

Overview

Wednesday, September 01, 2010

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We will not study pipe systems in detail as these are always solved with software

EGL, HGL

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Energy drives water through pipes. Visual tools to assist with overview of pipeline systems are the

Energy Grade Line: $V^2/2g+z+p/\rho g$ since we have a figure, the pipe is located at z so the energy grade line is the sum of the velocity and pressure heads above (sometimes below) the pipe

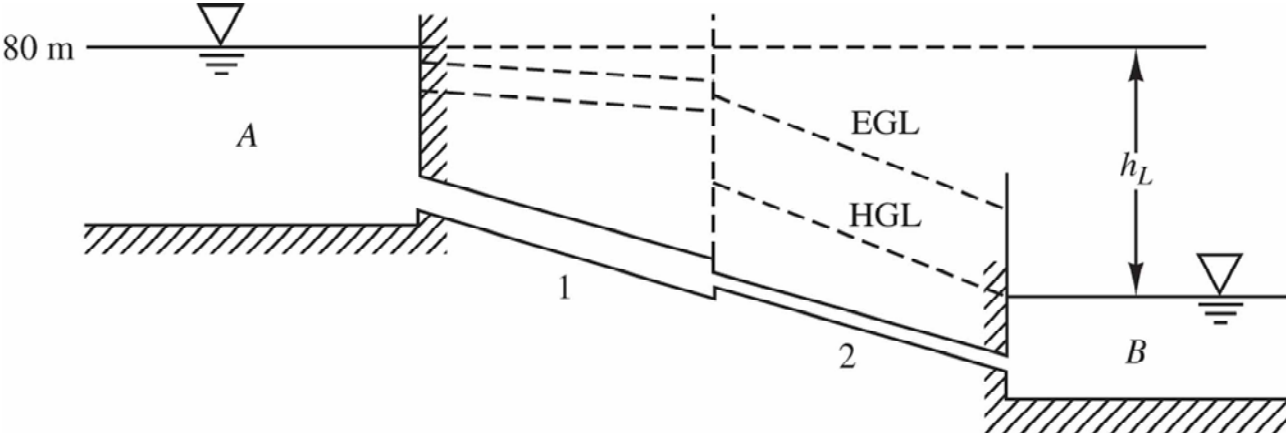
The energy grade line (EGL) gives a visual picture of energy loss/gain in the system. Where is most of the head loss occurring? Something important to an engineer

Hydraulic Grade Line: $z+p/\rho g$ which is one pressure head away from the pipe; as such it gives a visual measure of the pressure in the system; pressures too high rupture pipes and exacerbate leaks

Negative pressure can lead to cavitation

On the figure below, explain large pipes, small pipes, friction slope

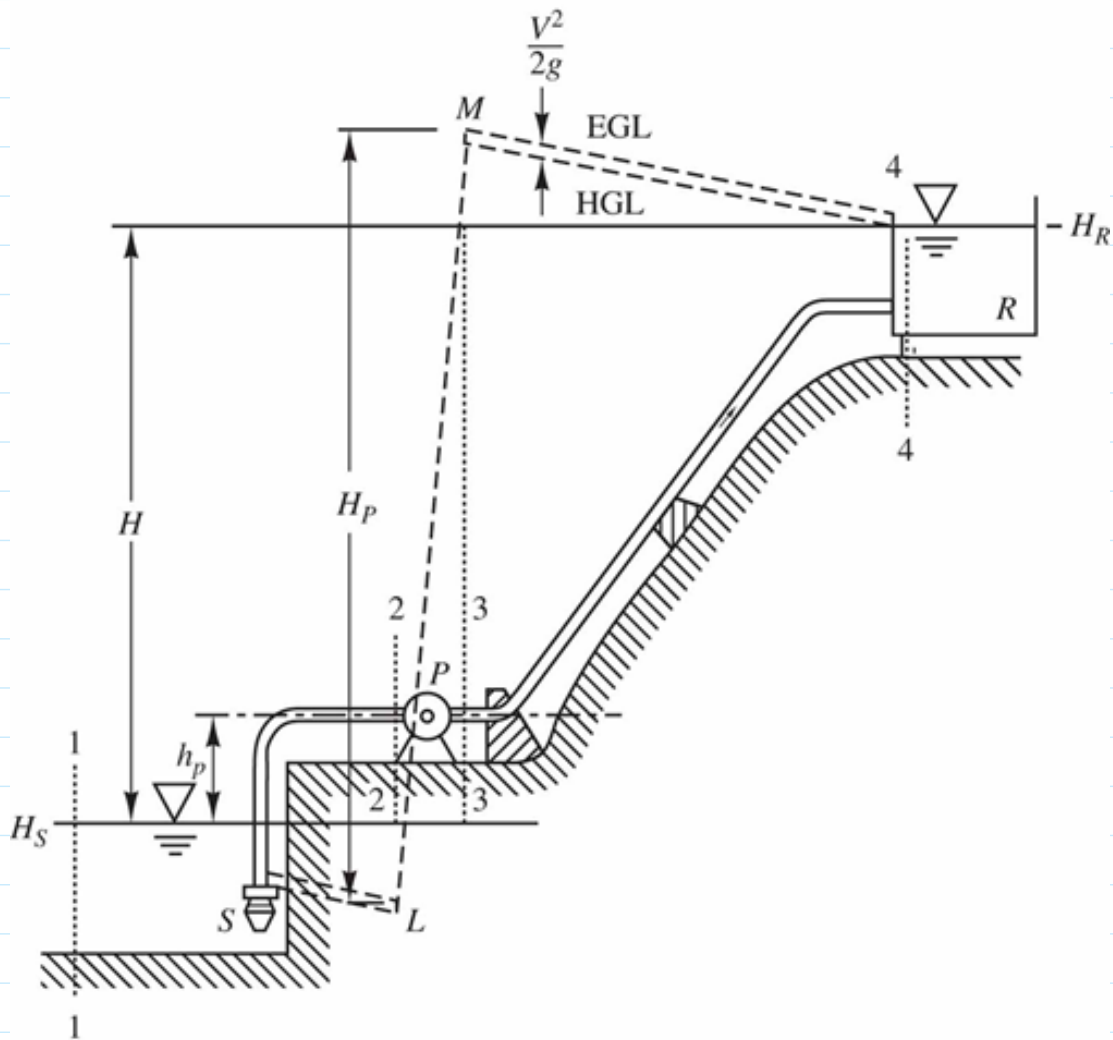
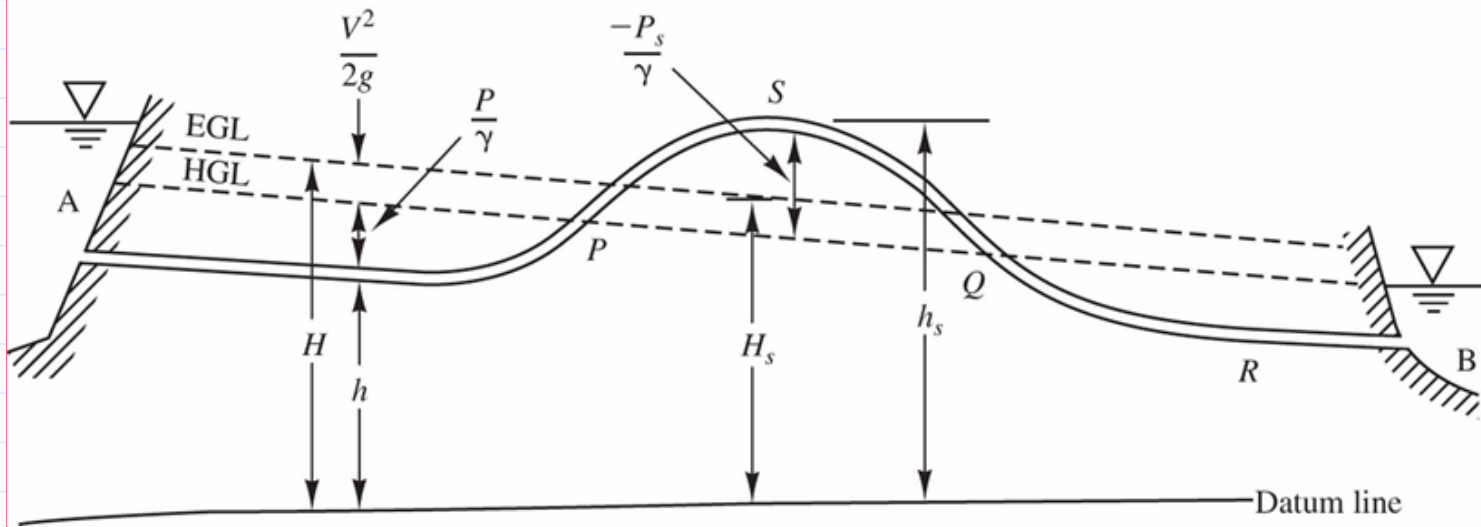
Figure 4.1



EGL, HGL examples

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Negative pressure

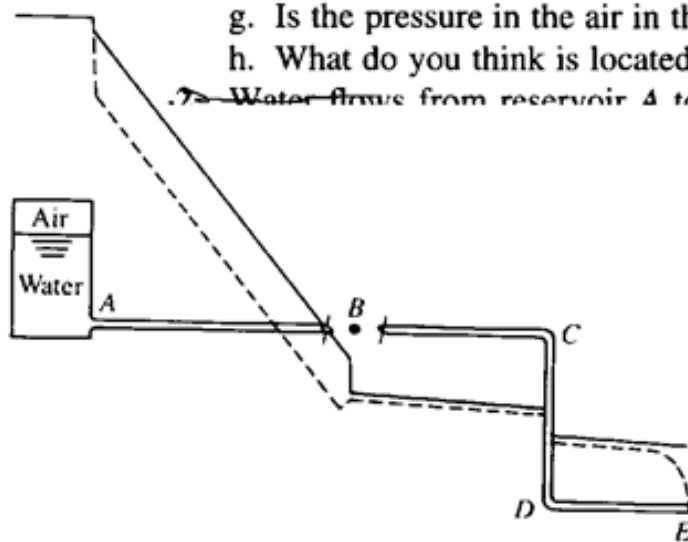


Class exercise

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PROBLEMS

5-1 a. Shown below are the HGL and EGL for a pipeline. Indicate which is the HGL and which is the EGL.



g. Is the pressure in the air in the tank above or below atmospheric pressure?

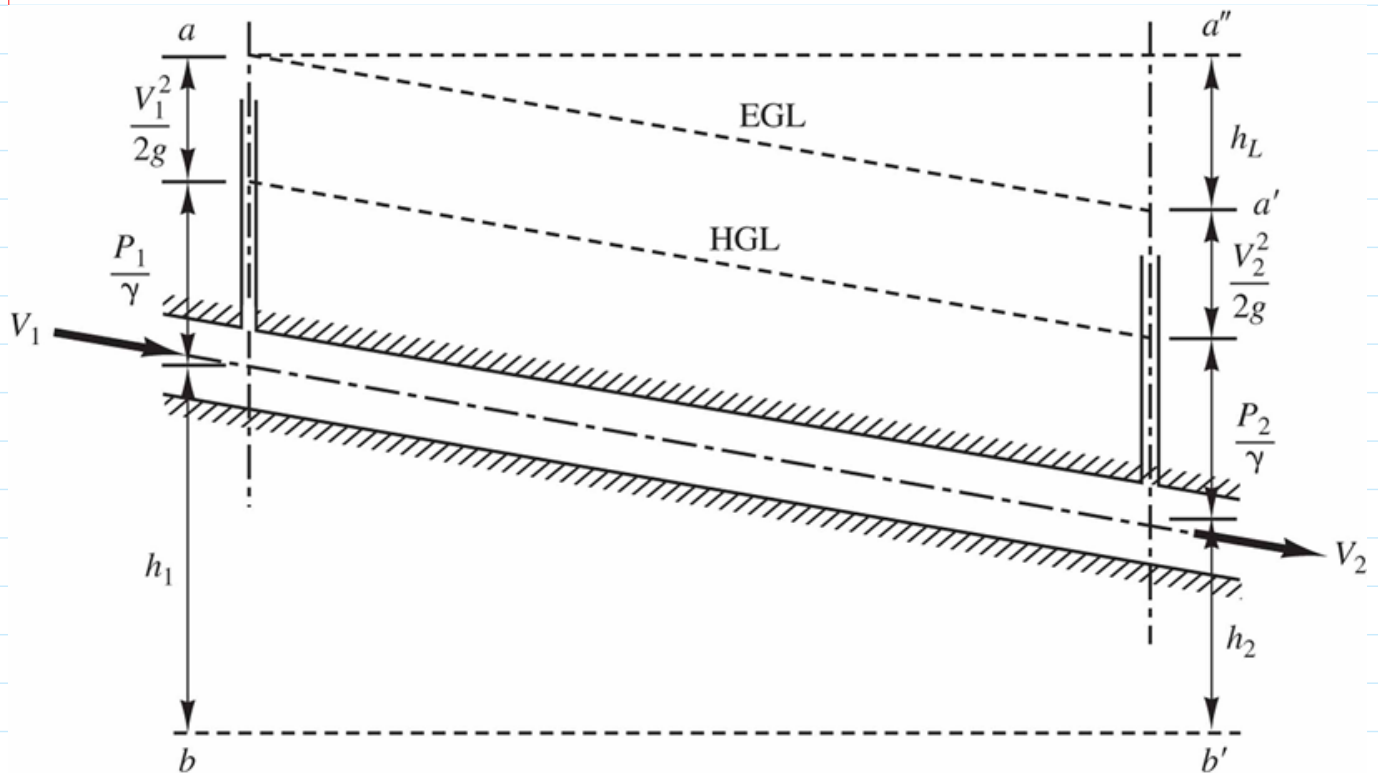
h. What do you think is located at point B?

~~Water flows from reservoir A to B. The water temperature in the system is 10°C.~~

- Are all pipes the same size? If not, which is the smallest?
- Is there any region in the pipe where the pressure is below atmospheric pressure? If so, where?
- Where is the point of maximum pressure in the system?
- Where is the point of minimum pressure in the system?
- What do you think is located at the end of the pipe at point E?

EGL, HGL

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Question: the standpipes do not capture any of the velocity head; how far does the water rise in the pipes?

Energy Grade Line = total energy per unit weight of the water in the system at any point drawn relative to the centerline of the pipe

Hydraulic Grade Line = elevation + pressure heads drawn from the centerline of the pipe, as such the height of the HGL from the pipe represents the pressure head

Energy Equation

Bernoulli's equation written using pressure and elevation heads is

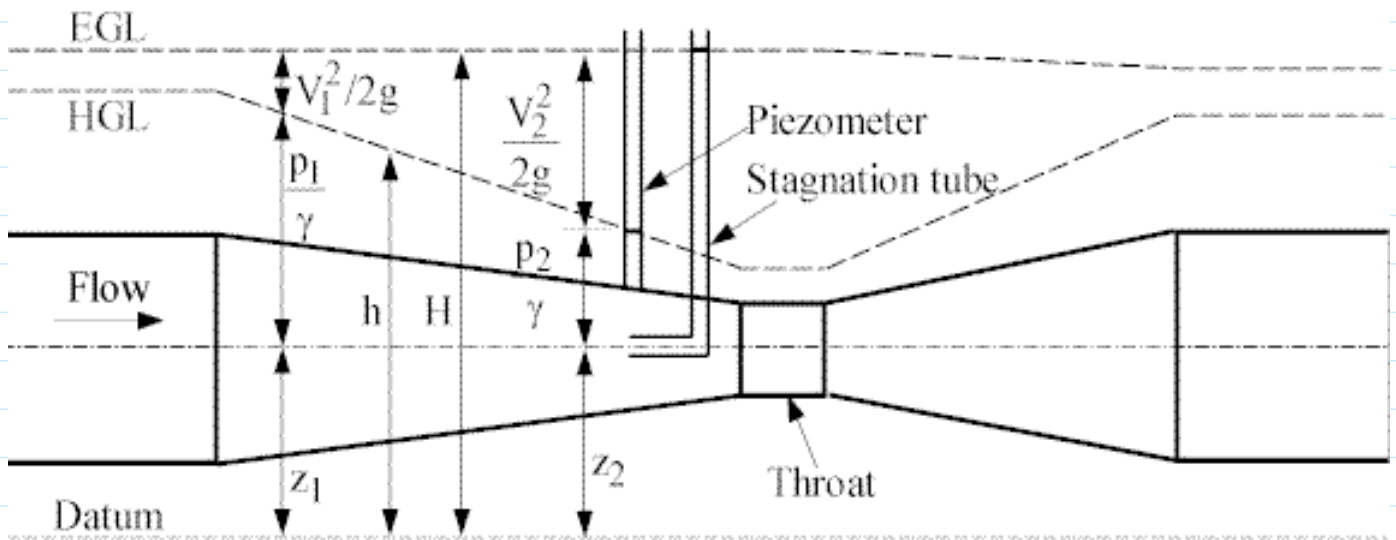
$$\frac{V_1^2}{2g} + \frac{p_1}{\gamma} + z_1 = \frac{V_2^2}{2g} + \frac{p_2}{\gamma} + z_2 = \text{constant}$$

Bernoulli's equation is the energy equation we use in Hydraulic Engineering minus the head loss term.

Head terms

Head	Terms	Grade line and position
elevation head	z	centerline of pipe
pressure head	$\frac{p}{\gamma}$	between centerline of pipe and HGL
velocity head	$\frac{V^2}{2g}$	between EGL and HGL
piezometric head	$h = \frac{p}{\gamma} + z$	HGL
total head	$H = \frac{V^2}{2g} + \frac{p}{\gamma} + z$	EGL

Since all of these heads have dimensions of length, they can be shown on a drawing or sketch (Fig. 4.1) that is drawn to correspond to physical dimensions. For flow in a pipe, z is usually taken to be the elevation of the centerline of the pipe. A *hydraulic grade line* (HGL) can be drawn to show the variation of the piezometric head. The distance from the centerline of the pipe to the HGL is the pressure head. An HGL above a pipe corresponds to positive pressure while an HGL below the centerline means that the pressure is negative. An *energy grade line* (EGL) shows the variation of the total head. Since the difference between the total head and the piezometric head is the velocity head, the distance between the EGL and the HGL is also the velocity head. (The flow disturbance and the internal shear in the expansion are large enough that Bernoulli's equation does not apply. The result is a decrease in the Bernoulli constant as the flow goes through the expansion. These effects will be discussed further in conjunction with the energy equation and flow in conduits.)



Schematic diagram

Fig. 4.1 - Experimental Apparatus to Illustrate Bernoulli's Equation and Grade Lines

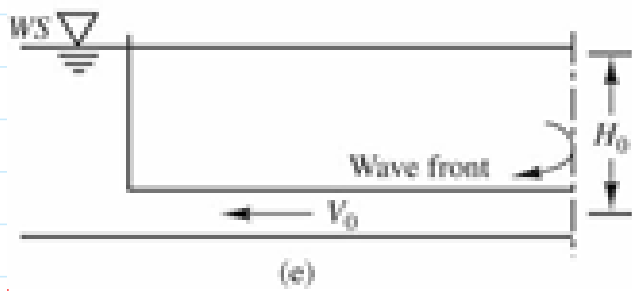
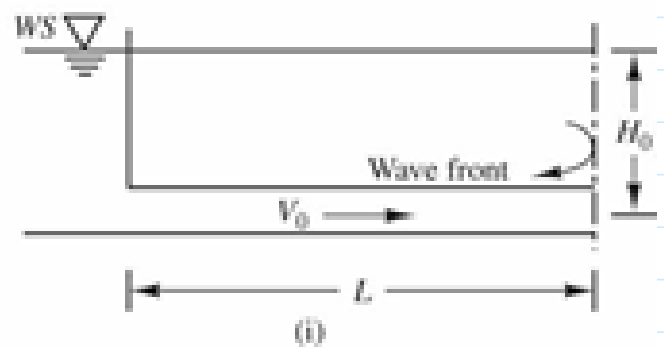
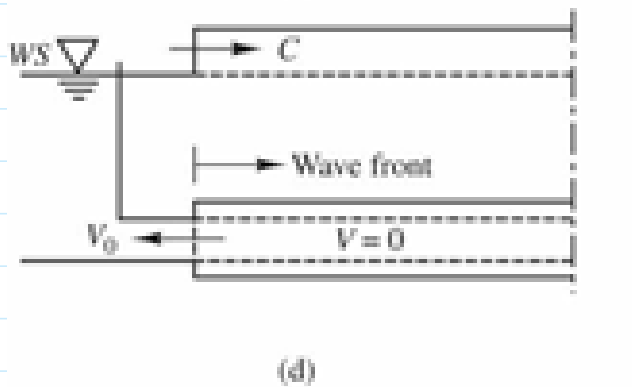
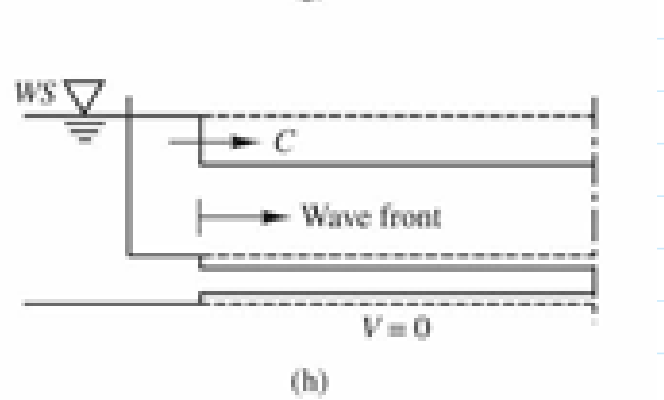
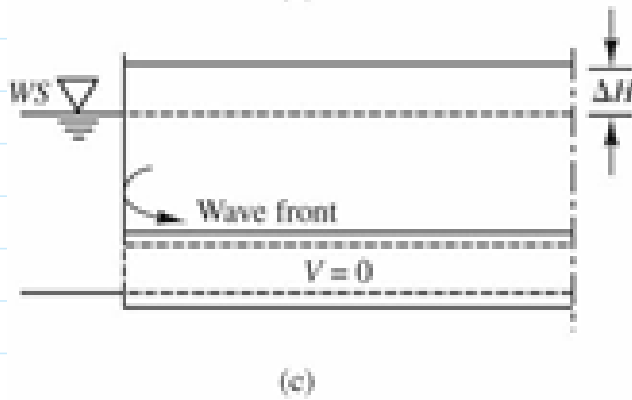
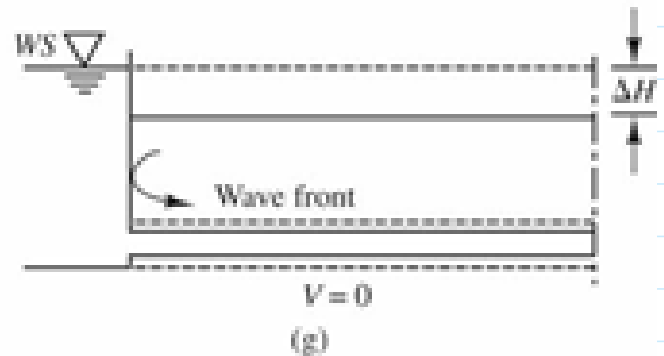
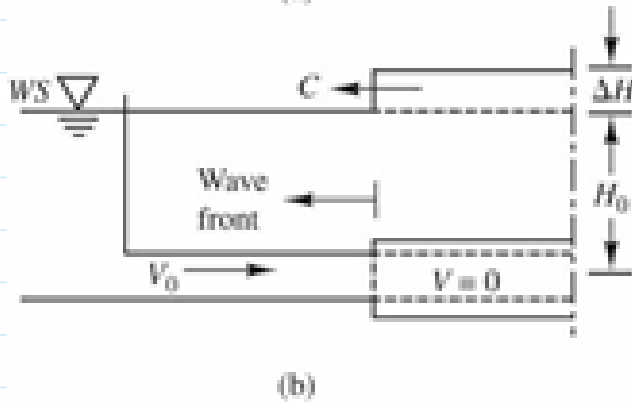
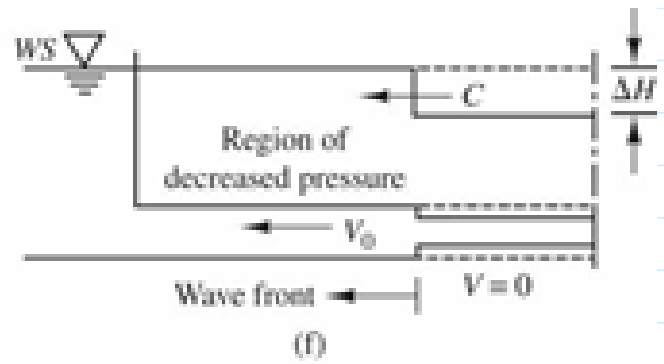
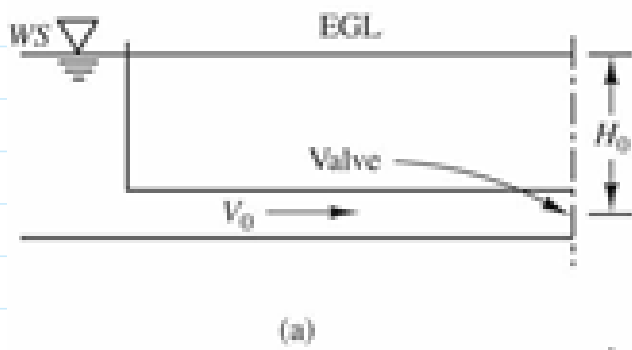
Draw the rise of the water into the piezometer and stagnation tube. If the stagnation tube is 10 cm long in the vertical direction, how fast is the water flowing through the system (assuming the drawing is to scale)? Where is the water flowing most rapidly?, Most slowly? Where is pressure the greatest? Where is pressure the lowest?

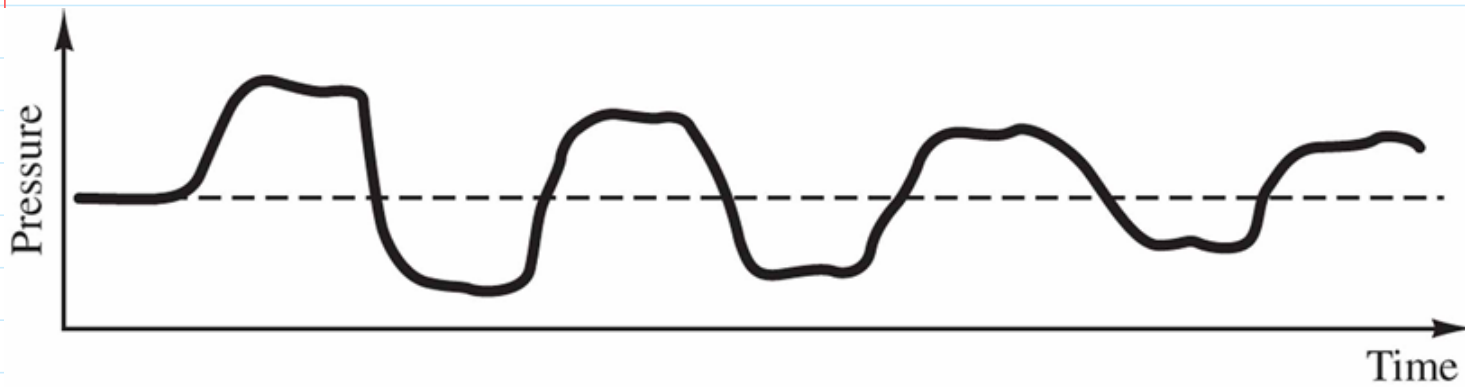
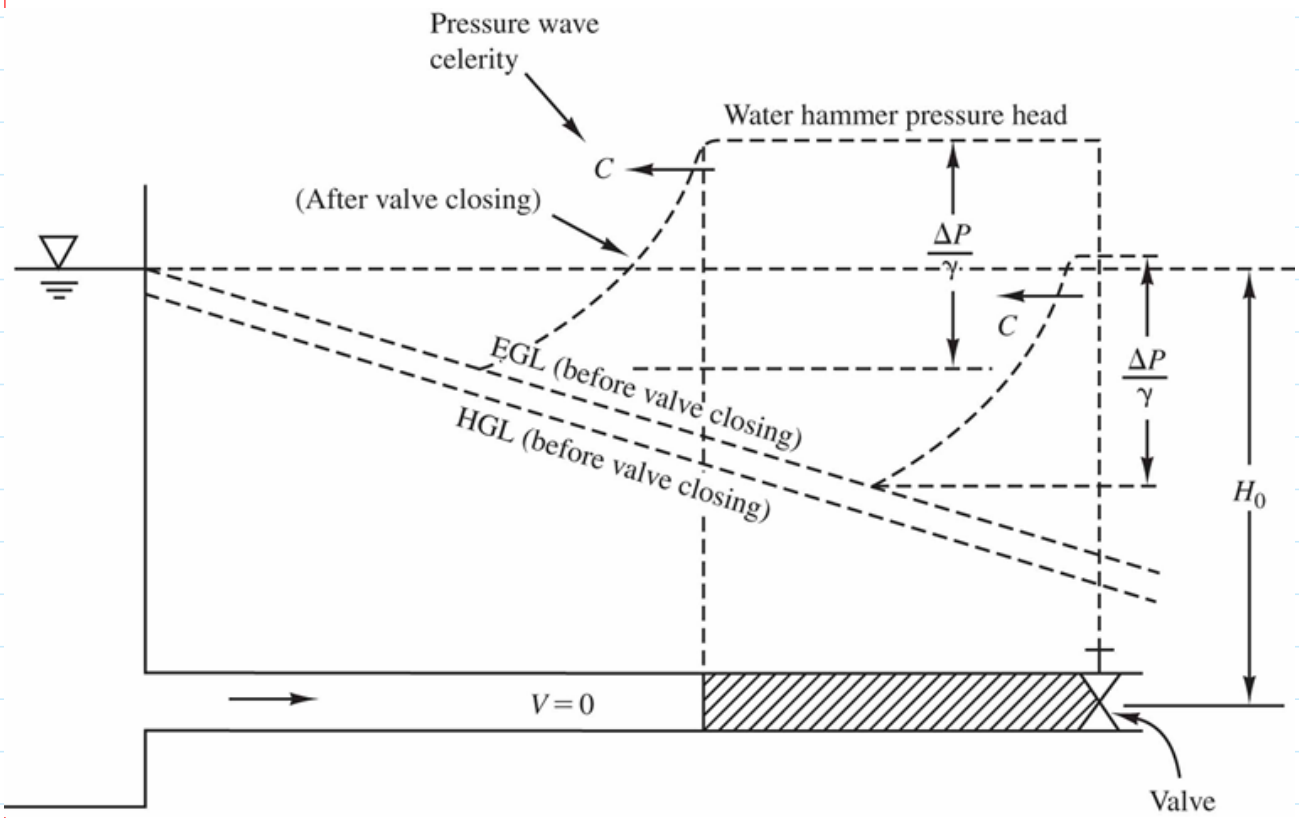
If velocity in the pipe changes, where does the energy come from?

How much head loss occurs in the system?

Water Hammer

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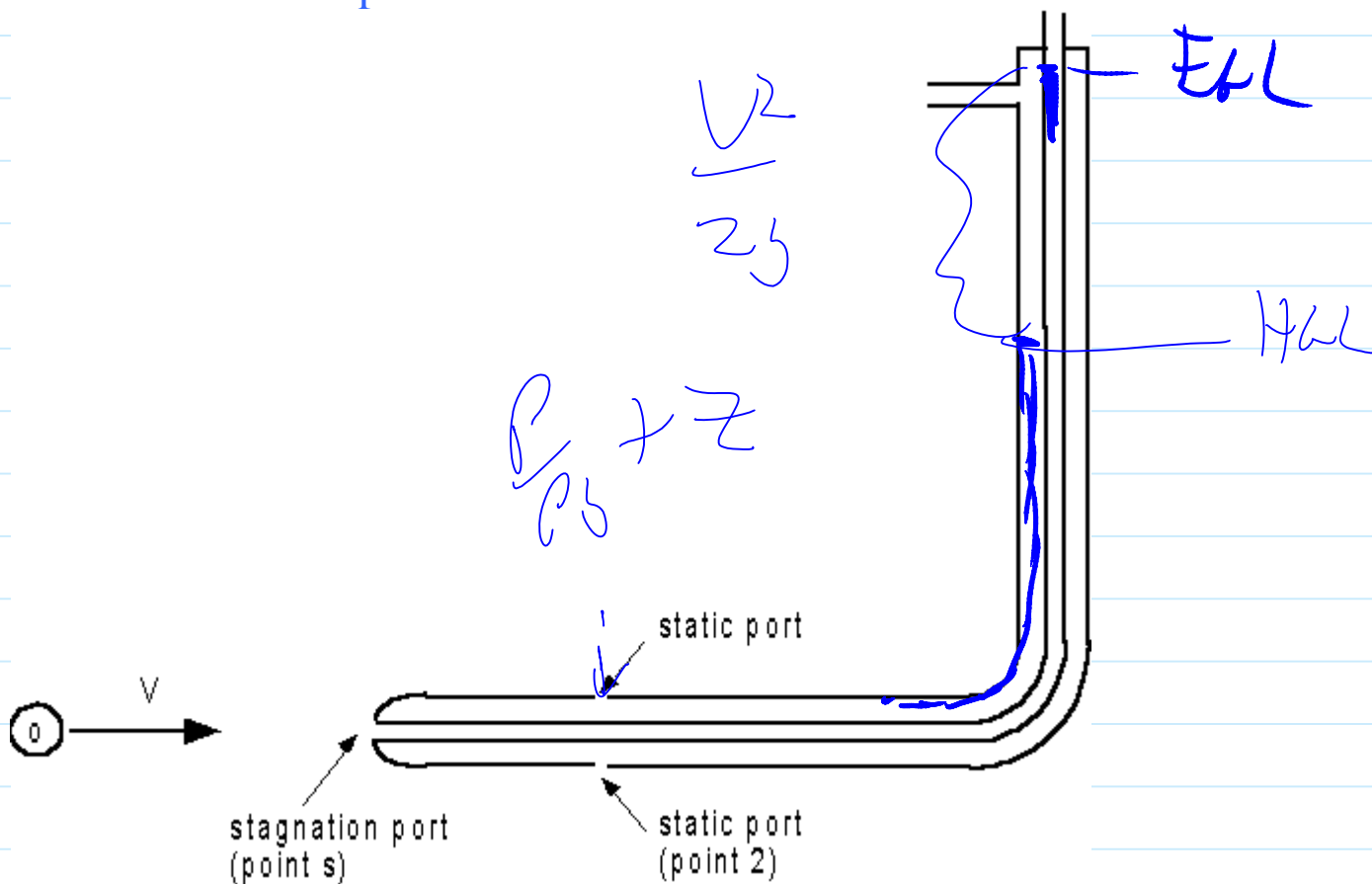


Pitot Tube

Monday, September 03, 2007
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Pitot Tube

The first piece of apparatus is a Pitot tube, which is shown schematically in Fig. 4.2. A Pitot tube is two concentric tubes. The inner tube is open at the front of the Pitot tube. This opening is called the stagnation port; it measures the total head. The outer tube is the static tube, which has a few openings on the side of the Pitot tube to measure the static (or piezometric) head. Both the stagnation tube and static tube have tubing connections at the top of the Pitot tube. A differential manometer connected to the two tubing connections will measure the difference between the two heads, i.e., it will measure the velocity head, which is the difference between the total head and the piezometric head.



Velocity is a vector, the static port does not measure the velocity head whereas the stagnation point does. The difference in water levels between the two is the velocity head. Measurement of the velocity head allows

whereas the stagnation point does. The difference in water levels between the two is the velocity head. Measurement of the velocity head allows calculation of the velocity.

Class Exercise:

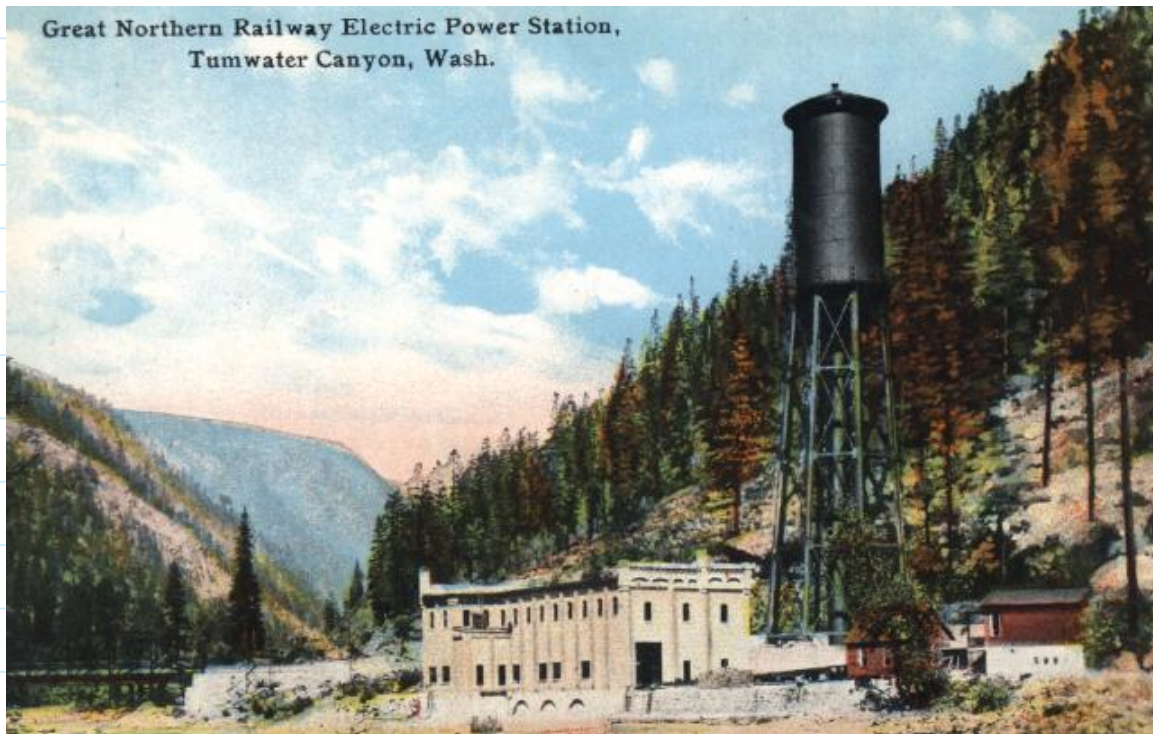
If the velocity head is 0.5 m, estimate the velocity

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Surge Tank

Monday, September 10, 2007
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Surge tanks can harness the forces produced when a valve closes



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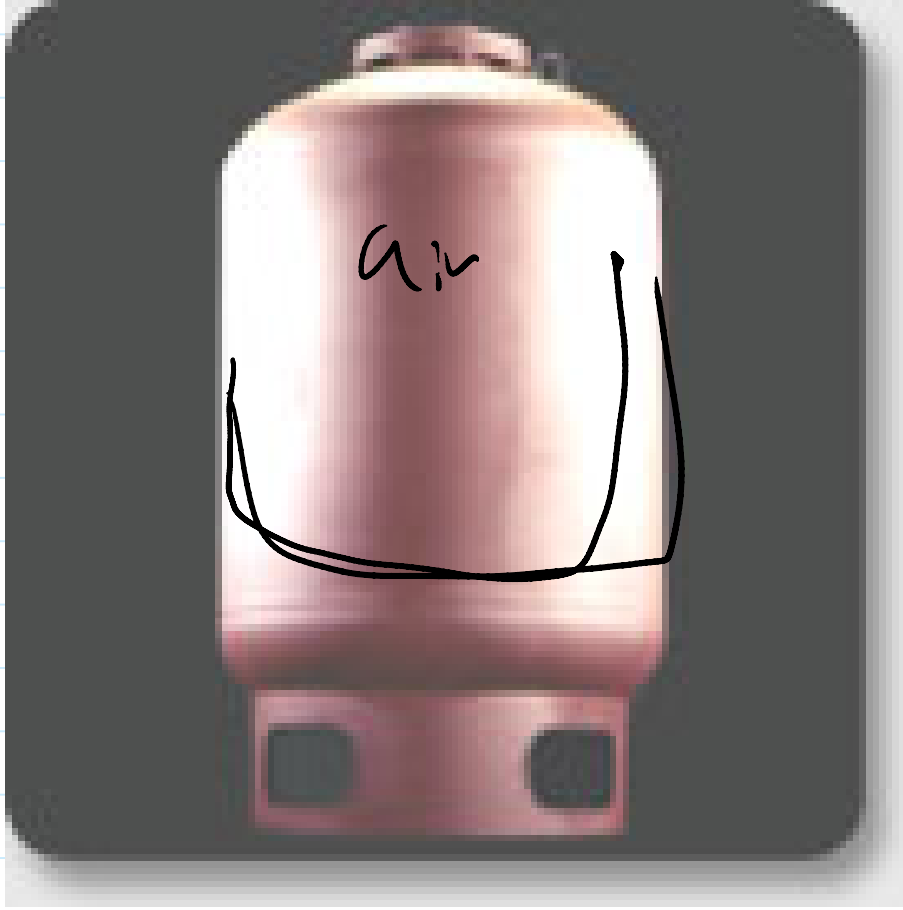
The stucco-covered brick powerhouse and surge tank were built about a mile below the dam in Tumwater Canyon with a large pipeline carrying water under pressure from the reservoir to the tank. Three turbines drove generators that converted water power to electricity.

Pasted from <http://www.gngoat.org/tumwater_canyon.htm>

When the turbines are suddenly shut off a water hammer could occur and rupture pipes. The surge tank prevents the sudden change in water pressure. The surge tank is either at atmospheric pressure (as in this

example) or has trapped air

Shock & Surge Tanks



Shock and Surge Tanks are ASME replaceable bladder type pre-charged hydropneumatic tanks for commercial, industrial, municipal and well water systems, to effectively control water hammer shock, and pump start-up/shot-down water surge. The vessels are fabricated to 250 PSI with large water system connection designed to accept potentially harmful water surge pressures quickly, with minimal pressure drop. The water is contained in a butyl bladder.

Shock & Surge Tank Models

SSA Shock & Surge Tanks (ASME)

The SSA Series Shock Arrestors are manufactured to ASME specifications and are rated to 240°F and 250 PSI. Tanks are factory pre-charged to 30 PSI and field

adjustable and are offered in sizes ranging from 10 to 660 gallons.