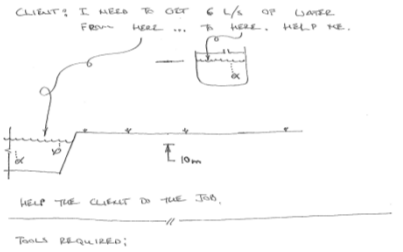
ENGR 292 Fluids and Thermodynamics

Scott Li, Ph.D., P.Eng.
Mechanical Engineering Technology
Camosun College

Feb.03, 2017

Fluid Dynamics

- ***A Starter Problem for Technologist***



2

Fluid Dynamics

The Procedure for designing a water pumping system

ENGR 292 Website:

http://www.fireflylabs.com/disted/courses/e292(2017)/e292-index.html

3

Step 1

1. Do Rough Layout

- ***Pipe***
- ***Pump***
- ***Valves***

4

Step 2

2. Determine Discharge Pipe Size

- $Q = vA$
- $A = \frac{\pi D^2}{4}$
- v ***: Select a velocity***

5

Step 3

3. Determine Suction Pipe Size

- ***One standard size larger than the size of discharge pipe***

6

Step 4

4. Calculate Actual Flow Velocities

- ***Discharge:*** $Q = vA$
- ***Suction:*** $Q = vA$

7

Step 5

5. Determine Reynolds Number

- ***Discharge:*** $N_R = \frac{vD\rho}{\mu}$
- ***Suction:*** $N_R = \frac{vD\rho}{\mu}$

8

Step 6

6. Choose Pipe Material

- ***Discharge:***
- ***Suction:***

Roughness ε

9

Step 7

7. Determine Relative Roughness:

- ***Discharge:*** $\frac{\varepsilon}{D_{Discharge}}$
- ***Suction:*** $\frac{\varepsilon}{D_{Suction}}$

10

Step 8

8. Determine Friction Factor f***:***

- ***Discharge: Moody Diagram***
- ***Suction: Moody Diagram***

11

Step 9

9. Determine Pipe Length:

- ***Discharge:***
- ***Suction:***

12

Design a Water Pumping System

10. Calculate Pipe Friction Head Loss, $h_{L\_friction}$

$$h_{L\_friction} = f\frac{L}{D}\frac{v^2}{2g}$$

- ***Discharge:***
- ***Suction:***

13

Design a Water Pumping System

11. Determine Minor Head Loss, h_L

$$h_{L\_Minor} = \left[\sum K\right]\frac{v^2}{2g}$$

- ***Discharge:***
- ***Suction:***

14

Design a Water Pumping System

12. Determine Head Added by Pump, h_A

General Energy Equation:

$$\frac{p_1}{\gamma} + z_1 + \frac{v_1^2}{2g} + h_A - h_R - h_L = \frac{p_2}{\gamma} + z_2 + \frac{v_2^2}{2g}$$

$$h_L = h_{L\_friction} + h_{L\_Minor}$$

15

Step 13

13. Select Pump, Q, h_A

- ***Pump Curves***

16

Step 14

14. Check suction design,

$$NPSH_A > NPSH_R$$

Or Change Design !

17