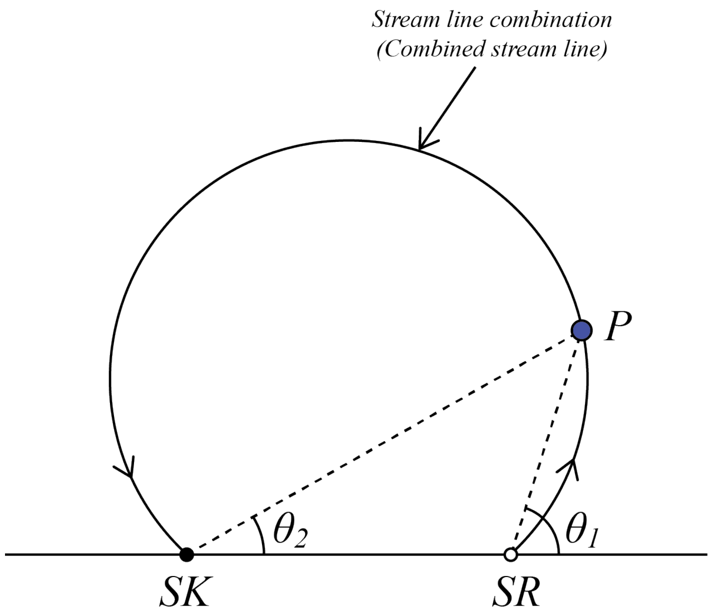
COMBINATION BASIC FLOW PATTERNS

- SOURCE + SINK
- DOUBLET

SOURCE + SINK

If the source flow and sink are combined, the stream line combination will form as follows:



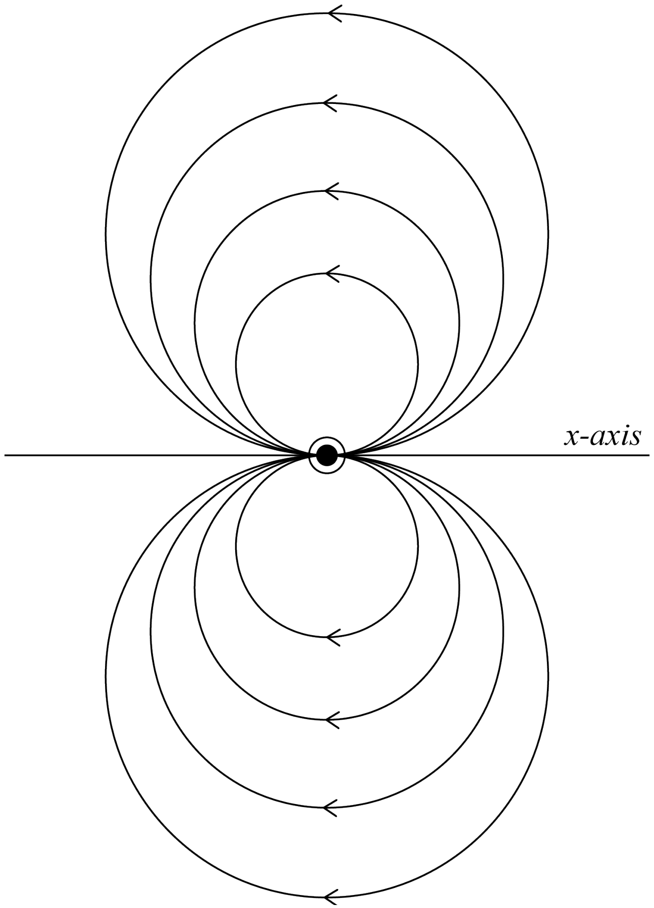


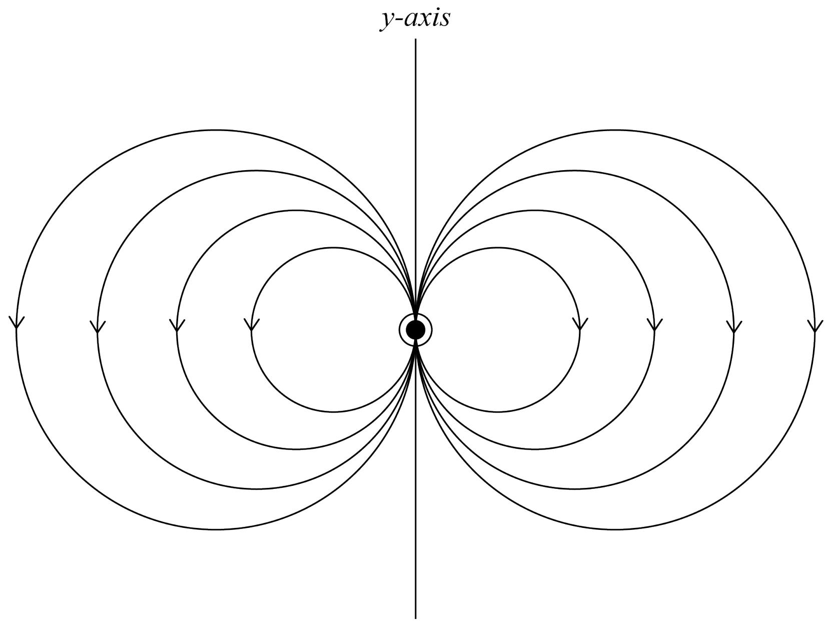
$$\psi_{combination} = \psi_{source} + \psi_{sink}$$
$$= \frac{m\theta_1}{2\pi} + \left(-\frac{m\theta_2}{2\pi}\right)$$
$$= \frac{m}{2\pi}(\theta_1 - \theta_2)$$

θ is in radian
strength of source = strength of sink

DOUBLET

Doubles are generated if the source flow and the sink flow meet on the same point. The stream line combination will be formed as follows:





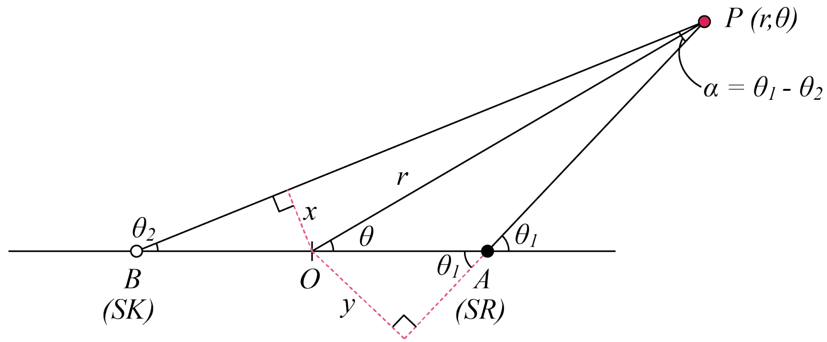
However, the stream function combination does not become as follows ;

$$\psi_{combination} = \frac{m}{2\pi}(\theta_1 - \theta_2)$$

Because the value of the angle (θ) becomes constant.

$$\theta_1 = \theta_2 = \theta$$

Consider the following positions:



$$\psi_{combination} = \psi_{source} + \psi_{sink}$$

$$= \frac{m\theta_1}{2\pi} + \left(-\frac{m\theta_2}{2\pi}\right)$$

$$= \frac{m}{2\pi}(\theta_1 - \theta_2)$$

$$\psi_{combination} = \frac{m}{2\pi}(\alpha)$$

$$r \cdot \alpha = x + y \quad = OB \sin\theta_2 + OA \sin\theta_1$$

$$\alpha \quad = \frac{OB \sin\theta_2 + OA \sin\theta_1}{r}$$

If the source and sink move towards the origin;

$$\theta_1 = \theta_2 = \theta$$

$$\alpha \quad = \frac{\sin\theta}{r}(OA + OB)$$

$$\alpha \quad = \frac{\sin\theta}{r}(AB)$$

$$\psi_{combination} \quad = \frac{m}{2\pi}(\alpha)$$

$$= \frac{m}{2\pi}\left(\frac{\sin\theta}{r}(AB)\right)$$

$$= \frac{m(AB)}{2\pi} \cdot \frac{\sin\theta}{r}$$

The value of m(AB) must be constant, and must not be zero.
Therefore, m(AB) is defined as the strength of doublet
$m(AB) = \mu =$ Strength of doublet

$$\psi_{doublet} \quad = \frac{\mu}{2\pi r} \cdot \sin\theta$$

COMPONENT VELOCITY

$$\psi_{doublet} = \frac{\mu}{2\pi r} \cdot \sin\theta$$

$$u_r = \frac{d\psi}{rd\theta} = \frac{1}{r} \cdot \frac{d}{d\theta}\left(\frac{\mu}{2\pi r} \cdot \sin\theta\right)$$

$$u_r = \frac{\mu}{2\pi r^2} \cdot \cos\theta$$

$$u_\theta = -\frac{d\psi}{dr} = -\frac{d}{dr}\left(\frac{\mu}{2\pi r} \cdot \sin\theta\right)$$

$$u_\theta = \frac{\mu}{2\pi r^2} \cdot \sin\theta$$

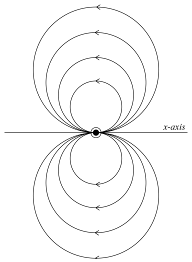
Resultant velocity :

$$q = \sqrt{(u_\theta)^2 + (u_r)^2} = \frac{\mu}{2\pi r^2}$$

Velocity potential, ϕ :

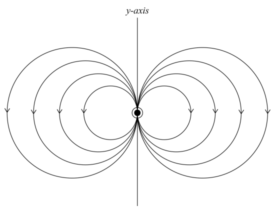
$$\phi = -\frac{\mu}{2\pi r} \cdot \cos\theta$$

Note:



$$\psi_{doublet} = \frac{\mu}{2\pi r} \cdot \sin\theta = \frac{\mu}{2\pi}\left(\frac{y}{x^2 + y^2}\right)$$

$$\phi_{doublet} = -\frac{\mu}{2\pi r} \cdot \cos\theta = -\frac{\mu}{2\pi}\left(\frac{x}{x^2 + y^2}\right)$$



$$\psi_{doublet} = \frac{\mu}{2\pi r} \cdot \cos\theta = \frac{\mu}{2\pi}\left(\frac{x}{x^2 + y^2}\right)$$

$$\phi_{doublet} = \frac{\mu}{2\pi r} \cdot \sin\theta = \frac{\mu}{2\pi}\left(\frac{y}{x^2 + y^2}\right)$$