(SI unit)

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Quantity	Prototype	model
Q	0.5	2.5
ω	2500	1800
D	0.2	
h		
ρ		
p		

$$\frac{Q_1}{\omega_1 D_1^3} = \frac{Q_2}{\omega_2 D_2^3}$$

$$\Rightarrow \quad D_2 = D_1 \sqrt[3]{\frac{Q_2}{Q_1} \frac{\omega_1}{\omega_2}}$$

$$= 0.2 \sqrt[3]{5 \times \frac{25}{18}}$$

$$= \frac{1}{\sqrt[3]{18}} \, m \qquad \approx 0.381571$$
$$\qquad\qquad\qquad = 381.571$$

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	Prototype	model
Q	0.75	
h	15	
ω	500	1000
D	0.25	
Power		2.25

$$\frac{P_1}{\omega_1^3 D_1^5} = \frac{P_2}{\omega_2^3 D_2^5}$$

$$P_1 = h_1 \rho Q_1 = 15 \times 1000 \times 0.75/1000$$

$$= 11.25 \ kW$$

$$D_2 = D_1 \left[\left(\frac{\omega_1}{\omega_2} \right)^3 \frac{P_2}{P_1} \right]^{1/5}$$

$$= 0.25 \left[\left(\frac{1}{2} \right)^3 \times \frac{1}{5} \right]^{1/5}$$

$$= \frac{0.25}{40^{1/5}} \qquad = 0.1195 \ m$$

$$\frac{Q_1}{\omega_1 D_1^3} = \frac{Q_2}{\omega_2 D_2^3}$$

$$\Rightarrow \quad Q_2 = Q_1 \frac{\omega_2}{\omega_1} \left(\frac{D_2}{D_1} \right)^3$$

$$= 0.75 \times \frac{2}{40^{1/5}} \qquad = 0.7173 \quad m^3 s^{-1}$$

$$\frac{h_1}{\omega_1^2 D_1^2} = \frac{h_2}{\omega_2^2 D_2^2}$$

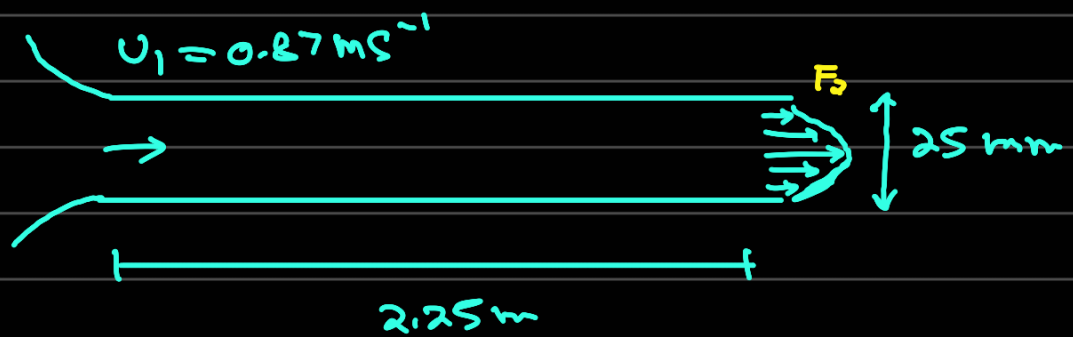$$\Rightarrow \quad h_2 = h_1 \left(\frac{\omega_2 D_2}{\omega_1 D_1} \right)^2$$

$$= 15 \left(\frac{2}{40^{1/5}} \right)^2$$

$$= \frac{60}{40^{2/5}} \qquad = 13.7192 \ J/kg$$

$$\rightarrow \quad D = 0.025 \ m \ , \quad v_1 = 0.87 \ ms^{-1}$$

$$L = 2.25m,$$

$$\frac{U(\partial s)}{U_c} = 1 - \left(\frac{\partial u}{R} \right)^2 \qquad P_1 - P_2 = 1.92 \ Pa$$

F_2

25 mm

2.25 m

$$U_1 \frac{\pi}{4} (d)^2 \, \rho = \int U(r) \, 2\pi r \, dr \, \rho$$

$$\Rightarrow U_1 \frac{\pi}{4} d^2 = \int_0^R 2\pi U_c \left[r - \frac{r^3}{R^2} \right] dr$$

$$= 2\pi U_c \left[\frac{R^2}{2} - \frac{R^2}{4} \right]$$

$$= \frac{\pi U_c R^2}{2} \qquad (R = d/2)$$

$$\Rightarrow U_c = \frac{U_1}{2} \left(\frac{d}{R} \right)^2 = 2 U_1$$

$$= 1.74 \, ms^{-1}$$

$$-\dot{m} U_1 + \int \rho U^2(r) \, 2\pi r \, dr$$

$$= (P_1 - P_2) \pi R^2$$
$$+ F_x$$