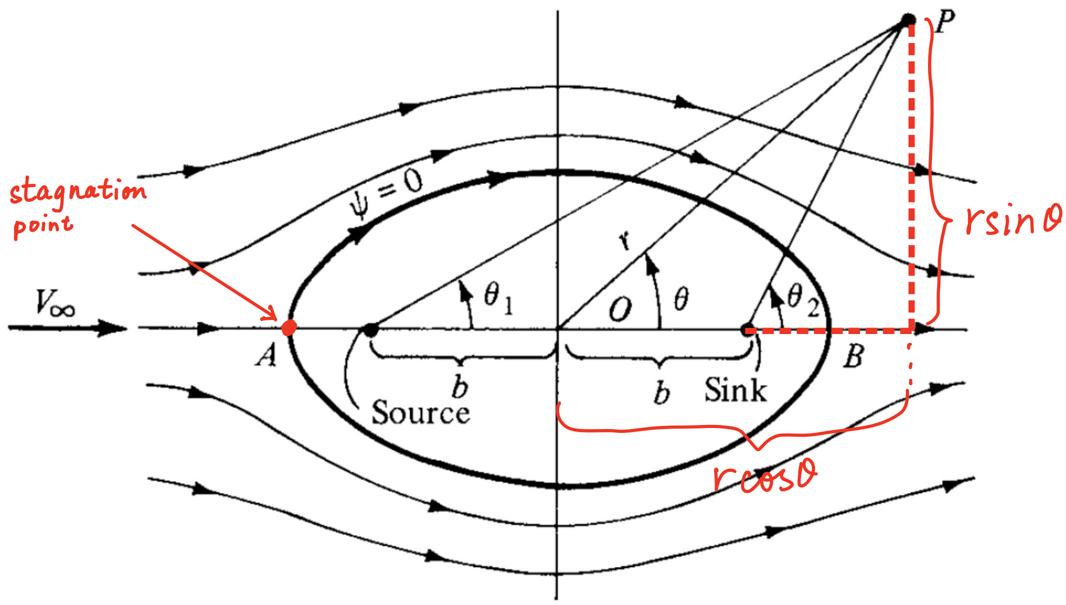


For the Rankine oval, we have

$$\psi = V_\infty r\sin\theta + \frac{\Lambda}{2\pi}(\theta_1 - \theta_2) \quad \cdots ①$$

For θ_1 and θ_2,

$$\theta_1 = \arctan\left(\frac{r\sin\theta}{r\cos\theta + b}\right) \quad \cdots ②$$

$$\theta_2 = \arctan\left(\frac{r\sin\theta}{r\cos\theta - b}\right) \quad \cdots ③$$

Let $x = r\cos\theta$, $y = r\sin\theta$, and substitude ②③ to ①

$$\psi = V_\infty y + \frac{\Lambda}{2\pi}\left(\arctan\left(\frac{y}{x+b}\right) - \arctan\left(\frac{y}{x-b}\right)\right)$$

For invicid, irrotational, incompressible flow,

$$u = \frac{\partial\psi}{\partial y}$$

$$= V_\infty + \frac{\Lambda}{2\pi}\left(\frac{1}{1+\left(\frac{y}{x+b}\right)^2}\cdot\frac{1}{x+b} - \frac{1}{1+\left(\frac{y}{x-b}\right)^2}\cdot\frac{1}{x-b}\right)$$

$$= V_\infty + \frac{\Lambda}{2\pi}\left(\frac{x+b}{(x+b)^2+y^2} - \frac{x-b}{(x-b)^2+y^2}\right)$$

For point A, i.e. stagnation point, we have

$$\begin{cases} u = 0 \\ y = 0 \end{cases}$$

Subtitude to u

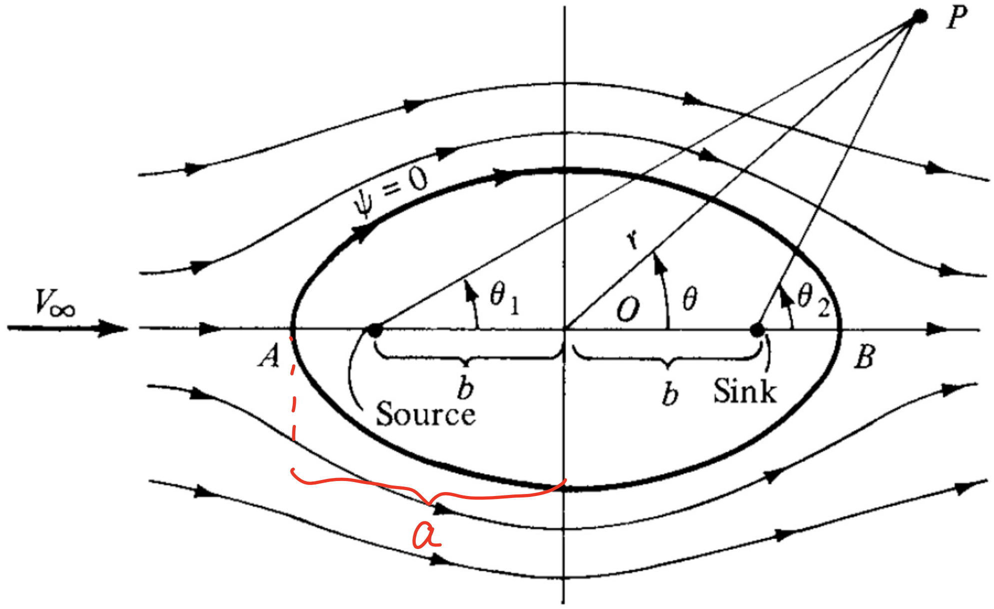
$$0 = u = V_\infty + \frac{\Lambda}{2\pi}\left(\frac{1}{x+b} - \frac{1}{x-b}\right)$$

$$\Rightarrow -\frac{2\pi V_\infty}{\Lambda} = \frac{-2b}{x^2 - b^2}$$

$$\Rightarrow x = \pm\sqrt{b^2 + \frac{\Lambda b}{\pi V_\infty}}$$

$$OA = OB = |x| = \sqrt{b^2 + \frac{\Lambda b}{\pi V_\infty}}$$

For $V_\infty = 10\,m/s$, $b = 1\,m$, $\Lambda = 20\,m^2/s$



$$\psi = 10y + \frac{10}{\pi}\left(\arctan\left(\frac{y}{x+1}\right) - \arctan\left(\frac{y}{x-1}\right)\right)$$

$$u = \frac{\partial \psi}{\partial y} = 10 + \frac{10}{\pi}\left(\frac{x+1}{(x+1)^2+y^2} - \frac{x-1}{(x-1)^2+y^2}\right)$$

$$v = -\frac{\partial \psi}{\partial x} = -\frac{10}{\pi}\left(\frac{1}{1+\left(\frac{y}{x+1}\right)^2}\cdot\frac{-y}{(x+1)^2} - \frac{1}{1+\left(\frac{y}{x-1}\right)^2}\cdot\frac{-y}{(x+1)^2}\right)$$

$$= \frac{10}{\pi}\left(\frac{y}{(x+1)^2+y^2} - \frac{y}{(x-1)^2+y^2}\right)$$

$$V = u^2 + v^2$$

$$\mathbf{V(x,y)} = \sqrt{\left(10 + \frac{10}{\pi}\left(\frac{x+1}{(x+1)^2+y^2} - \frac{x-1}{(x-1)^2+y^2}\right)\right)^2 + \left(\frac{10}{\pi}\left(\frac{y}{(x+1)^2+y^2} - \frac{y}{(x-1)^2+y^2}\right)\right)^2}$$

$$C_p(x,y) = 1 - \left(\frac{V(x,y)}{V_\infty}\right)^2$$

$$u = \frac{\partial \psi}{\partial y} = 10 + \frac{10}{z}\left(\frac{x+1}{(x+1)^2+y^2} - \frac{x-1}{(x-1)^2+y^2}\right)$$

$$v = -\frac{\partial \psi}{\partial x} = \frac{10}{z}\left(\frac{y}{(x+1)^2+y^2} - \frac{y}{(x-1)^2+y^2}\right)$$

$$\nabla \times \vec{V} = 0$$

$$\Rightarrow \quad u\,dy = v\,dx$$

$$\Rightarrow \frac{dy}{dx} = \frac{\frac{10}{z}\left(\frac{y}{(x+1)^2+y^2} - \frac{y}{(x-1)^2+y^2}\right)}{10 + \frac{10}{z}\left(\frac{x+1}{(x+1)^2+y^2} - \frac{x-1}{(x-1)^2+y^2}\right)}$$