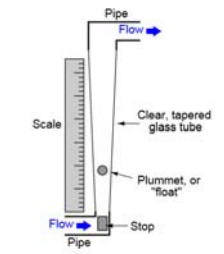

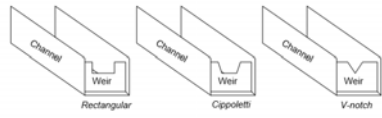
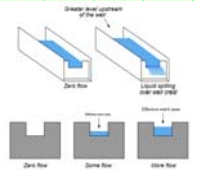



		1
<h1 style="margin: 0;">Flow Measurement</h1> <p style="margin: 0;">Daniel Kohn University of Memphis TECH 3821 Fall 2015</p>		

	Rotameter	2
	<ul style="list-style-type: none"> Variable area flowmeter (aka rotameter) <div style="display: flex; align-items: center; justify-content: center;">   </div>	

	Weir and Flume	3
	<ul style="list-style-type: none"> Variable area flowmeter used to measure flow rate through open channels (like irrigation ditches) <div style="display: flex; align-items: center; justify-content: center;">    </div>	

	Pressure Based	4
○	<p style="text-align: center;">Constriction in the pipe causes a linear acceleration. The Pressure Differential is then used to calculate flow.</p>	

	Pressure Based	5
○	<ul style="list-style-type: none"> Another method of pressure based flow measurement is to cause a deceleration (negative acceleration) 	

	Installation	6
○	<ul style="list-style-type: none"> Proper Installation Consideration <ul style="list-style-type: none"> Necessary Upstream and downstream straight pipe lengths Beta ratio (ratio of orifice boar diameter to pipe diameter) Impulse tube tap locations Tap Finish Transmitter location in relation to pipe 	

7

Large-scale disturbances

Fluid flow

Velocity profile

Straight pipe length

Fluid flow

Velocity profile

Velocity profile

Velocity profile

Proper mounting position for measuring gas flow

Pipe

Proper mounting position for measuring liquid flow

Velocity Based

8

The Law of Continuity for fluids states that the product of mass density (ρ), cross-sectional pipe area (A) and average velocity (\bar{v}) must remain constant through any continuous length of pipe:

$\rho_1 A_1 \bar{v}_1$ $\rho_2 A_2 \bar{v}_2$ $\rho_3 A_3 \bar{v}_3$

Turbine Flowmeters

9

- Use a free spinning turbine wheel to measure fluid velocity (much like a windmill)


Cable

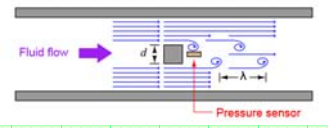
Turbine blades



Turbine wheel

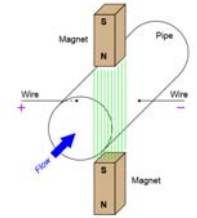
Fluid flow

Turbine shaft

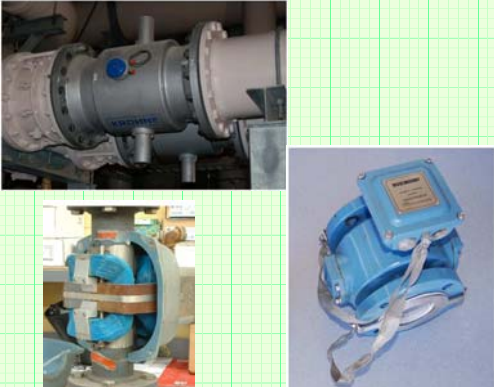
	Paddlewheel Flowmeter	10
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<input type="radio"/>		

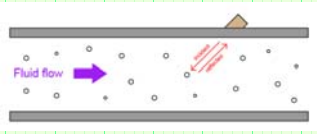
	Vortex	11
<input type="radio"/>	<ul style="list-style-type: none">When a fluid passes a stationary object, there is a tendency for the fluid to form vortices on either side of the object.	
		
<input type="radio"/>	<ul style="list-style-type: none">These vortices can be detected using pressure sensors and are relative to the fluid flow	

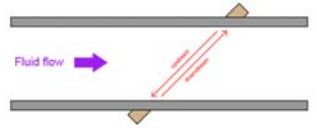
	Vortex	12
<input type="radio"/>		
<input type="radio"/>		

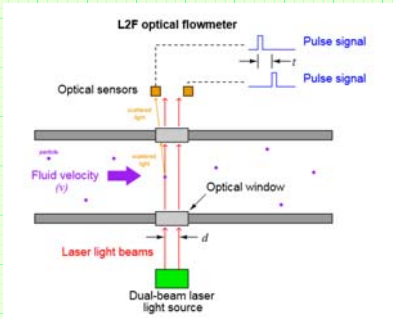
		Magnetic Flowmeters	13
○	<ul style="list-style-type: none"> The direction of liquid flow cuts perpendicularly through the lines of magnetic flux, generating a voltage along an axis perpendicular to both. Metal electrodes opposite each other in the pipe wall intercept this voltage, making it readable to an electronic circuit. 		
○			


		Mag Flow	14
○	<ul style="list-style-type: none"> Considerations The liquid must be a reasonably good conductor of electricity The pipe must be completely filled with liquid to ensure contact with both probes as well as to ensure flow across the entire cross-section of the pipe The flowtube must be properly grounded to avoid errors caused by stray electric currents in the liquid 		
○			

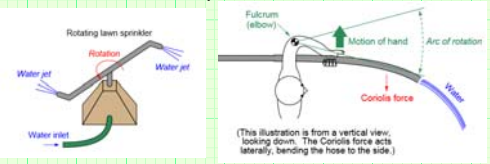
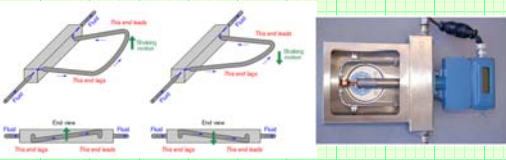
		Mag Flow	15
○			
○			

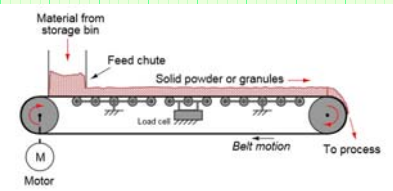
	Ultrasonic	16
○	<ul style="list-style-type: none"> Ultrasonic flowmeters use the Doppler effect (measuring the frequency shift on the sound to measure velocity) 	
○		

	Transit Time	17
○	<p>Transit-time flowmeters, sometimes called counterpropagation flowmeters, use a pair of opposed sensors to measure the time difference between a sound pulse traveling with the fluid flow versus a sound pulse traveling against the fluid flow. Since the motion of fluid tends to carry a sound wave along, the sound pulse transmitted downstream will make the journey faster than a sound pulse transmitted upstream¹⁰.</p>	
○		

	Optical Flowmeters	18
○		
○		

	Positive Displacement	19
○	<ul style="list-style-type: none"> • Passes a fixed volume of fluid though with every cycle. 	
○		

	Coriolis Flowmeter	20
○	<ul style="list-style-type: none"> • Works similar to a sprinkler 	
	 <p>(This illustration is from a vertical view, looking down. The Coriolis force acts laterally, bending the hose to the side.)</p>	
○	<p style="text-align: center;">Practical Coriolis Flowmeter</p> 	

	Weight feeders	21
○		
○	