Instrumentation
Flow

Course Objectives

1. Define fluid flow, flow rate, and total flow, and give common units for each.
2. Describe direct and indirect flow measurement and give common applications.
3. Identify common types of instruments for measuring flow including: rotameter; weight feeders, flow transmitters using Venturi tube, flow nozzle, pipe elbow, pitot tube, annubar, and orifice plate sensing elements; and flow meters using target flow device using magnetic, vortex, turbine, mass, ultrasonic, Coriolis, and positive displacement principles.
4. Describe the operation of common flow measurement instruments.
5. Describe typical applications for common flow measurement instruments.
6. Describe safety concerns for common flow measurement instruments.
7. Describe typical malfunctions for common flow measurement instruments.
8. Identify common flow instrument symbols on P&IDs.
9. Measure flow using concepts and principles of measurement for common instruments.
10. Solve common problems encountered when using flow measurement instruments.

Key Terms (Define the following)

fluid movement - _____

_____

Bernoulli's Principle - _____

_____

orifice plate - _____

_____

pitot tube - _____

_____

rotameter - _____

_____

ultrasonic flow meter - _____

_____

Principles

Flow Instrumentation Categories				
Pressure - based	**Positive displacement**	**Velocity-based**	**Mass**	**Solid material**
Orifices	Nutating disc	Turbine	Coriolis	Weighfeeder
Venturi	Oval gear	Vortex	Thermal mass	
Flow nozzles	Rotary vein	Electromagnetic		
Elbow				
Pitot				
Averaging pitot/ Anubar				
Target flow				
Variable flow area (rotameter)				

Applications	Liquid					Gas		
Flow Instrument	**Clean**	**Dirty**	**Viscous**	**Corrosive**	**Slurry**	**Clean**	**Dirty**	**Steam**
Orifice plate	●	○	○	○	○	●	○	●
Venturi tube	●	◒	○	◒	◒	●	◒	◒
Flow nozzle	●	◒	○	◒	○	●	◒	◒
Pipe elbow	●	●	○	◒	◒	●	○	●
Pitot tube	●	○	○	◒	○	●	○	●
Target flow	●	●	●	◒	○	●	●	○
Variable area	●	◒	◒	◒	○	●	○	○
Nutating disc	●	◒	●	◒	○	●	○	○
Oval gear	●	◒	●	◒	○	●	○	○
Rotary vein	●	◒	●	◒	○	●	○	○
Turbine	●	○	○	◒	○	●	○	○
Vortex	●	◒	○	◒	○	●	◒	○
Electromagnetic	●	●	●	●	●	○	○	○
Ultrasonic	◒	●	◒	●	●	○	○	○
Thermal mass	◒	○	◒	○	○	●	○	○
Coriolis	●	●	●	◒	●	◒	◒	◒

Pressure Positive Diplacement Velocity Mass ● Yes ◒ Maybe ○ No

Questions

1. The variety of flow meters and flow transmitters you will see in the field can be categorized by the
   - ☐ temperature scale used
   - ☐ type of process material being measured
   - ☐ viscosity range
   - ☐ method they use to measure flow

2. A measure of how much volume of a fluid is moving past a certain location during a unit of time is called _____ flow.

3. List four pressure-based flow instruments.
   1) _____
   2) _____
   3) _____
   4) _____

4. The Venturi tube has a _____ shaped inlet and outlet.
   - ☐ Triangular
   - ☐ Smooth cone
   - ☐ Smooth D

5. What does a flow nozzle use to restrict fluid flow?

   _____

   _____

   _____