

MECH 293 - WEEK 2

CLASS II - SERIES PIPELINE FLOW

ALL IS KNOWN EXCEPT THE FLOWRATE.

- THIS MAY SOUND EASY BUT IT IS INDEED MORE COMPLEX THAN CLASS I SYSTEMS.
- THE SOLUTION OFTEN REQUIRES ITERATION

ITERATION EXAMPLE

- FIND 'a' BY ITERATION

$$a = 1 - \frac{1}{2}a \rightarrow \text{DIRECT SOLUTION: } a = 1 - \frac{1}{2}a$$



ITERATION

- ① REWRITE EQⁿ LIKE SO...

$$a_{\text{NEW}} = 1 - \frac{1}{2}a_{\text{OLD}}$$

$$a + \frac{1}{2}a = 1$$

$$a(1 + \frac{1}{2}) = 1$$

$$a = \frac{1}{(1 + \frac{1}{2})}$$

$$a = 0.667$$

NO PROBLEM!

- ② GUESS AT $a_{\text{OLD}} \rightarrow a_{\text{OLD}} = 1$

- ③ FIND $a_{\text{NEW}} \rightarrow a_{\text{NEW}} = 1 - \frac{1}{2}a_{\text{OLD}} = 1 - \frac{1}{2}(1) = \frac{1}{2}$

- ④ MAKE $a_{\text{OLD}} = a_{\text{NEW}} \rightarrow a_{\text{OLD}} = a_{\text{NEW}} = \frac{1}{2}$

- ⑤ ITERATE ... (REPEAT ③ & ④ UNTIL $a_{\text{NEW}} \approx a_{\text{OLD}}$)

OR UNTIL THE % DIFFERENCE = $\frac{a_{\text{NEW}} - a_{\text{OLD}}}{a_{\text{OLD}}} \times 100$ IS LESS THAN YOU NEED.

TRY IT

a_{NEW}	a_{OLD}
-	1
0.5	1
0.75	0.5
0.625	0.75
0.688	0.625
0.656	0.688
0.672	0.656
0.664	0.672
0.668	0.664
0.666	0.668
0.667	0.666
0.667	0.667

← SAME ∴



∴ $a = 0.667$ (TO 3 PLACES)

TO APPLY THIS IDEA TO CLASS II FLOW SYSTEMS ONE HAS TO SEE THE PROBLEM.

IN A PIPE TO GET \dot{Q} ... YOU NEED THE VELOCITY, U .

- f (FRICTION FACTOR) DEPENDS ON U
- TO FIND f YOU NEED N_R WHICH REQUIRES U
- YOU CAN'T SOLVE FOR f OR N_R DIRECTLY BECAUSE THE MOODY DIAGRAM OR THE COMPLEX SWAMEE-JAIN EQⁿ IS REQUIRED.
- ITERATION IS OFTEN THE SIMPLIST WAY

DO THIS ...

① FIND AN EQⁿ RELATING U AND f .

$$\text{USE: } \frac{P_1 - P_2}{\gamma} + (z_1 - z_2) + \frac{U_1^2 - U_2^2}{2g} + h_A - h_L - h_R = 0$$

$$\text{AND: } h_L = \left[f \left(\sum \frac{L}{D} \right) + \sum \left(\frac{K}{D} \right) \right] \frac{U^2}{2g}$$

② FIND AN EQⁿ RELATING U AND N_R

$$\text{USE: } N_R = \frac{UD\rho}{\mu}$$

③ GUESS AT f . (TRY $f = 0.015$ OR SOME OTHER).

④ USING ① CALCULATE U

⑤ USING ② & ④ CALCULATE N_R

⑥ FIND A NEW, BETTER f FROM THE MOODY DIAGRAM OR SWAMEE-JAIN.

REPEAT UNTIL YOUR U DOES NOT CHANGE