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What Flow Technology Can I Use to Measure This?

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The amount of instrumentation on the market today to measure flow is mind boggling.

Making the decision on what technology to use can be daunting, many experienced plant personnel either use what they are comfortable with or count on their supplier (salesperson) to help them out with different technologies.

Consider some questions to ask yourself in the beginning of the decision making process that could lead you down the path to successfully choosing measurement devices:

- Why is the measurement required? For example:
  - To control or optimize the process
  - To meet state regulations
  - For monitoring or indication
  - As a safety safeguard
  - To warn of a process upset
- What is the expected result of the measurement?
- How much is this instrument going to cost me?
- What modifications am I going to have to make to my process piping or at the receiving device such as the PLC or DCS?
- How accurate or repeatable does the measurement need to be?
- What are the expected lifespan and maintenance requirements?

The answers to those questions, and others, should help you determine the most important criteria to assess your choices for your circumstance, since many flow technologies can often apply. We will expound on some of those choices below.

Mechanical or Electronic Flow Meters

Choices for making flow measurement include Differential Pressure with primary flow elements like orifice or Venturi; mechanical devices such as Variable Area, Turbine or Positive Displacement meters; and electronic flowmeters like Magnetic flow, Vortex, Ultrasonic, Coriolis Mass, among others. Each meter technology has advantages and drawbacks.

The process and desired measurement should be defined prior to choosing a technology for making the measurement. To allow for the widest choice of instrumentation able to perform the measurement, we shall specify a meter to measure water in a closed pipe which is completely full. This is the simplest of all flow conditions, and all of the instruments mentioned above would apply.

First let's summarize each devices method of measurement and finish with a matrix to compare each meter.

Differential Pressure with Primary Flow Element

In simple terms this measurement is made by placing a device into a flow stream (primary element) which will produce a pressure drop which is proportional to a flow rate. Orifice plates or a Venturi meter are the most popular flow elements, others include nozzles, pitot tubes and others. A differential pressure measuring device produces an output or an indication which is proportional to the flow rate.

These meters require mounting in the pipe, so there are installation costs to consider. Regular maintenance is necessary for calibration and inspection or cleaning the taps and the pressure devices.

Orifice Plates

Venturi

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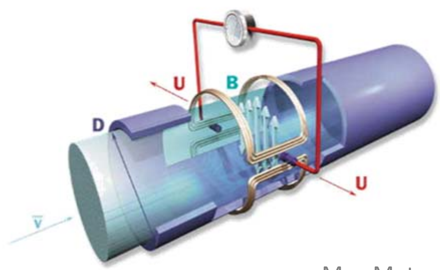
Electromagnetic Flow Meters

Magnetic Flow meters (magmeters) use Faraday's Laws of induction to make the measurement. When a conductor (Water) flows through a magnetic field, a voltage is generated. The voltage is directly proportional to the velocity of the conductor (process fluid). With a known cross sectional area of the meter body the velocity is directly proportional to the volume flow rate.

Magnetic Flow meters require installation in a pipe so there is associated expense along with the price of the meter. Usually these flow meters are maintenance free and require no regular recalibration.

- U = K x B x V x D
- K = instrument constant
- B = magnetic field strength
- V = mean flow velocity

D = electrode spacing



Mag Meter

KROHNE OPTIFLUX 4300C

Vortex Flowmeters

Vortex meters are also a velocity measuring device, this meter measures the vortices produced when a product flows around an obstruction. Picture a flag waving in the wind or water in stream going around a rock. The vortices caused by the obstruction have a frequency, the frequency is proportional to the velocity of the product moving through the measurement chamber. The frequency is measured in different methods depending on the manufacturer. Again this is a device that infers a flow rate based on velocity and cross sectional area of the measuring chamber.

These are installed directly into the flow stream. Some of these meters also include a pressure and temperature measurement to output mass flow. These meters require insertion into the process piping.

A downstream view of a KROHNE vortex meter with sensor behind the shedder bar

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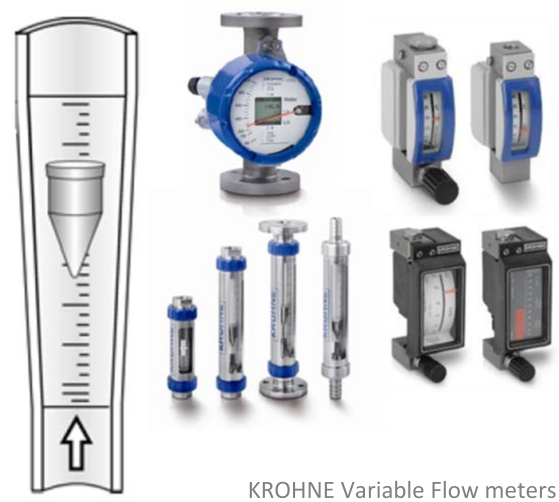
Variable Area Flowmeters

Variable Area flow meters, these meters are unique as they require no power to operate. The technology behind these meters is simply described an equilibrium. The measurement tube is of a tapered design, smaller diameter at the inlet and larger diameter at the outlet.

Inside the measuring chamber is a float which is designed to match the density of the product being measured. As the flow increases the float moves higher in the chamber. A scale is printed on the measuring tube, if the tube is transparent or a magnetic pick is used if the measuring tube is armored. These meters also have the ability to be powered and report on a 4-20mA loop. Limit switches can be added to alarm on high and low flow rates. Some manufacturers supply these meters not only for flow moving from bottom to top, but from top to bottom or horizontally.



KROHNE Variable Flow meters and example of float and cone

Turbine Flowmeters

Turbine meters, these meters are a mechanical type meter that also measure velocity. The fluid passing over the turbine moves a set of blades, each time rotation of the blades indicates a volume of product. Normally these units require no power; the output is a frequency or pulse that is generated by as magnetic pick up. These meters are viewed as being accurate and repeatable. These also require insertion into the flow stream so extra cost is involved along with the meter price.

Because these are mechanical meters they are subject to wear, which means over time the meter will lose accuracy. These meters require somewhat frequent recalibration. The cleaner the application the less wear and tear on the meters so recalibration is not required as frequently

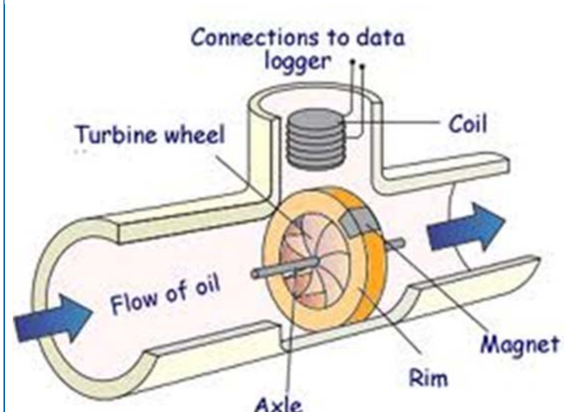


Diagram of a turbine meter

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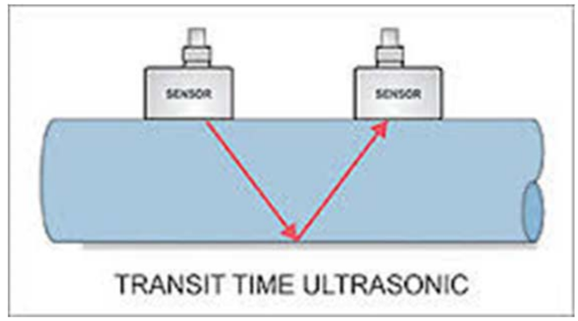
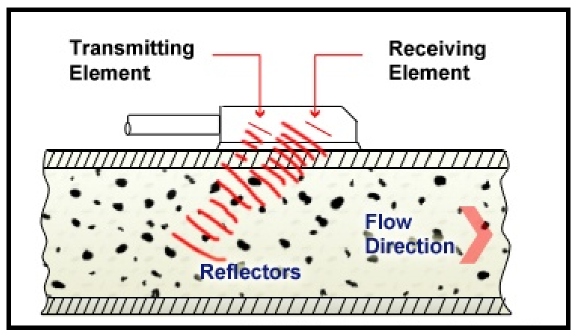
Ultrasonic Flowmeters

Ultrasonic Meters, these meters come in two general configurations, referred to as Clamp on and spool piece. The clamp on meter is attached to the outside of the process piping, the spool piece requires the process pipe to be cut and the meter installed in the flow stream.

There are two technologies utilized in Ultrasonic measurement, Transit Time and Doppler, the transit time sends a sound wave across the pipe from one transducer to another with the flow, then a sound wave is sent in the opposite direction. The flow causes a change in the time it takes the sound wave to travel across the pipe. Travelling with the flow less time, against the flow a longer time, the difference in time is proportional to the velocity of the process fluid.

The Doppler technology sends a sound wave into the product and looks for a return which bounces off particles in the flow stream, then measures a frequency shift to determine flow velocity. Transit time is designed for cleaner product, low suspended solids and entrained air, the Doppler is designed for processes where there are higher amounts of suspended solids or entrained gases, it requires something to “bounce” back the signal.





Doppler Ultrasonic

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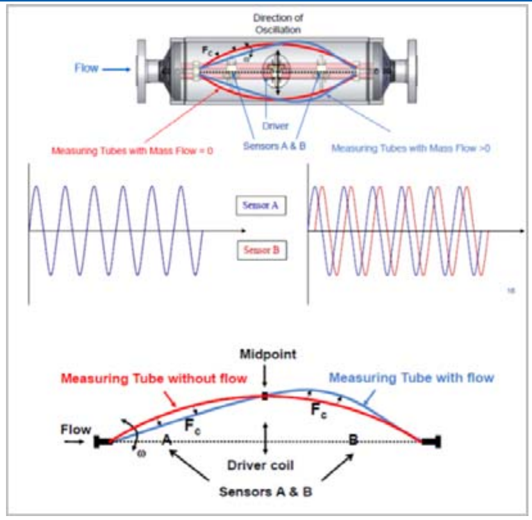
Coriolis Mass Flow

Coriolis Mass Flow meters, this meter is actually the fastest growing product used in flow measurement. This meter works on the Coriolis effect, simply put the meter operates by measuring a frequency at no flow conditions, when flow begins there is a shift in the phase of the frequency this phase shift is proportional to the rate of flow. Other benefits of this measurement include a mass measurement. The frequency the meter sees changes with the density of the product in the measuring tubes. A less dense product causes a higher frequency and conversely a more dense material causes a lower frequency. So while these meters give a mass flow derived from the frequency reading it also infers a volumetric flow using the mass flow and cross sectional area of the measuring tube.



As you have seen from the tables above, the meter technology of choice really depends on the application specific requirements. Always try to begin with the details of the process, and don't skimp on the amount of information you can gather. For example, flowing viscosity might be a big factor in selecting the right variable area or turbine meter, but that information might require some research to determine.

Remember also that the performance of the meter depends on the fluid it was specified to operate in. If the process conditions, such as flow rate, are prone to vary dramatically then a few meter choices like Coriolis, magnetic or ultrasonic might be better than others since they have a wide flow range envelope whereas differential pressure elements or variable area meters might be too limited, for example.

There are many flow selection resources at your disposal from many manufacturers' website, including our own that can help you find the applicable meter choices that would be optimal for your specific flow application, so take advantage of them often.

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