MEASURING FLOW RATE with a PITOT TUBE

Dr. Faith Morrison
Michigan Tech University

YouTube: DrMorrisonMTU

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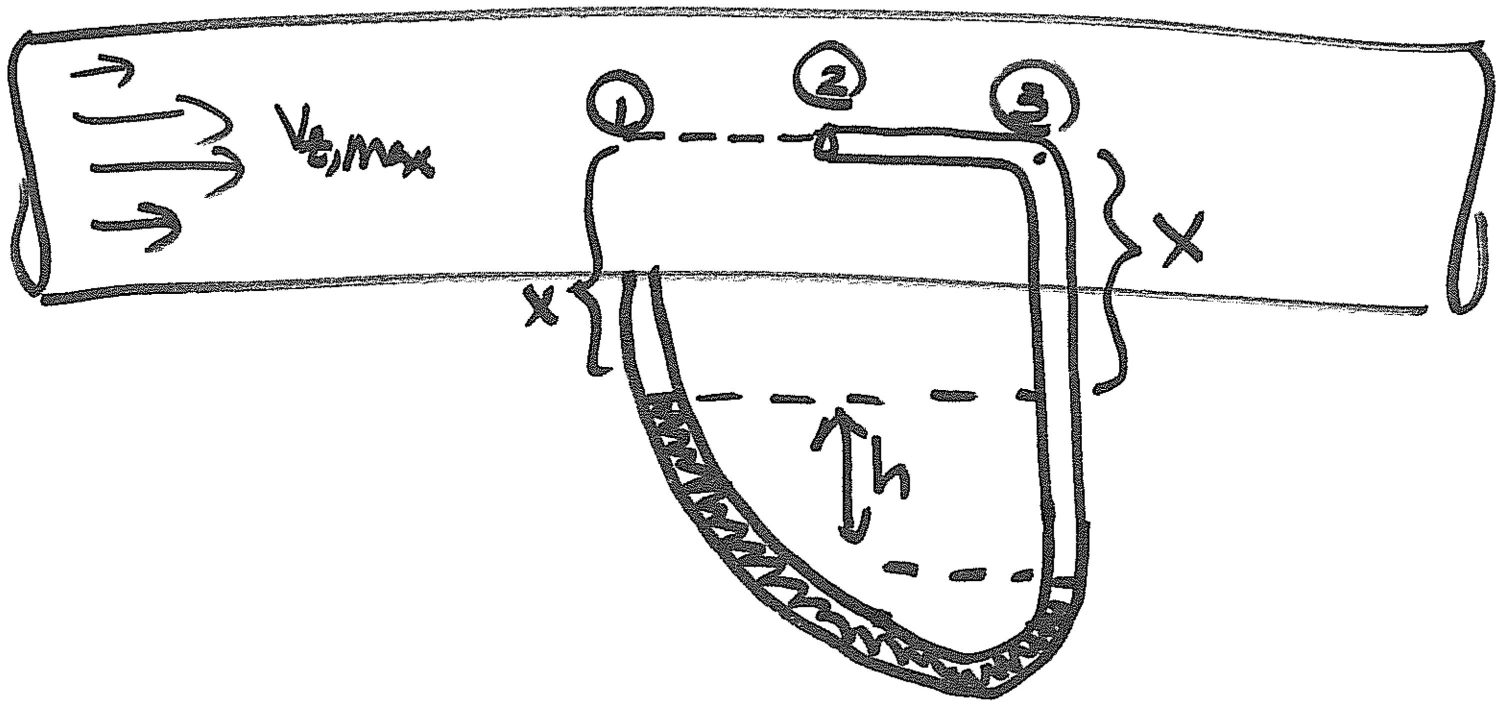
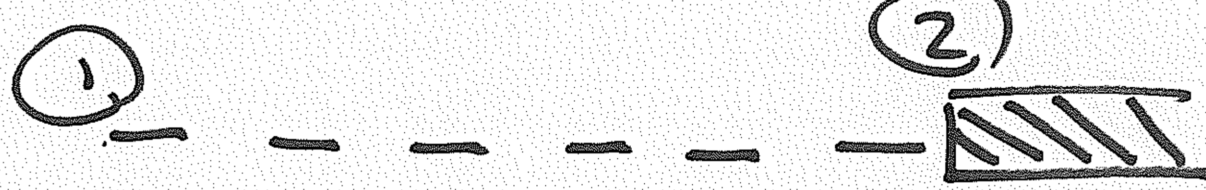
Example: A pitot tube is used to measure the flow rate of water at 20°C in the center of a pipe having an inside diameter of 102.3 *mm*. The manometer reading is 78 mm of carbon tetrachloride at 20°C. The pitot tube coefficient is 0.98. Calculate the velocity at the center of the tube, the average velocity, and the flow rate.



$\alpha = 1$, turbulent flow



MEB

$$\frac{\Delta P}{\rho} + \frac{\Delta V^2}{2\alpha} + g\cancel{\Delta z} + \cancel{F} = \cancel{\frac{W_{s,on}}{\dot{m}}}$$

$$\frac{P_2 - P_1}{\rho} + \frac{\cancel{V_2^2} - V_1^2}{2} = 0$$

$$V_1 = V_{z,max} = \sqrt{\frac{2(P_2 - P_1)}{\rho_w}}$$

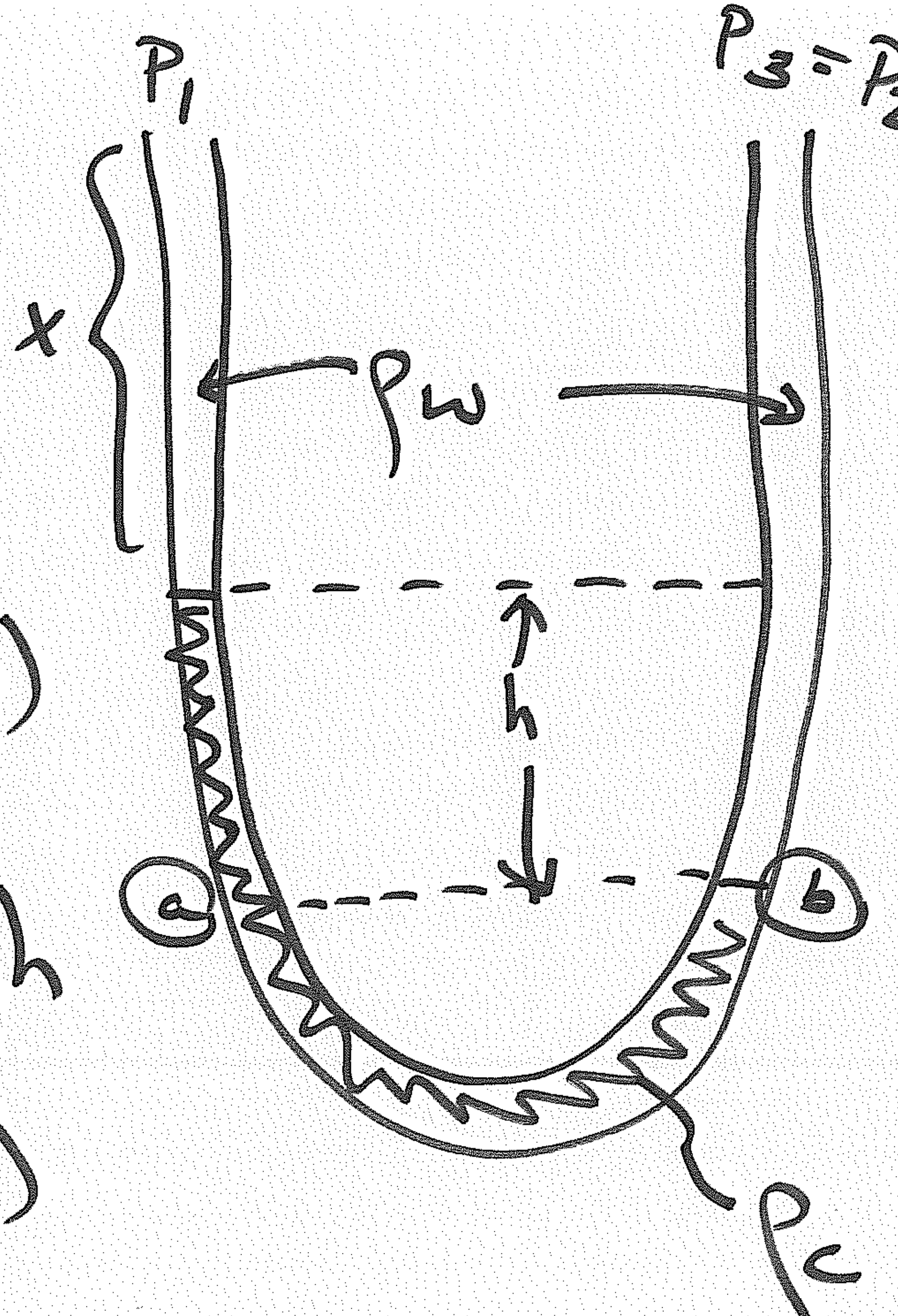
$$P_a = P_b$$

$$P_1 + \cancel{\rho_w g x} + \rho_c g h$$

$$= P_2 + \rho_w g(\cancel{x} + h)$$

$$P_2 - P_1 = \rho_c g h - \rho_w g h$$

$$= (\rho_c - \rho_w)(gh)$$



$$V_{z,max} = \sqrt{\frac{2(\rho_c - \rho_w) g h}{\rho_w}}$$

To calculate $\langle V \rangle$, see Fig 2.10-2 Geankoplis for data on $\frac{\langle V \rangle}{V_{z,max}}$ as a function of Re based on $V_{z,max}$. Finally, to get Q,

$$Q = \langle V \rangle \pi R^2$$

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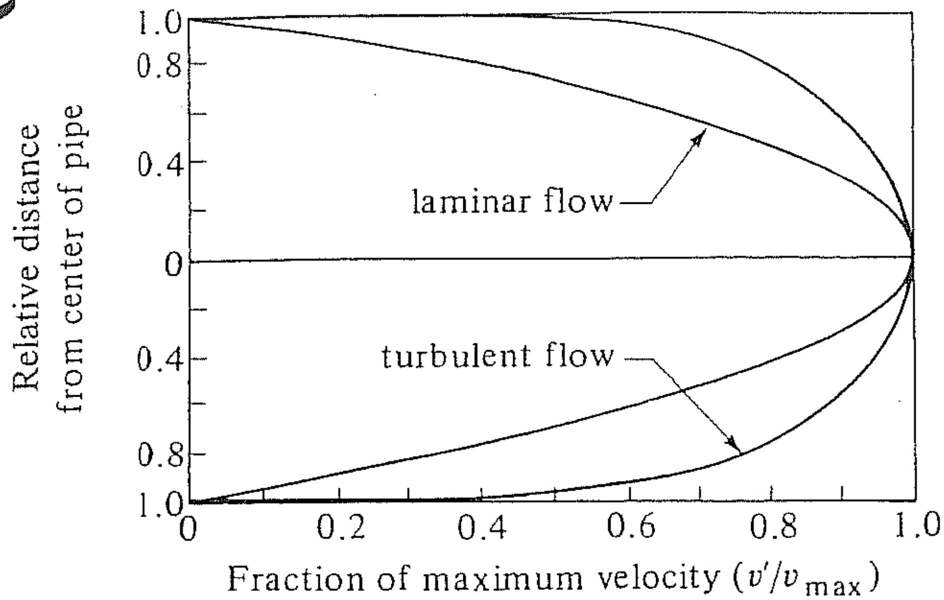

FIGURE 2.10-1. *Velocity distribution of a fluid across a pipe.*

Ref: C.J. Geankoplis "Transport Processes + Sep'n Process Principles Prentice Hall 2003

$$\langle v \rangle = \frac{Q}{\pi R^2}$$

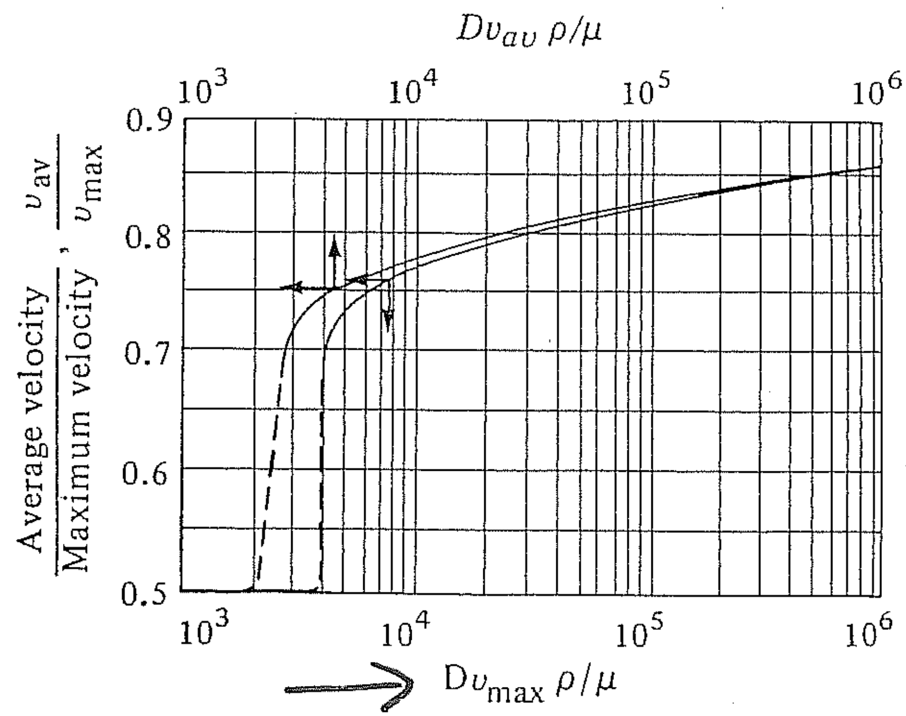

FIGURE 2.10-2. *Ratio v_{av}/v_{max} as a function of Reynolds num-*