Part 1. Flow Measurement Devices

1. What are common devices used to measure flow in a pipe flow network?

Piot, Venturi, Nozzle, Orifice

1. What is the difference between the flow measurement devices discussed in class?

How much frictional losses occur due to each one

1. What is a discharge coefficient and why is it used?

It is a variable that is used to account for different geometries for flow devices. Specifically used for Venturi, Nozzle, and Orifice meters. For square orifice meters with Reynolds numbers over 2000, cd is 0.61

1. Identify the standard pressure tap locations for a given flow measurement device.

For Venturi, it is in the narrow section. For nozzle it is upstream ans downstream. For Orifice meters, there are four possible locations: 1 inch on each side, D and D/2, corner taps, and 2 ½ D and 8D taps

1. What are the governing equations for using these flow measurement devices?

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1. What are the applicable ranges over which the constants for these equations can be used?

Look at table 10.2 or slide 79

Part 2. Pump Sizing

1. What is the difference between a positive displacement pump and a centrifugal pump?

Positive displacement pumps have constant flow rates but variable pressures. Centrifugal pumps have constant pressures but variable flow rate

1. Label key parts of a centrifugal pump (inlet/suction, suction eye, impeller, volute, outlet/discharge).

Diagram of a diagram of a turbine

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1. Identify kinetic and pressure energy transitions at various locations of a centrifugal pump.

A graph with lines and text

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1. How is basic pump sizing performed?

Finding the pump head required for a flow rate and choosing the pump that will achieve that with the lowest power requirements

1. How do you calculate pump head?

Solving Bernoulli’s equation for neg ws and dividing by g

1. What is pump efficiency and how is it calculated?

The ratio of the power of the pomp compared to the power of the motor needed to power the pump. It is usually found on a pump chart

1. How is pump power calculated?

Brake horsepower is calculated using the formula below. If your fluid is water, you can use the pump chart values

A math problem with numbers and symbols

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1. What is BHP and how is it calculated? Pump power is BHP
2. What is the Best Efficiency Point of a pump?

The flow rate and pump head such that the efficiency of the pump is the highest

1. What is maximum suction lift and how can it be calculated?

Maximum height a pump can be stationed above a fluid to avoid cavitation

A math equation on a white sheet

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1. What is cavitation? Is cavitation good or bad? Why?

It is when your pressure in the pipe is lower than that of the liquid’s vapor pressure, so gas starts forming; bad; because it will damage the pump

1. What is net positive suction head (NPSH)?

The minimum pressure head required at the suction port to prevent cavitation

1. What is the System Operating Line of a pipe flow network?

A graph that maps the required pump head for a flow rate in a pipe system

1. Identify the various aspects of a pump performance chart.

A graph with lines and numbers

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1. How do you specify a pump based on the system requirements of a given pipe flow network?

Always go up

Part 3. Flow in Porous Media

1. What is porosity and how is it defined?
2. What are the superficial and interstitial velocities?
3. What is the hydraulic diameter for a porous medium composed of spherical particles?
4. How do you determine the friction factor for flow through a porous medium?
5. How do you determine the Reynolds number through a porous medium?
6. What equations can be used to describe friction loss in porous media and when are they applicable?
7. What is the difference between the Blake-Kozeny and the Carman-Kozeny equations?
8. What is permeability?
9. What is Darcy’s law?
10. What are the key parameters determining flow resistance in a filtration system?
11. What is the basic equation governing filter performance?

Part 4. Particle Flow

1. What is the difference between internal and external flows?
2. What is drag force, what are the components that comprise it? How is it calculated?
3. What is Stokes Law and when is it applicable?
4. What is relative velocity and how is it determined?
5. How do you determine the Reynolds number for particle flow?
6. What is the boundary layer?
7. For particle flow, label the relevant flow zones around the particle.
8. What equations can be used to calculate the drag coefficient for particle flow?
9. Label the various regimes of the drag coefficient vs. Reynolds number diagram?
10. What is Archimedes Number and how is it calculated?
11. How do you calculate the necessary fluid velocity needed to suspend a particle?

Part 5. Fluidization

1. What does it mean when a bed of solid particles is said to be “fluidized”?
2. What is meant by incipient fluidization?
3. How do you determine the pressure drop needed to fluidize a bed of solid particles?
4. How do you calculate the minimum superficial fluid velocity needed for incipient fluidization?
5. How do you calculate the superficial fluid velocity required to sweep the particle bed away?
6. How do you determine the effective particle diameter for non-spherical particles?

Part 6. Two-Phase Pipe Flow (Liquid—Solid and Gas—Liquid)

1. What is a slurry?
2. The maintenance of a liquid-solid suspension is dependent on a number of different factors. Identify these factors.
3. What is the difference between a homogeneous and heterogeneous slurry flow?
4. For homogeneous slurry flow, how is the density of the slurry mixture determined?
5. For homogeneous slurry flow, what is the importance of solids concentration on how the viscosity of the slurry mixture is determined?
6. How do you determine the Reynolds number for a homogeneous slurry flow?
7. How do you determine the Fanning friction factor for homogeneous slurry flows?
8. For heterogeneous slurry flow, identify the various flow regimes in a pressure gradient versus average mixture velocity flow curve.
9. What is the minimum deposit velocity and how is it calculated?
10. How is the particle terminal velocity calculated?
11. How is the particle friction velocity calculated?
12. What is the criterion for a non-settling particle in a suspension?
13. What is the Froude Number and how is it calculated for a particle?
14. For heterogeneous fluid-particle flow in a horizontal pipe, how is the total pressure drop for the mixture determined?
15. For heterogeneous fluid-particle flow in a horizontal pipe, how is the dimensionless slip velocity determined?
16. What are the relevant fluid and flow parameters associated with two-phase gas-liquid flows?
17. What impact does pipe orientation have on gas-liquid flow in a pipe?
18. If given a general diagram of a gas-liquid phase distribution within a section of pipe could you identify its associated flow regime?
19. What is the purpose of a flow regime map for gas-liquid flows?
20. What is the difference between the phase holdup and the no-slip phase holdup of a gas-liquid flow?
21. What is flow quality and how is it determined?
22. What are some common correlations used in determining phase holdup and pressure gradients in pipes containing gas-liquid flows?
23. How do you determine the Froude Number of a gas-liquid mixture flow in a pipe?