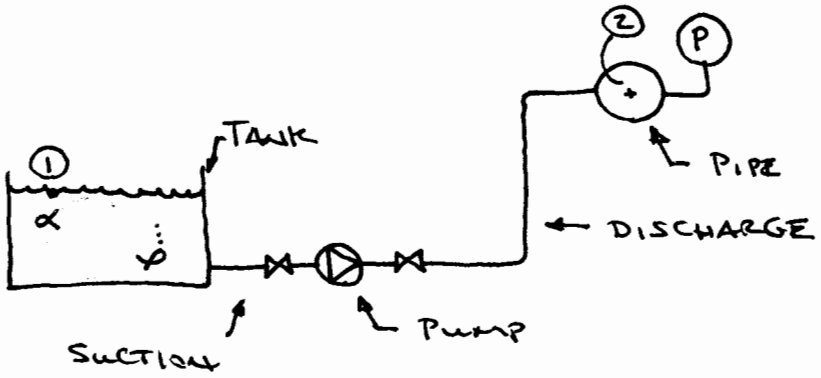
MENG 293 - WEEK 1

CLASS I - SERIES PIPELINE FLOW
ALL IS KNOWN EXCEPT h_A (OR SOME OTHER P)

TYPICAL LAYOUT A

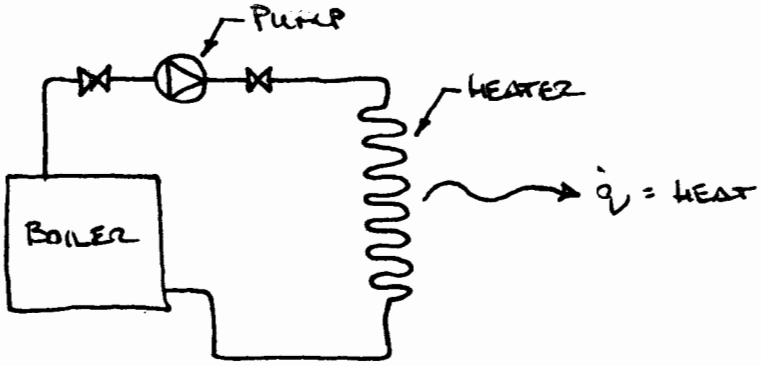


FLUID: IN AT ONE END OUT AT THE OTHER

$Z_1 - Z_2 > 0$

① & ② ARE SEPARATE.

TYPICAL LAYOUT B



FLUID: GOES ROUND AND ROUND

$Z_1 - Z_2 = 0$

$P_1 - P_2 = 0$

IN FACT...
① & ② ARE AT THE SAME SPOT.

$$\frac{P_1}{\gamma} + z_1 + \frac{V_2^2}{2g} + h_A - h_L - h_R = \frac{P_2}{\gamma} + z_2 + \frac{V_2^2}{2g}$$

OR

$$\frac{(P_1 - P_2)}{\gamma} + (z_1 - z_2) + \frac{V_1^2 - V_2^2}{2g} + h_A - h_L - h_R = 0$$

} GENERAL FLOW ENERGY EQ^N

NOTE: γ = SPECIFIC WEIGHT, $\frac{N}{m^3}$ or $\frac{lb}{FT^3}$

$= \rho g$ (ρ = DENSITY, $\frac{kg}{m^3}$ or $\frac{slugs}{FT^3}$)

OFTEN THE GOAL IN PIPE DESIGN IS TO FIND $\boxed{h_A}$

h_A = THE HEAD (OR PRESSURE) ADDED BY THE PUMP.

THIS WHAT YOU SOLVE FOR.

IF YOU DON'T HAVE PUMP CURVES OR A CATALOG YOU CAN FIGURE HOW MUCH <u>POWER</u> A PUMP MUST ADD USING...

$$P_{INPUT} = h_A \gamma \dot{Q} / e_m$$

NOT A DESIGN EQ^n

P_{INPUT} ← POWER INPUT.

e_m ← PUMP EFFICIENCY.

FINDING h_L (SYSTEM LOSSES).

SYSTEM LOSSES COME FROM TWO PLACES.

1. THE PIPE
2. THE FITTINGS

① <u>PIPE LOSSES</u>: $h_L = f\left(\frac{L}{D}\right)\left(\frac{V^2}{2g}\right)$; f = FRICTION FACTOR

L = PIPE LENGTH

D = PIPE ID

V = FLOW VELOCITY

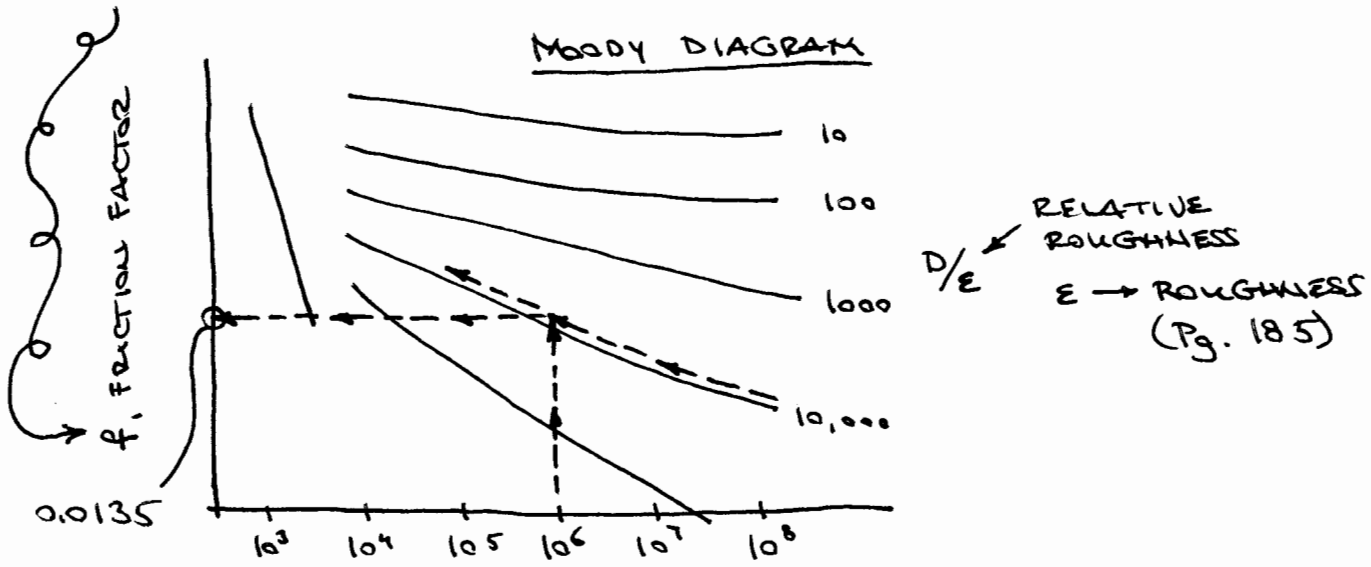
② <u>FITTING LOSSES</u>: $h_L = \left[\Sigma K + f\left(\Sigma \frac{L_E}{D}\right)\right]\frac{V^2}{2g}$; K = LOSS COEFF.

$\frac{L_E}{D}$ = EQUIVALENT LENGTH OF FITTING PER DIAM.

<u>TO GET</u>: f → MOODY DIAGRAM (Pg. 186)
<u>OR</u>
SWAMEE-JAIN EQ^n (Pg. 195, EQ^n 8-7)

K → LOOK IT UP
$\frac{L_E}{D}$ → LOOK IT UP
} CH. 10 OF MOTT.

FIND f (FRICTION FACTOR)



$$N_R = \frac{VD\rho}{\eta} = \frac{VD}{\nu} = \text{REYNOLDS NUMBER}$$

EXAMPLE: $N_R = 10^6$, $\frac{D}{\epsilon} = 10{,}000$ $\Big\}$ $f = 0.0135$

ALSO

$$f = \frac{0.25}{\left[\text{LOG}\left[\frac{1}{3.7(D/\epsilon)} + \frac{5.74}{N_R^{0.9}}\right]\right]^2}$$