

[A4] (1)

$$(a) \Delta p = \frac{F}{S} = \frac{1}{S} \times L \int \tau_w d\Gamma = \frac{1}{S} \times L \times \Gamma \bar{\tau}_w = \frac{L \Gamma}{S} \times \bar{\tau}_w$$

$$(b) S = \frac{\pi d^2}{4}, \Gamma = \pi d \quad s'1)$$

$$\frac{L \Gamma}{S} = 4 \times \frac{L}{d} \quad s'2) \quad \Delta p = 4 f \times \frac{L}{d} \times \frac{1}{2} \rho v^2$$

$$(c) \frac{4}{d_{eq}} = \frac{\Gamma}{S} \quad s'1)$$

$$d_{eq} = 4 \times \frac{S}{\Gamma}$$

$$s'2) S = \frac{\pi(d_1^2 - d_2^2)}{4}$$

$$\Gamma = \pi d_1 + \pi d_2$$



$$s'1) d_{eq} = \frac{d_1 - d_2}{1} = \underline{14.4 \text{ mm}}$$

$$Re = \frac{\rho v d_{eq}}{\mu} = 21600$$

$$s'2) f = 0.0791 Re^{-0.25} = 0.00652$$

$$\frac{\Delta p}{2} = 4 f \times \frac{\rho v^2}{2} \cdot \frac{1}{d_{eq}} = \underline{2038 \text{ Pa}}$$