Flowmeters

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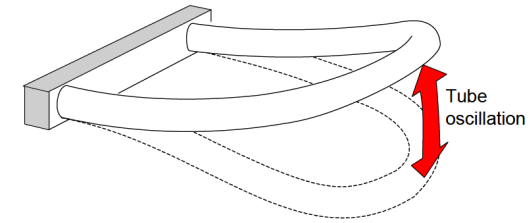
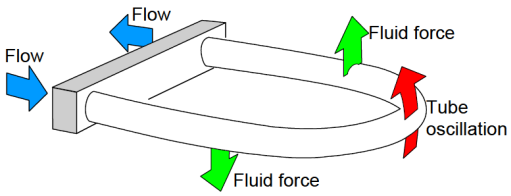
Coriolis Flowmeter

- Coriolis mass flowmeters measure the force resulting from acceleration caused by mass moving toward (or away from) a center of rotation.
- Example: When riding a merry-go-round, a person moving toward or away from the center experiences a force.
- The effect can be demonstrated by flowing water in a loop of flexible hose that is “swung” back and forth in front of the body with both hands.
- Because water is flowing towards and away from the hands, opposite forces are generated, which cause the hose to twist.
- In a Coriolis mass flowmeter, the “swinging” is generated by vibrating the tube(s) in which the fluid flows.
- The amount of twist is proportional to the mass flow rate of fluid passing through the tube(s).
- Sensors and a Coriolis mass flowmeter transmitter are used to measure the twist and generate a linear flow signal.

http://www.flowmeters.com/coriolis-mass-technology

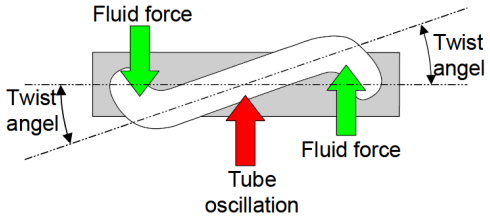


Oscillatory motion applied to a single tube



Forces acting on the tube as a result of fluid flow

www.instrumentationtoolbox.com



The complete loop is twisted by an amount that is directly and linearly to the mass flow rate of the fluid

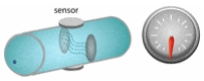
Coriolis Flowmeter

- Coriolis mass flowmeter represent about 21% of all flowmeters sold.
- Use with petroleum liquids and natural gas both compressed and liquefied. Also, with water, acids, caustic, chemicals, and gases/vapors.
- Because mass flow is measured, the measurement is not affected by fluid density changes
- The cost is high, especially for line sizes above four inches.
- Pressure drop can be a consideration for “U” shaped tube designs and high viscosity fluids.

http://www.flowmeters.com/coriolis-mass-technology

Magnetic Flowmeter

- Magnetic flowmeters use Faraday's Law of Electromagnetic Induction to determine the flow of liquid in a pipe.
- In a magnetic flowmeter, a magnetic field is generated and channeled into the liquid flowing through the pipe.
- Following Faraday's Law, flow of a conductive liquid through the magnetic field will cause a voltage signal to be sensed by electrodes located on the flow tube walls.
- When the fluid moves faster, more voltage is generated. Faraday's Law states that the voltage generated is proportional to the movement of the flowing liquid.
- The electronic transmitter processes the voltage signal to determine liquid flow.



http://www.flowmeters.com/magnetic-technology

Magnetic Flowmeter

- In contrast with many other flowmeter technologies, magnetic flowmeter technology produces signals that are linear with flow.
- As such, the turndown associated with magnetic flowmeters can approach 20:1 or better without sacrificing accuracy.
- They represent about 23% of all flowmeters sold.

http://www.flowmeters.com/magnetic-technology

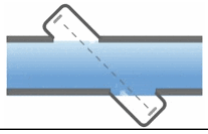
Magnetic Flowmeter

- Magnetic flowmeters measure the velocity of conductive liquids in pipes, such as water, acids, caustic, and slurries.
- Magnetic flowmeters can measure properly when the electrical conductivity of the liquid is greater than approximately 5µS/cm.
- This flowmeter does not obstruct flow, so it can be applied to clean, sanitary, dirty, corrosive and abrasive liquids.
- Magnetic flowmeters can be applied to the flow of liquids that are conductive, so hydrocarbons and gases cannot be measured with this technology due to their non-conductive nature and gaseous state, respectively.
- Magnetic flowmeters do not require much upstream and downstream straight run so they can be installed in relatively short meter runs.
- Magnetic flowmeters typically require 3-5 diameters of upstream straight run and 0-3 diameters of downstream straight run measured from the plane of the magnetic flowmeter electrodes.

Ultrasonic flowmeters

- Ultrasonic flowmeters use sound waves to determine the velocity of a fluid flowing in a pipe.
- At no flow conditions, the frequencies of an ultrasonic wave transmitted into a pipe and its reflections from the fluid are the same.
- Under flowing conditions, the frequency of the reflected wave is different due to the Doppler effect.
- When the fluid moves faster, the frequency shift increases linearly.
- Transit time ultrasonic flowmeters send and receive ultrasonic waves between transducers in both the upstream and downstream directions in the pipe.
- Under flowing conditions, the upstream wave will travel slower and take more time than the (faster) downstream wave.
- When the fluid moves faster, the difference between the upstream and downstream times increases.
- The transmitter processes upstream and downstream times to determine the flow rate.

http://www.flowmeters.com/ultrasonic-technology



Ultrasonic flowmeters

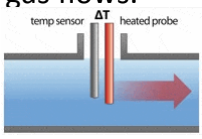
- Advantages: High turndown, handles high pressures, is repeatable (consistent), handles extreme temperatures, can be used clamped to the outside of a pipe without penetration, is low maintenance, highly reliable and self–diagnosing.
- Disadvantages: High cost, sensitivity to stray process vibrations, problems with pipe diameter change due to buildup and clamp-on units have lower accuracy.
- Ultrasonic flowmeters do not obstruct flow so they can be applied to sanitary, corrosive and abrasive liquids.
- Some ultrasonic flowmeters use clamp-on transducers that can be mounted external to the pipe and do not have any wetted parts.
- They represent about 12% of all flowmeters sold.

http://www.flowmeters.com/ultrasonic-technology

Thermal flowmeters

- Thermal flowmeters use the thermal properties of the fluid to measure the flow of a fluid flowing in a pipe or duct.
- In a typical thermal flowmeter, a measured amount of heat is applied to the heater of the sensor.
- Some of this heat is lost to the flowing fluid.
- As flow increases, more heat is lost.
- The amount of heat lost is sensed using temperature measurement(s) in the sensor.
- The transmitter uses the heat input and temperature measurements to determine fluid flow.
- Most thermal flowmeters are used to measure gas flows.

http://www.flowmeters.com/thermal-technology



Thermal flowmeters

- Thermals are middling cost and they are good for low pressure gas.
- The best attribute is that if the gas is known, the meter reads true mass flow without needing to include pressure in a calculation.
- The accuracy is medium only and they are used primarily for gas. Not good for steam flow.
- Thermal flowmeters are most commonly used to measure the mass flow of clean gases, such as air, nitrogen, hydrogen, helium, ammonia, argon, and other industrial gases. Mixtures, such as flue stack flow and biogas flow, can be measured when their composition is known.
- An advantage of this technology is its dependence upon thermal properties that are almost independent of gas density.
- Thermal flowmeters can be applied to clean, sanitary, and corrosive gases where the thermal properties of the fluid are known.
- Thermal flowmeters represent 2% of global flowmeter sales.

http://www.flowmeters.com/thermal-technology