Pipelines and Pipe Networks

Chapter 4 - STUDENT OUTCOMES

1. Explain the hydraulic principles used to analyze and design **pipelines connecting two reservoirs**.
2. Describe the **negative pressure scenarios** that can occur in pipelines and pumps.
3. Understand **branching pipe system** analysis.
4. Define the hydraulic concepts used to evaluate the flow in complex **pipe networks**.
5. Describe **water hammer** phenomena in pipelines and the available solution methodologies.
6. **Calculate solutions to various pipeline and pipe network problems that involve these concepts.**

Definitions and Concepts

(Pipe Systems, Pipelines, and Pipe Networks)

Pipe Systems: an arrangement of interconnecting pipes in series, parallel, or branches to transport fluids.

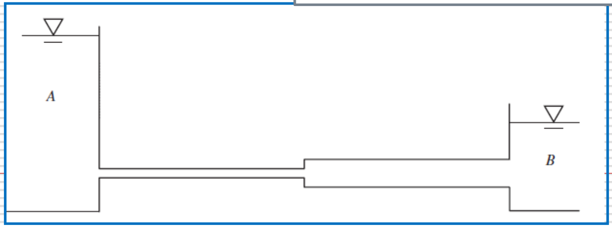
Pipelines:

Pipe Networks:

The Two Reservoir Problem: (See the figure below.)

Q: How do you determine the head loss?

Q: Between what 2 points?



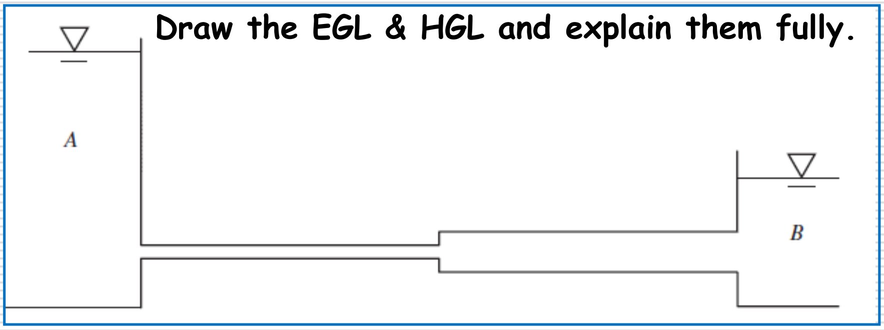
Definitions and Concepts

(Pipelines Connecting Two Reservoirs)

The Two Reservoir Problem: (See the figure below.)

Q: Write out the equation that results from balancing energy between the two reservoir (water) surfaces.

Draw the EGL & HGL and explain them fully.



Two Reservoir Example Problem

(Find the <u>head loss</u> given pipe size, material, and flow rate.)

Determine the water surface elevation in reservoir "A."

Energy Eq'n: $h_A - h_B = h_L$

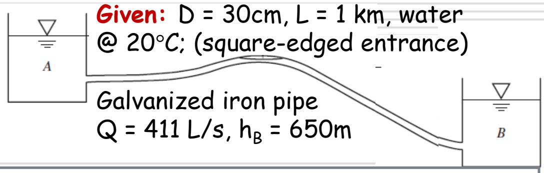
h_L =

h_L =

Given: D = 30cm, L = 1 km, water @ 20°C; (square-edged entrance)

Galvanized iron pipe

Q = 411 L/s, h_B = 650m



Two Reservoir Example Problem

(Find the <u>flow rate</u> given pipe size, material, and head loss.)

Determine the flow rate in the galvanized iron pipe.

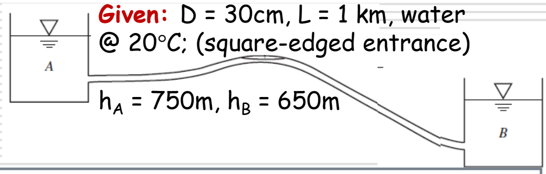
$h_A - h_B = 100m = h_L$

$h_L = h_e + h_f + h_d$

$h_L = [f(L/D)+\sum K](V^2/2g)$

Given: D = 30cm, L = 1 km, water @ 20°C; (square-edged entrance)

h_A = 750m, h_B = 650m



Two Reservoir Example Problem

(Find the <u>pipe size</u> given material, flow rate, and head loss.)

Determine the galvanized iron pipe size required.

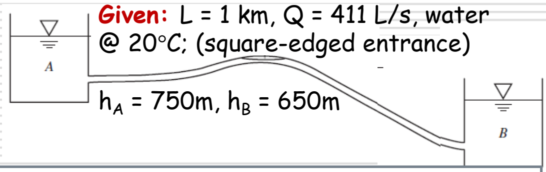
$h_A - h_B = 100m = h_L$

$h_L = h_e + h_f + h_d$

$h_L = [f(L/D)+\sum K](V^2/2g)$

Given: L = 1 km, Q = 411 L/s, water @ 20°C; (square-edged entrance)

h_A = 750m, h_B = 650m

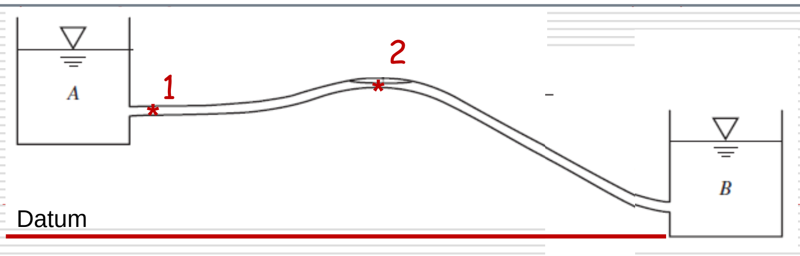


Pipelines with Negative Pressure

(When does pressure becomes sub-atmospheric?)

Exercise 1: Draw the EGL and HGL for the pipeline below.
Exercise 2: Given the datum, draw and identify the three forms of energy at point 1. Repeat for point 2.

Q: What can you say about the pressure head at point 2?
Q: When is this scenario likely to happen?



Negative Pressure Example

Homework Problems:

Determine the pressure head at the summit of the pipeline.

Balance energy: A to B

Found Q=411 L/s. Next?

Given: D = 30cm, L = 1 km, water @ 20°C; summit (s) is 400m from A.

h_A = 750m, h_s = 715m, h_B = 650m