

MECH 263 - WEEK 2 CONTINUED

CLASS III - SERIES PIPEFLOW SYSTEMS
THE PIPE SIZE (DIAMETER)
IS NOT KNOWN.

- THIS IS THE MOST REALISTIC AND OPEN-ENDED TYPE OF SYSTEM. IT IS NORMAL NOT TO KNOW THE PIPE DIAMETER BEFORE STARTING A DESIGN.
- THERE ARE AT LEAST TWO WAYS OF FIGURING OUT A GOOD DIAMETER OF PIPE TO USE.

METHOD ②: BY ITERATION (THE HARD WAY).


FOR JUST A STRAIGHT LENGTH OF PIPE (NO FITTINGS)

$$\textcircled{A} \left. \begin{aligned} h_L &= f \left(\frac{L}{D} \right) \left(\frac{V^2}{2g} \right) \\ V &= \frac{Q}{A} \\ A &= \frac{\pi D^2}{4} \end{aligned} \right\} V = \frac{4Q}{\pi D^2} \Rightarrow V^2 = \frac{16Q^2}{\pi^2 D^4} \left. \begin{aligned} h_L &= f \left(\frac{L}{D} \right) \left(\frac{16Q^2}{\pi^2 D^4 (2g)} \right) \\ &= \frac{8LQ^2}{\pi^2 g} \left(\frac{f}{D^5} \right) \end{aligned} \right\}$$

NOW SOLVE FOR D: $D = \left(\frac{8LQ^2}{\pi^2 g h_L f} \right)^{1/5} = (C_1 \times f)^{0.2}$

ALL KNOWN 

$$\textcircled{B} \left. \begin{aligned} N_R &= \frac{VD\rho}{\mu} \\ V &= \frac{4Q}{\pi D^2} \end{aligned} \right\} N_R = \frac{4Q}{\pi D^2} \times \frac{D\rho}{\mu} = \frac{4Q\rho}{\pi\mu} \times \frac{1}{D} = \frac{C_2}{D}$$

ALL KNOWN 

③ GUESS AT f (TRY 0.015 OR 0.02)

FIND: $D = (C_1 \times f)^{0.2}$

FIND: $N_R = C_2 / D$

FIND: $\frac{D}{E}$

USE MOODY DIAGRAM OR SWAMEE-JAIN TO GET A NEW f

ITERATE UNTIL f DOESN'T CHANGE.

BLURK! METHOD ② LOOKS LIKE A LOT OF WORK!

THERE MUST BE A BETTER WAY!

METHOD ①: USE RECOMMENDED FLOW VELOCITIES
TO DETERMINE THE PIPE DIAMETER.
(USE THIS METHOD ALL THE TIME.)

RECALL: $Q = VA$ AND $A = \frac{\pi D^2}{4}$ → SOLVE FOR D.
↑ KNOWN ↑ ↑ SOLVE FOR THIS ↑
YOU SELECT THIS BASED ON RECOMMENDED U'S
END
EASY!

HERE ARE A FEW POINTS ABOUT SELECTING A GOOD OPERATING VELOCITY.

- NEVER USE A VELOCITY LESS THAN 0.6 m/s (2 ft/s).
 - AIR WILL GET TRAPPED AT HIGH POINTS IF YOU DO.
- IN BUILDINGS WHERE NOISE IS IMPORTANT CHOOSE VELOCITIES LESS THAN 3 m/s (10 ft/s).
 - HIGHER THAN THIS AND THE FLOW WILL MAKE NOISE.
- IN INDUSTRIAL SETTINGS YOU CAN CHOOSE VERY HIGH VELOCITIES. THE PIPE WILL BE SMALL BUT YOUR PUMP WILL BE BIG.
- PIPE IS EXPENSIVE, TRY TO CHOOSE REASONABLE HIGH'ISH VELOCITY TO KEEP THE COST OF THE PROJECT DOWN.