Welcome to Tech Tuesday

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FTI FLOW TECHNOLOGY™

FTI Flow Technology, Inc.

Considerations for Selecting Flow Measurement Instrumentation

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Agenda

- Common flow terms
- Application considerations for selecting the proper technology
  - The Application Data Sheet
  - Special Considerations
- Review of flow measurement principles:
  - Theory of operation
  - Benefits and boundaries
- Meter technologies covered:
  - Coriolis
  - Vortex
  - Thermal Mass
  - Differential pressure (various styles)
  - Turbine
  - Electro-Magnetic
  - Positive Displacement
  - Ultrasonic

Common Flow Terminology

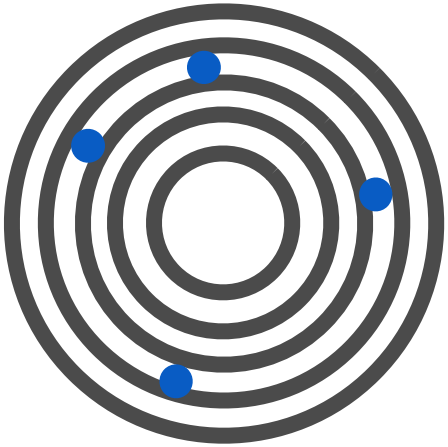
Common Flow Terminology

- Turndown: Ratio of Max flow to minimum accurate flow
  - i.e. Meter with 100 GPM max flow rate and 100:1 turndown has a minimum flow rate of 1 GPM
  - Also referred to as rangeability
- K-factor: the number of output pulses per unit volume from a flowmeter, such as pulses per gallon
  - Also referred to as calibration factor
- Resolution: what each pulse produced by the meter represents.
  - Inverse of the K-Factor. The K-factor is pulses per unit of volume. The resolution is the volume per unit pulse.
  - Critical characteristic, primarily when measuring very low flow rates or very small total volumes.

Other Fluid Properties

- Density
  - Defined as mass per unit volume (units of lbs/gal, kg/m^3, etc.)
  - Varies with temperature
- Specific Gravity (S.G.)
  - The ratio of a fluid's density to that of water
  - Found by dividing fluid's density by water's density at 60 Deg F. (unitless)
  - Varies with temperature
- Viscosity
  - A measure of a fluid's resistance to shear or angular deformation (resistance to flow)
  - Absolute (cP) and kinematic (cSt) viscosity (ratio of cP to S.G.)
  - Varies with temperature

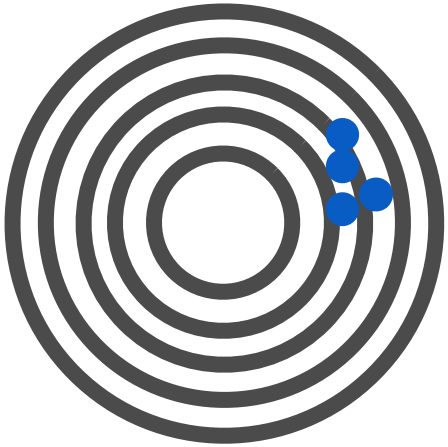
Performance Terminology: Repeatability



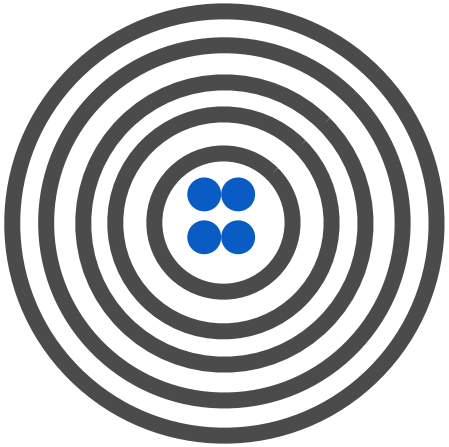
Not Repeatable

Repeatability:

- Differs from accuracy
- Ability to produce same results



Repeatable but not accurate



Accurate and Repeatable

Application Considerations

- Accuracy needed
- Purpose of process (controlling a process, batching, leak detection, etc.)
- Fluid being measured
  - Physical properties (suspended solids, chemical compatibility, etc.)
- Viscosity at operating temperature
- Estimated flow range
- Operating temperature
- Operating pressure
- Installation envelope and orientation (limited space, vertical, horizontal)
- Display required
- Output required (analog, frequency, Modbus, etc)
- Area classification
- Budget

The Application Data Sheet

Liquid Description: _____

Fluid Viscosity: _____ cP / cstk / SSU at _____ °F/°C min SG/Density _____

and: _____ cP / cstk / SSU at _____ °F/°C max SG/Density _____

PH: _____ % Solids _____ which pass through _____ mesh screen

Flow Rate (GPM / other _____): Min _____ Max _____ Norm _____ ☐ Steady ☐ Pulsating

Temperature (°F/°C): _____ Min _____ Max _____ Norm _____ Time at Max _____

Pressure (PSIG / other _____): Min _____ Max _____ Norm _____ Max allowable drop _____

Clean-in-Place: ☐ No ☐ Yes Liquid _____ Rate (GPM) _____ Temp (°F) _____ Time _____

Application Engineers use this to understand fluid specifics

- Pertinent detail on pressure, temperature, suspended solids, flow range required, viscosity and pressure drop
- Used to determine the correct meter technology

The Application Data Sheet

Piping: Sizing / Sch _____ Material _____ Preferred End Fitting _____

Power Available: ❑ _____ (specify) VDC ❑ 110/60 VAC ❑ 220/50–60 VAC

Display Required: ❑ Rate ❑ Total ❑ Rate & Total ❑ None

Output Required: ❑ Pulse ❑ 0–10 VDC Analog ❑ 4–20 mA ❑ Batch Relays

Engineering Units: ❑ Volumetric Actual Units ❑ Volumetric Standard Units ❑ Mass Units

❑ Computer Interface/Specify: _____

Mounting Configuration: ❑ Meter Mount ❑ Wall Mount ❑ Panel Mount

Enclosure Connections: ❑ Conduit Hubs ❑ MS Connectors

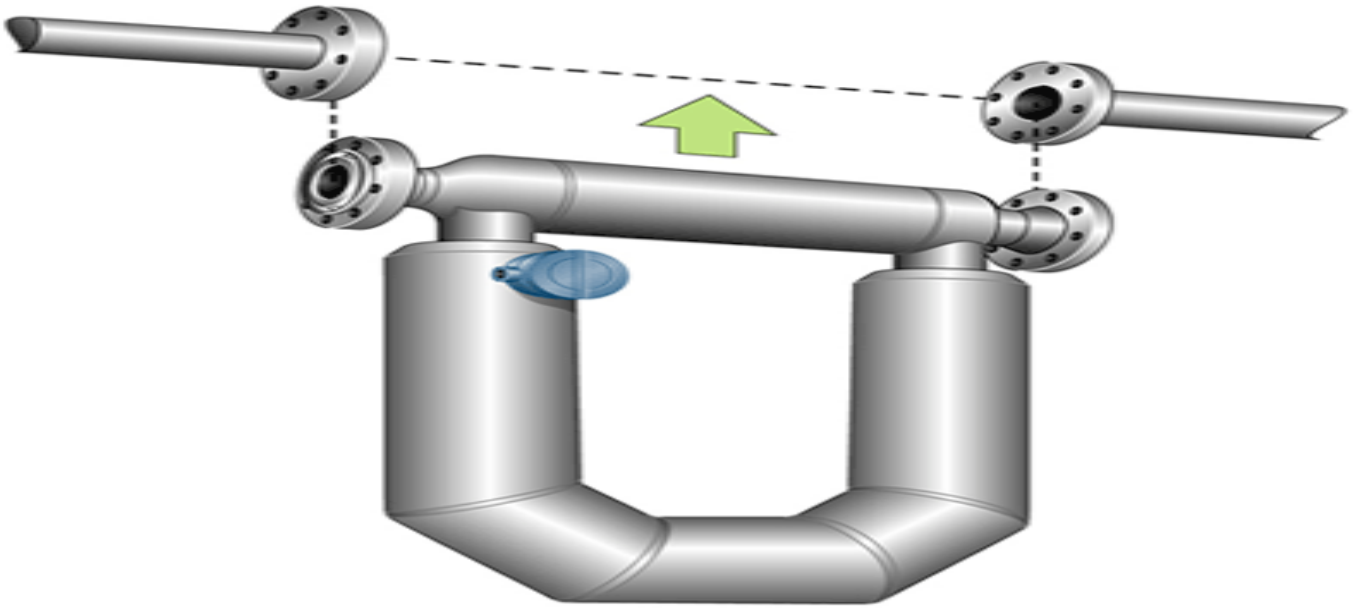
Hazardous Environment: ❑ No ❑ Yes Class/Div/Group _____

Accuracy Desired: _____ (❑ % of reading, ❑ % of full scale)

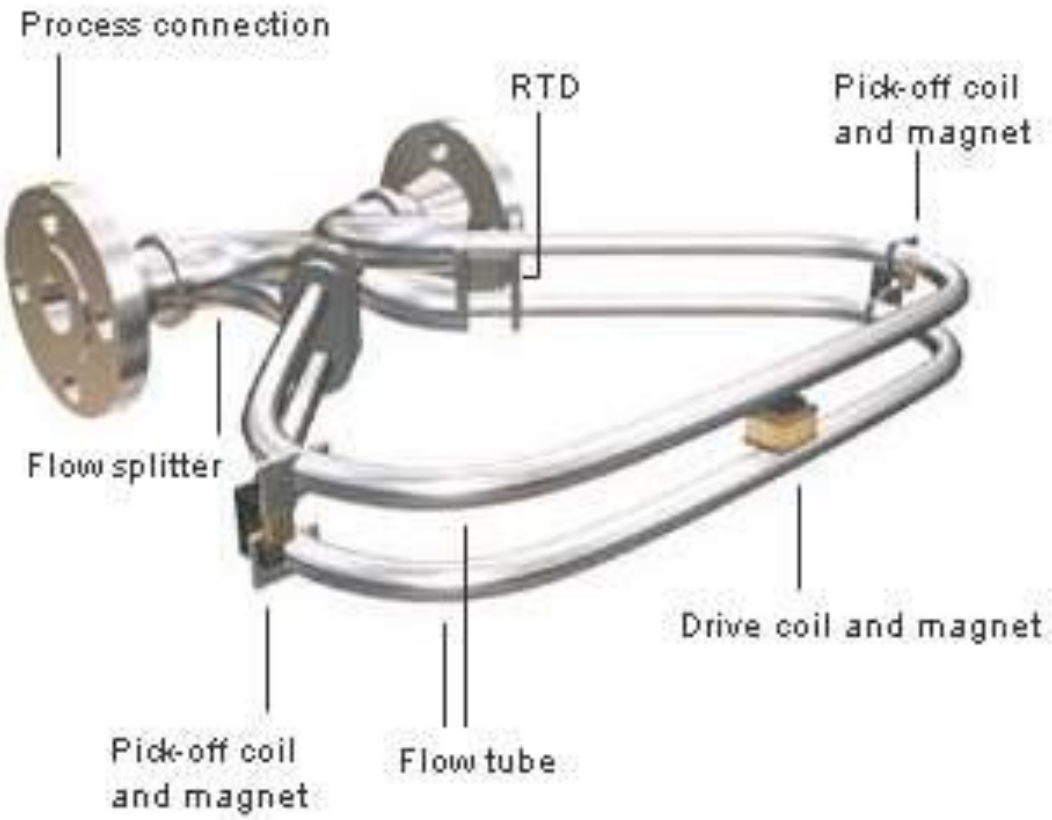
Used to complete the meter configuration

- Electronics required (?), how configured – integral, remote
- End fittings
- Special considerations?

Coriolis flow meter technology

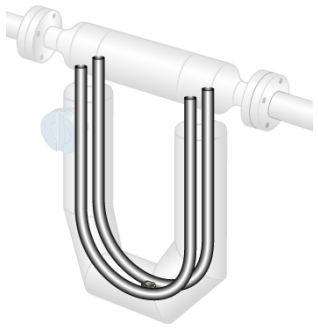


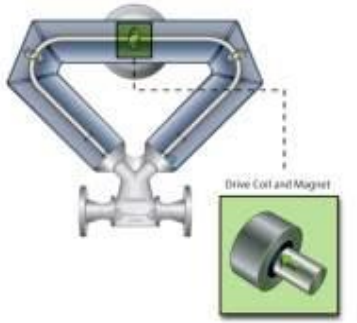
Typical Components of a Coriolis Meter



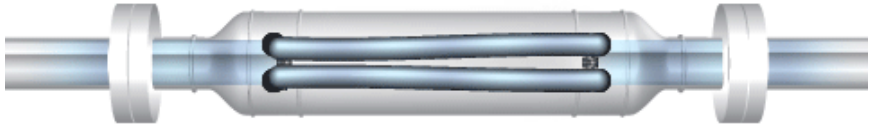
Theory of Operation – Coriolis

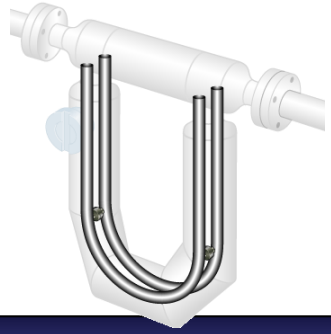
- Process fluid enters the sensor and flow is split with half the flow through each tube. The sensor flow tubes are vibrated in opposition to each other by energizing a drive coil. Tubes are oscillated at their natural frequency.

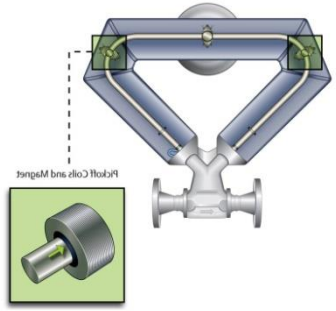




- Magnet and coil assemblies, called pick-offs, are mounted on the flow tubes. As each coil moves through the uniform magnetic field of the adjacent magnet it creates a voltage in the form of a sine wave.

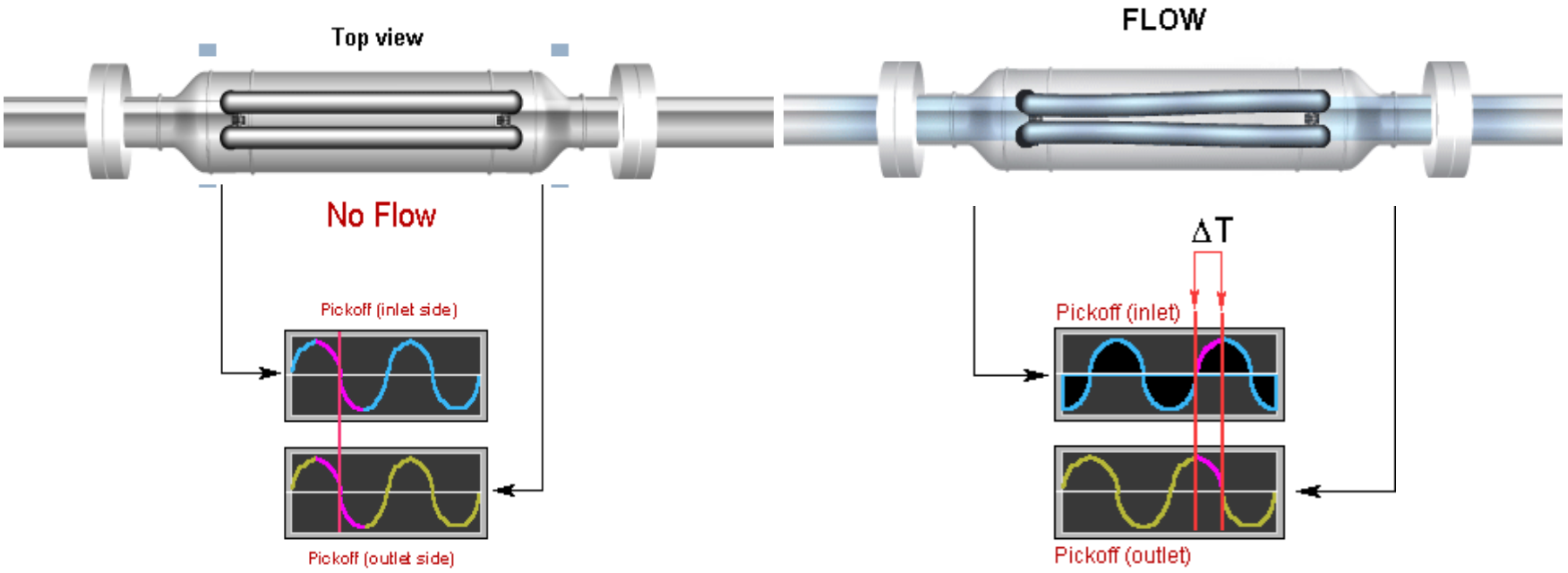






Theory of Operation – Coriolis

- During a no flow condition, there is no Coriolis effect and the sine waves are in phase with each other.
- When fluid is moving through the sensor's tubes, Coriolis forces are induced causing the flow tubes to twist in opposition to each other. The time difference between the sine waves is measured and is called Delta-T which is directly proportional to the mass flow rate.



Coriolis flow meters
Benefits and Boundaries

Benefits:

- Measurement unaffected by fluid density changes
  - Can measure accurately in changing density applications
- Suitable for liquid, gas, and steam
- Highest accuracy – suitable for custody transfer
- Multivariable measurement: mass flow, density, temperature
- Highly reliable / low maintenance
- Easy installation; no inlet or outlet sections required

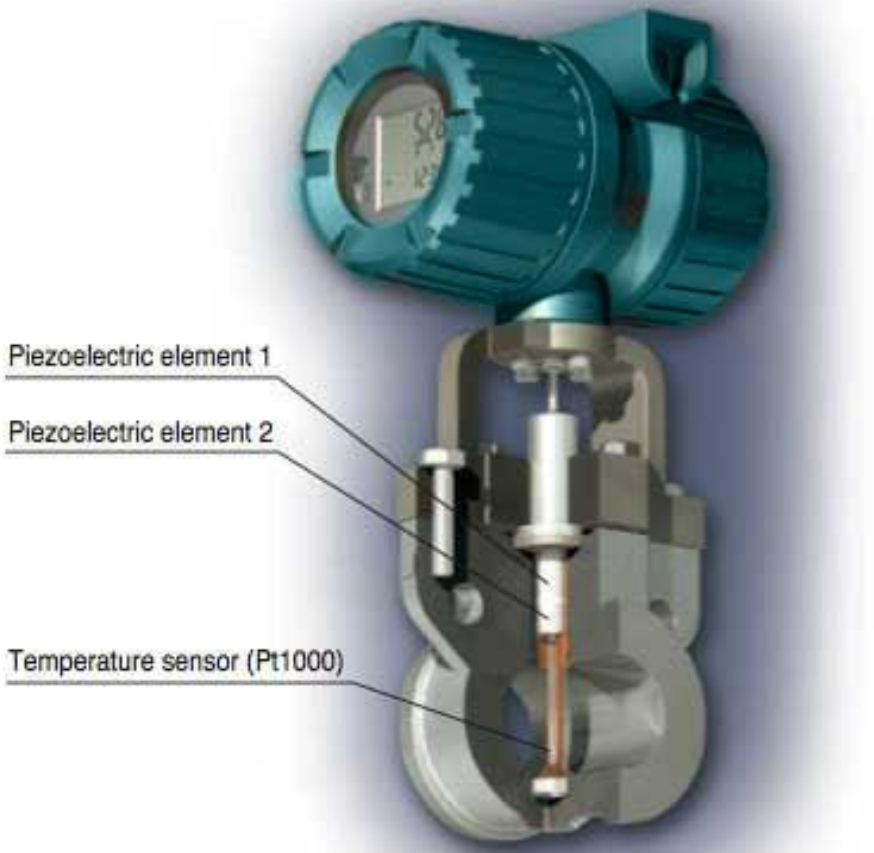
Boundaries:

- Expensive, especially for sizes above 2″
- Large installation footprint for U-tube and Omega tube designs
- Pressure drop can be a considerably higher for older “U-shaped” tube designs and high viscosity fluids
- Limited wetted material selection
- Limited and/or expensive for corrosive fluids

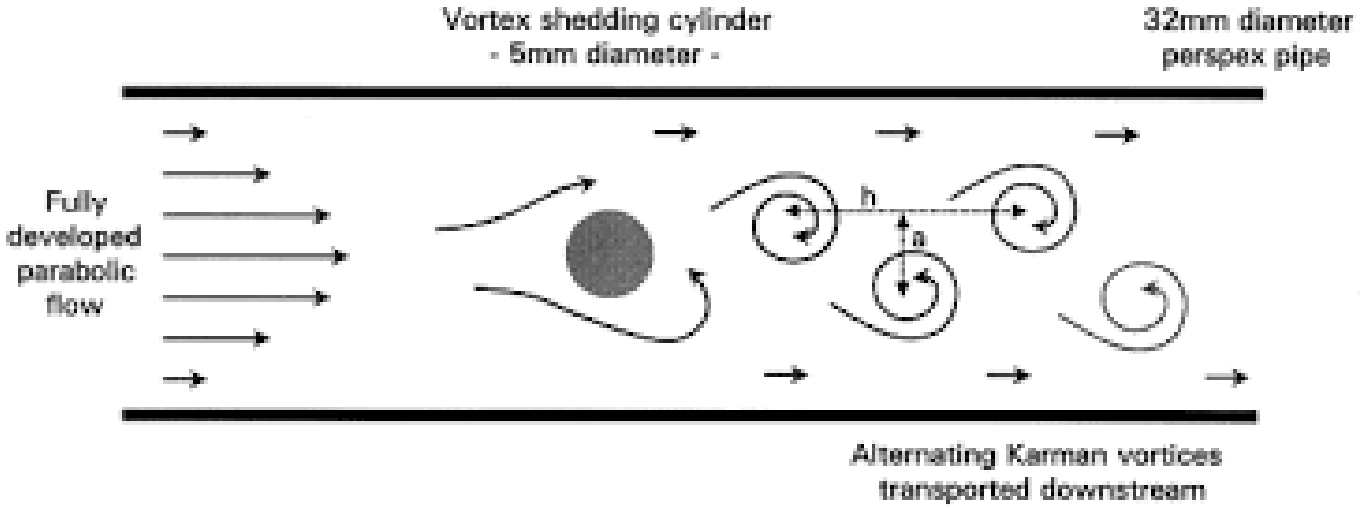
Coriolis Applications

- Food and beverage ingredient measurement
  - Oils, sweeteners
  - Where densities change from batch to batch
- Chemical processing
  - Solvents, gases, oils, adhesives and resins
  - Where high accuracy is needed to maintain batch control
- Oil and Gas processing
  - Solvents, oil and water separation
  - Custody transfer
- Test and measurement
  - Engine fuel flow (gasoline, diesel fuel, natural gas)

Vortex Shedding flow meter



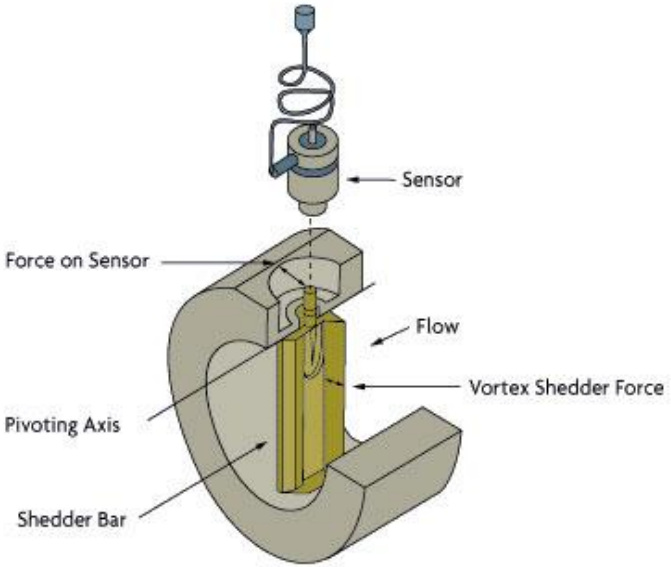
Vortex Shedding Theory

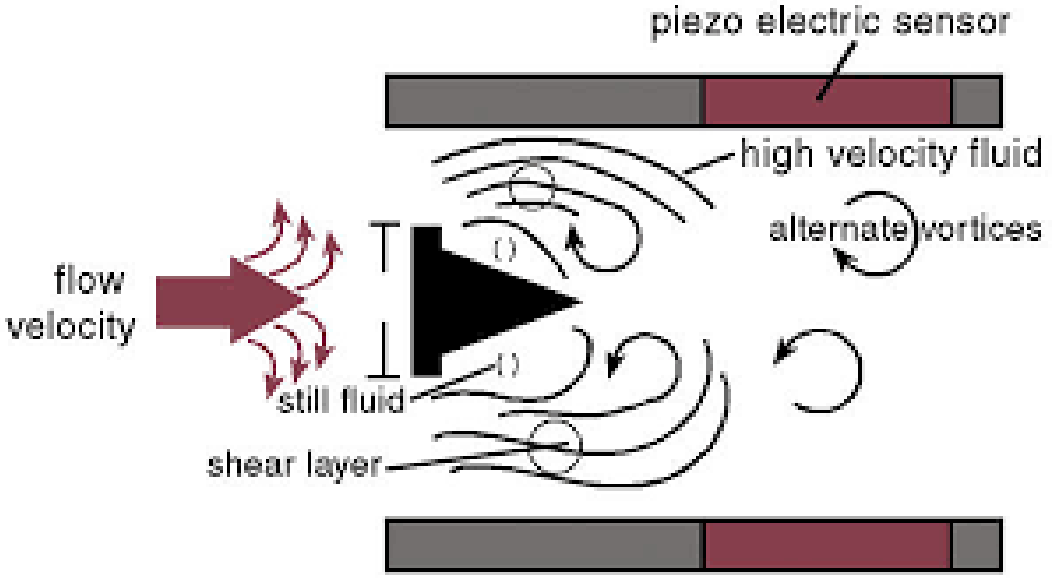


A physicist named Theodore von Karman, described the effect where a non-streamlined object (also called a bluff body) placed in the path of a fast-flowing stream

- It causes the fluid to alternately separate from the object on its two downstream sides
- The boundary layer becomes detached and curls back on itself, forming vortices
- The distance between the vortices was constant and depended solely on the size of the rock that formed it

Vortex Shedding flow meter





Vortex flow meters:

- On the side of the bluff body where the vortex is being formed, the fluid velocity is higher and the pressure is lower
- As the vortex moves downstream, it grows in strength and size, and eventually detaches or sheds itself. This is followed by a vortex's being formed on the other side of the bluff body.
- The alternating vortices are spaced at equal distances..
- The pressure oscillation around the bluff body is detected.
- The frequency of the oscillation is proportional to the velocity of the flow

Vortex flow meters
Benefits and Boundaries

Benefits:

- Suitable for liquid, gas, and vapors
- Variety of installation methods, inline or insertion probe
- Inexpensive, especially in smaller sizes
- No moving parts, low maintenance

Boundaries:

- Not suitable for pulsating flow
- Requires long inlet and outlet runs, 30 pipe diameters upstream is typical
- Cannot be used for high viscous fluids, low pressure gases.
- Minimum velocity to create vortex shedding effect, struggles with low velocity
- Lower accuracy compared to other technologies at low end of range
- Limited turn-down range
- Pressure drop may be high as the meter bore is sometimes reduced to increase velocity

Vortex meter applications

- Steam Measurement
- Dirty and wet gas
- Air flow
- Natural gas
- Water/DI water

Thermal Mass Meter

Thermal Mass: theory of operation

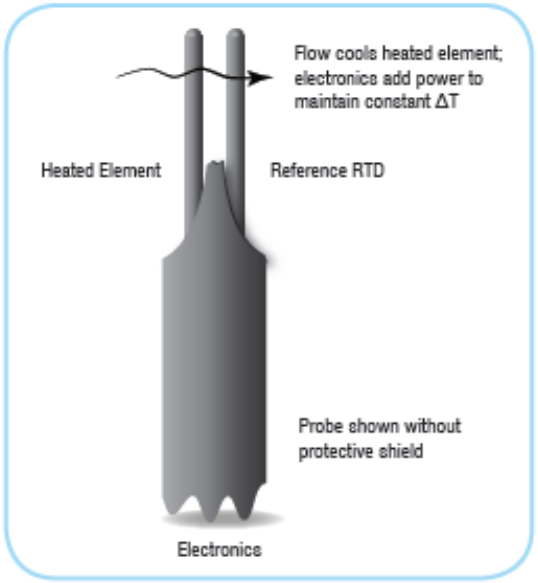
The initial term and first “hot-wire anemometer” was developed back in 1914 by Louie Vesso King

- Basis for King’s Law
- Mathematically describes heat transfer in air flows using a heated wire
- As the air moves over the wire, it causes a loss of temperature in the wire and removes some of the wire’s heat energy.
- Correlated this heat transfer to measure mass velocity at a point in the flow

Thermal mass flow meters:

- Rate of heat absorbed by a fluid flowing in a pipe or duct is directly proportional to its mass flow
- Fluid flowing over a source of heat absorbs the heat and cools the source.
- As flow increases, more heat is absorbed
- The amount of heat dissipated from the heat source is proportional to the gas mass flow and its thermal properties
- Therefore, measurement of the heat transfer supplies data from which a mass flow rate may be calculated.

Thermal Mass: typical configuration



Thermal flow meters typically use a constant temperature differential (ΔT) technology to measure mass flow rate of air and gases.

The thermal mass flow sensor consists of:

- Two Resistance Temperature Detectors (RTD's)
- The reference RTD measures the gas temperature
- The second RTD is heated and acts as a flow sensor
- The heated element is kept at a constant temperature and the instrument electronics measure the cooling effect of the gas flow
- The electrical power required to maintain a constant temperature differential is directly proportional to the mass flow rate of the process gas
- A transmitter linearizes this data and converts to a usable output signal

Thermal flow meters
Benefits and Boundaries

Benefits:

- Medium initial set up cost
- Low pressure drop
- No moving parts
- Wide turndown range
- Large line size options

Boundaries:

- Can easily go out of calibration
- For (clean) gas only
- Sensitive to gas composition

Thermal flow meters
Applications

- Compressed air flow and distribution
- Natural gas consumption (burner and boiler feed control)
- Monitoring and control of stack or flue gas (where composition known)
- Landfill gas recovery
- Flare gas measurement
- Gas flow mixing & blending
- Gas leak testing and detection

Differential Pressure flow meters

DP Meters: Theory of operation

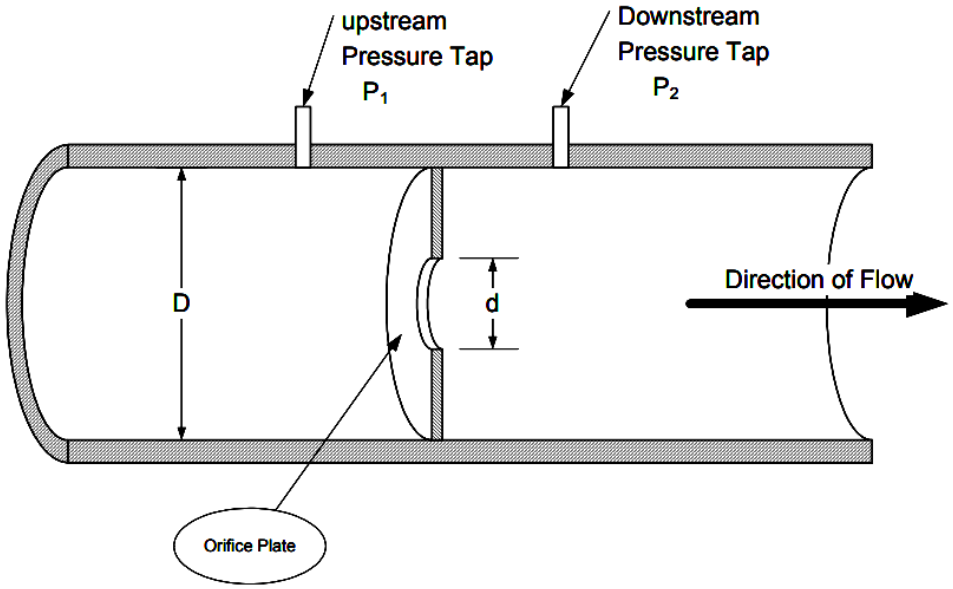
Differential pressure (DP) flow meters employ the Bernoulli equation

The Bernoulli equation assumes that your fluid and device meet four criteria:

1. Fluid is incompressible
2. Fluid is non-viscous
3. Flow is steady
4. Flow is along a streamline

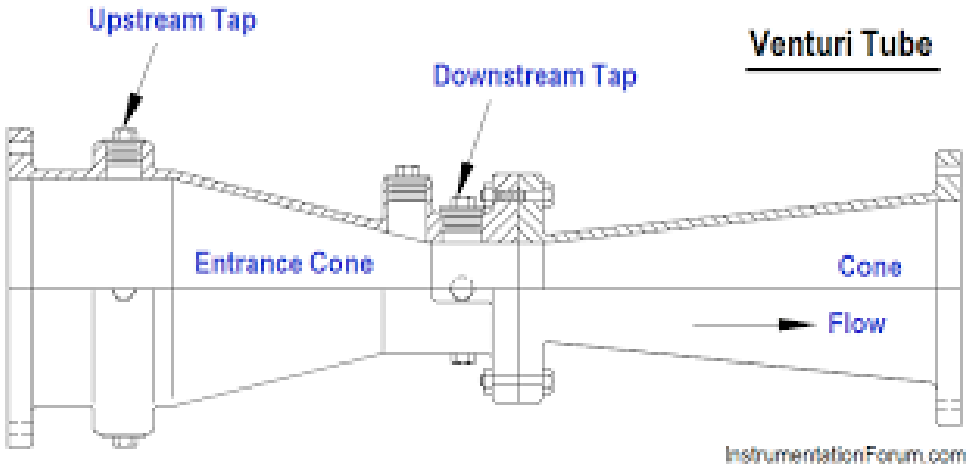
- Describes the relationship between pressure and velocity of a flow.
- DP Meters guide the flow into a section with different cross section areas (different pipe diameters) that causes variations in flow velocity and pressure
- By measuring the changes in pressure, the flow velocity can then be calculated.

Orifice Plate



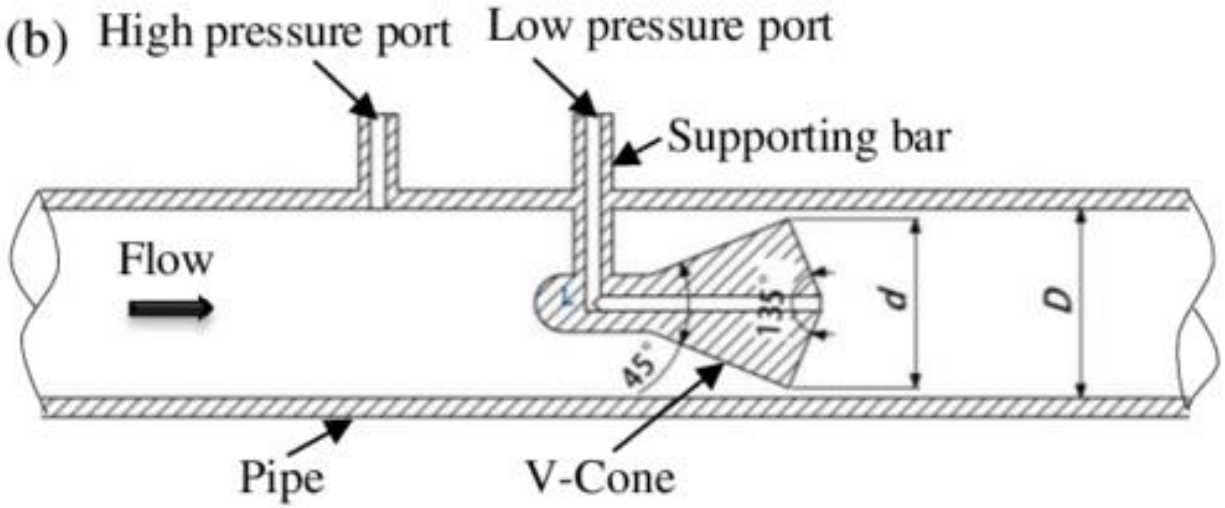
- A flat plate with an opening is inserted into the pipe and placed perpendicular to the flow stream.
- As the flowing fluid passes through the orifice plate, the restricted cross section area causes an increase in velocity and decrease in pressure.
- The pressure difference before and after the orifice plate is used to calculate the flow velocity.

Venturi tube



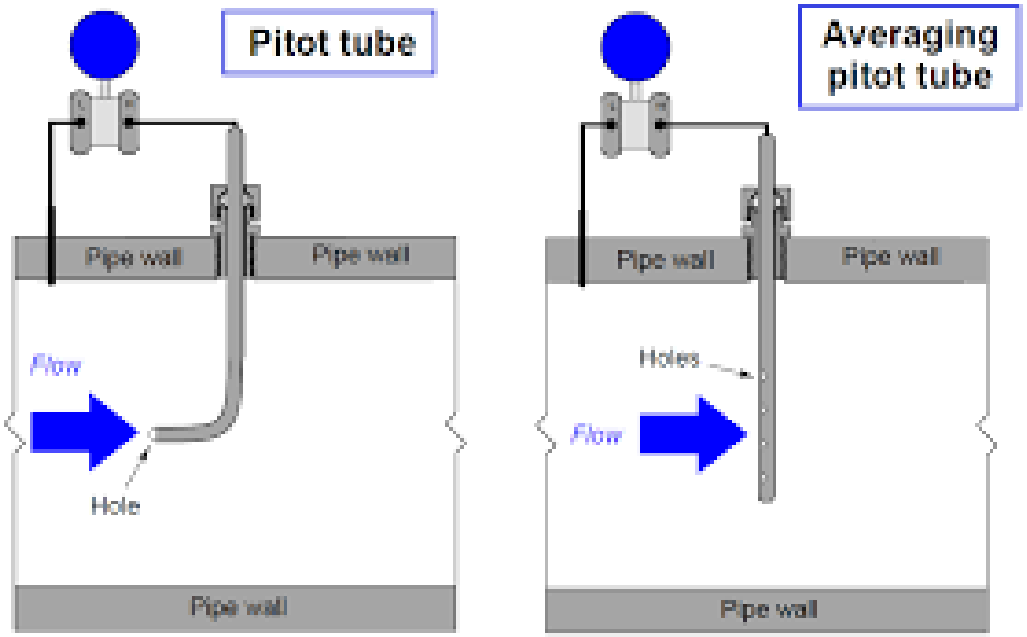
- A section of tube forms a relatively long passage with smooth entry and exit.
- A Venturi tube is connected to the existing pipe, first narrowing down in diameter then opening up back to the original pipe diameter.
- The changes in cross section area cause changes in velocity and pressure of the flow.
- Differential pressure of the unrestricted and restricted flow is measured and flow velocity determined.

V- Cone



- Differential pressure is created by a cone placed in the center of the pipe
- Flow rate is calculated by measuring the difference between the pressure upstream of the cone at the meter wall and the pressure downstream of the cone through its center.

Pitot Tube



- A probe with an open tip (Pitot tube) is inserted into the flow field.
- The tip is the stationary (zero velocity) point of the flow. Its pressure, compared to the static pressure, is used to calculate the flow velocity.
- Pitot tubes can measure flow velocity at the point of measurement.
- Similar to Pitot tubes but with multiple openings, averaging Pitot tubes take the flow profile into consideration to provide better over all accuracy in pipe flows.

Differential Pressure flow meters Benefits and Boundaries

Benefits:

- Suitable for liquid, gas, and steam
- Large size range
- Tolerates extreme process conditions (high pressure and temp)
- Transmitter can be replaced without shutting down the process
- Entirely electronic with no moving parts

Boundaries:

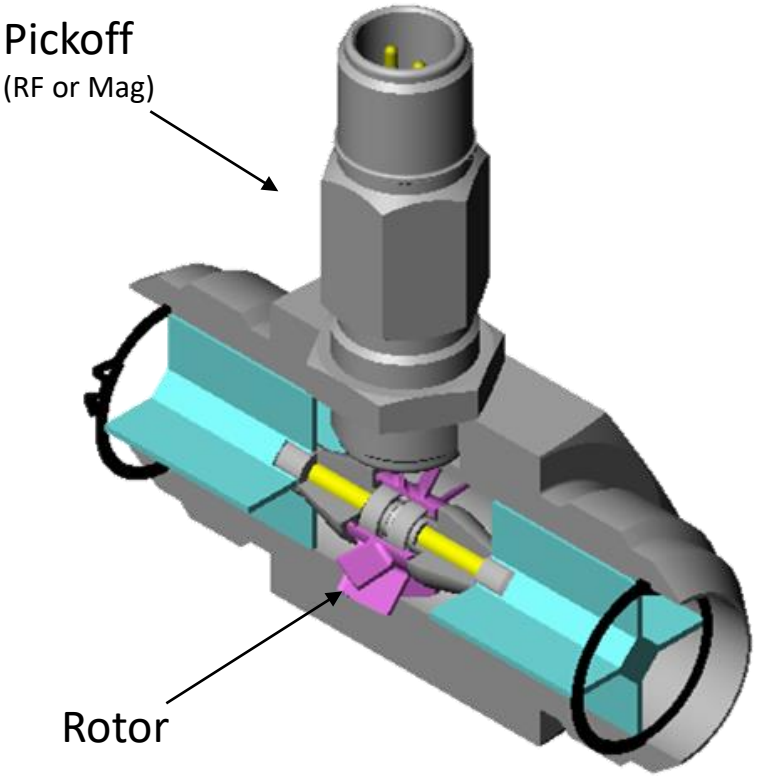
- Limited rangeability (3:1 or 10:1)
- Inferior accuracy compared to other technologies
- Long straight run requirements
- Affected by changes in density, pressure, and viscosity
- Causes unrecoverable pressure drop

Differential Pressure flow meters Applications

- Air
- Natural Gas
- Water
- Clean and dirty liquids
- Industrial gases
- Chemicals
- Slurries

Turbine Flow Meters

Theory of Operation

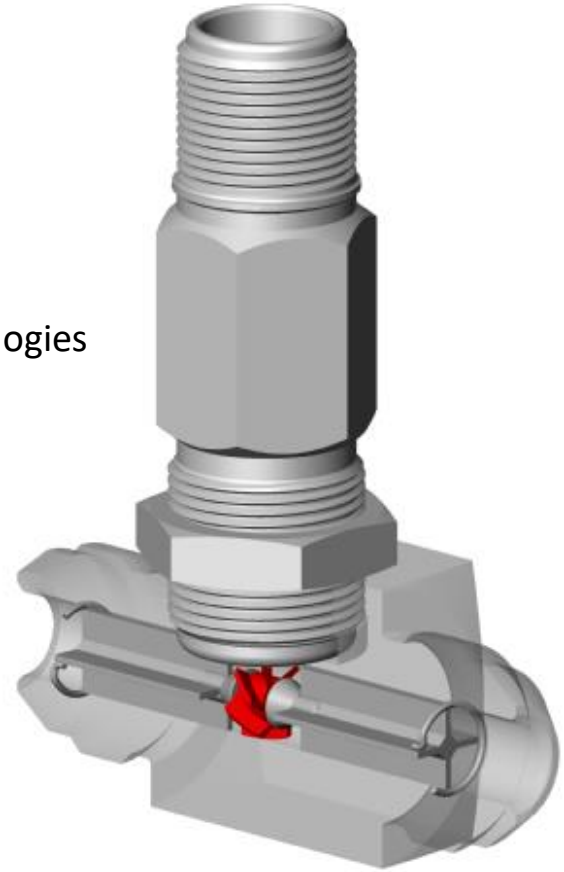


Theory:

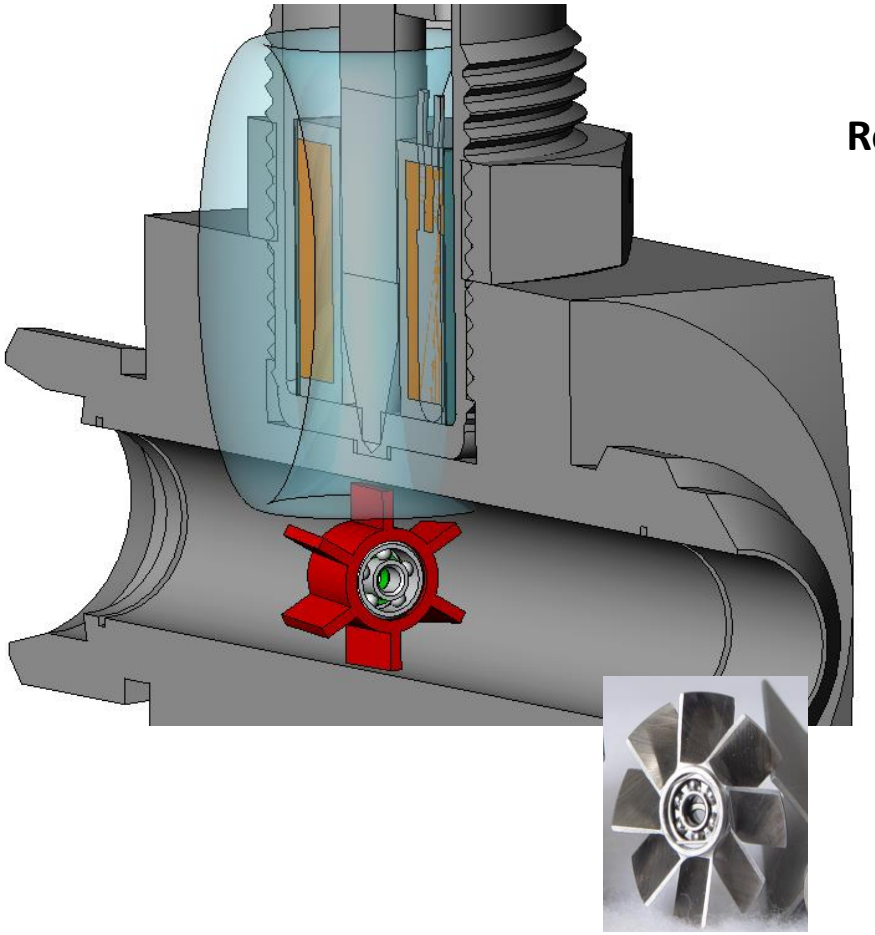
- Free spinning rotor (made of ferrous material) mounted inside at right angles to the flow.
- The rotor is suspended in the flow by 2 end supports which act to straighten the flow prior to reaching the turbine.
- As the flow reaches the turbine, the turbine begins to spin due to the applied force by the flow.
- The rotation of the rotor is proportional to the rate of flow.
- A pick-off sensor is mounted above the rotor to create a field - either magnetic or RF
- The pick-off sensor produces pulses as soon as the rotor blades pass by.
- The pulses generated by the pick-off sensor operate at a frequency that correlates to the velocity of the fluid.

Why Precision Turbine?

- **Accurate**
  - +/- 0.12% Reading achievable
    - Calibration Accuracy +/- 0.05% Reading
    - Linearity +/- 0.1% Reading
    - Repeatability +/- 0.05% Reading
- **Wide Range**
  - 100:1 turndown
- **Compact**
  - Very small footprint compared to other in-line meter technologies
- **High Resolution**
  - Can be used for leak detection
    - FT4-6 meter 48,000 pulses/gallon
    - FTO-1 meter 800,000 pulses/gallon
- **High Speed**
  - 1 ms response to a step change typical
- **Rugged Design**
  - Advanced bearing technology
  - High Shock designs available
- **Cost Effective**
  - Price advantage over other high accuracy technologies
- **Advanced Electronics**
  - High Speed Processing
  - Temperature compensation



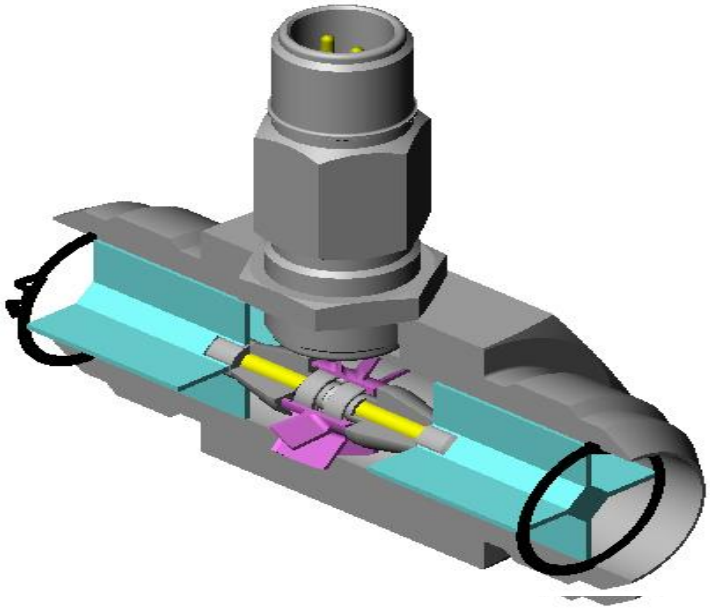
Repeatability 0.05%; High Turndown 100:1



Repeatability & Turndown

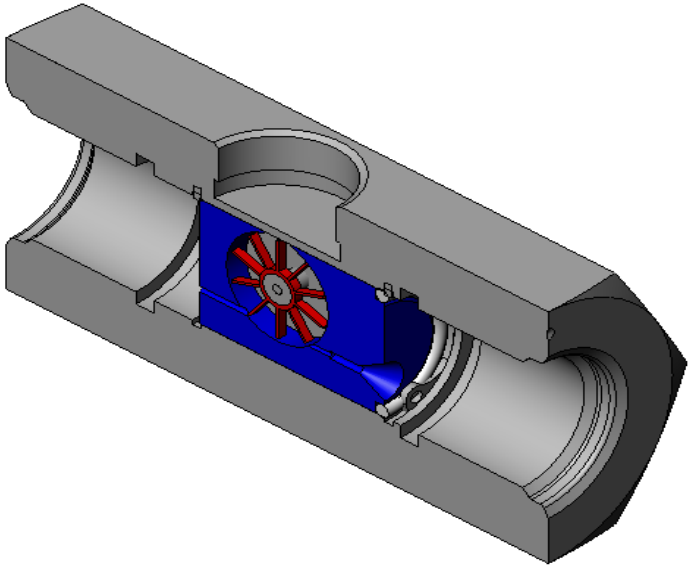
- Repeatability of the turbine is fundamentally driven by any change in the rotational drag on the rotor.
- High repeatability achieved by the use of high precision low frictional drag bearings that are very stable over time.
- Low frictional drag & turbine blade angle optimization ensures high turndown performance.

Meter Construction



Axial Construction

- Full bore through entire meter
- Rugged, vibration tolerant design



Tangential Construction

- Uses internal capsule
- Extremely high resolution

Precision turbine flow meter Benefits and Boundaries

Benefits:

- High accuracy (±0.12% accuracy)
- Repeatability (0.05% of reading)
- Fast response rate (down to a few milliseconds)
- High pressure and temperature capabilities (5,000 psi higher rating achieved via special end fittings and 750°F with high-temperature pick coils)
- Compact rugged construction.
- Advanced electronics that perform temperature compensation, signal conditioning and linearization

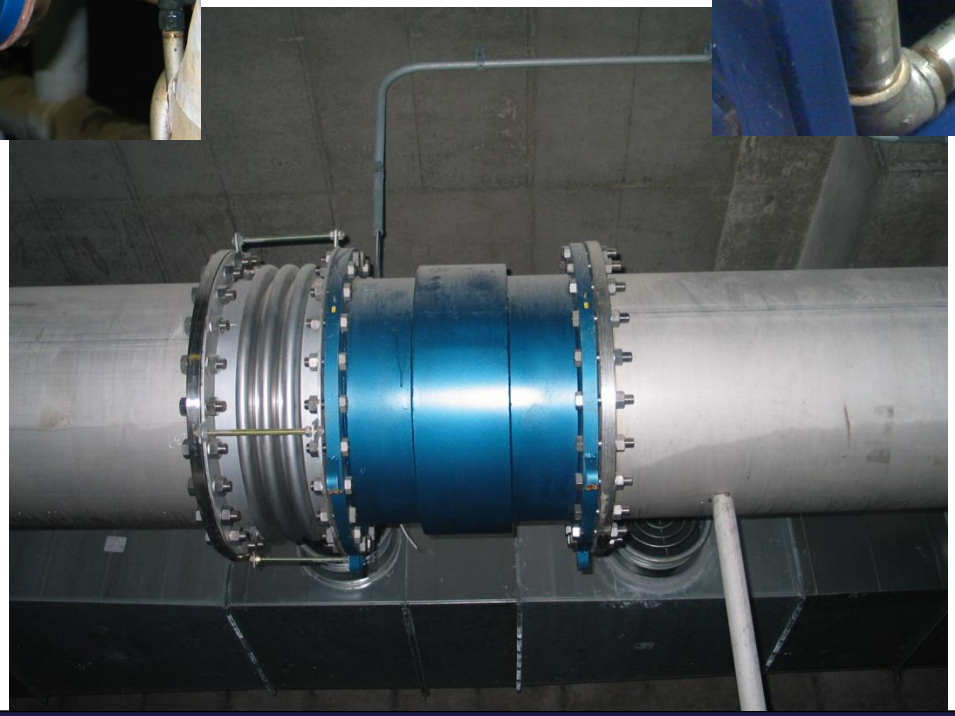
Boundaries:

- Moving parts
- For clean liquids and gases only
- Materials of construction could limit use with corrosive liquids

Precision Turbine Applications

- Food and beverage:
  - CIP systems, RO water
- Pharmaceutical:
  - DI water
- Chemical processing
  - Solvents, gases, oils
  - Where high accuracy is needed to maintain batch control
- Test and measurement
  - Engine fuel flow (gasoline, diesel fuel, natural gas)
    - On board and test cell
  - Engine coolant flow
  - Hydraulic system and component testing

Electromagnetic Flowmeter



Theory of Operation: Faradays Law

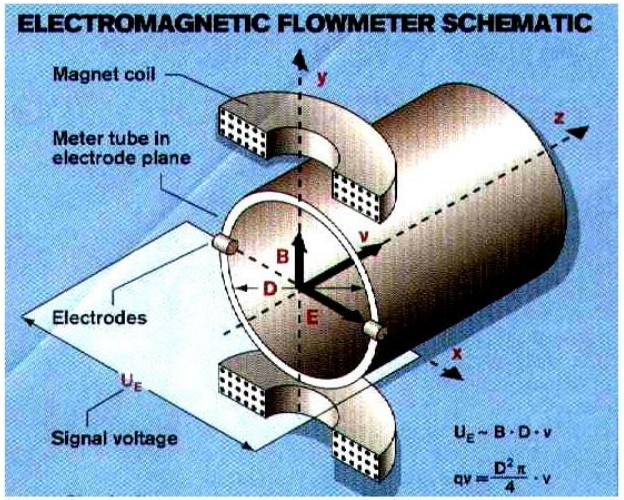
All magnetic flow meters rely on Faraday's Law that states that an EMF is induced in a coil when a conductor passes through a magnetic field. In this case the conductor is a flowing conductive liquid.

$$e = k*B*D*v$$

Where:

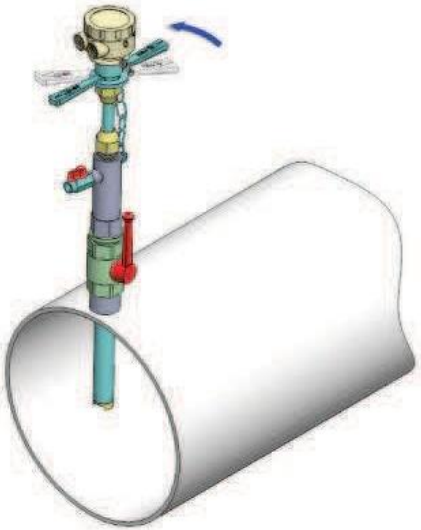
- B (field) is *constant* by design
- D is *constant* as it is the distance between the electrodes E1 and E2 positioned at the extremities of a diameter perpendicular to the flow;
- v represents the velocity of the liquid
- k is a *constant*;
- Therefore:

e is proportional to the fluid velocity



The signal is not affected by temp, pressure and viscosity changes.

Flow Tube Options



- Wide size range ¼” to 96”
- Variety of liner materials:
  - –Teflon
  - –Plastics
  - –Ceramics
- Electrode Material:
  - –316 SS
  - –Hastelloy C
  - –Tantalum
  - –Titanium
  - –Platinum
- Installation methods:
  - –Flanged
  - –NPT
  - –Triclamp
  - –Wafer
  - –Insertion probe

Transmitter

- Typically available in AC, DC or battery power
- 4-20mA, frequency, scaled pulse outputs
- Modbus, HART protocols
- Display of rate and total
- Access to menus for scaling, units, alarms, etc
- Integral and remote mount options

Mag flow meters
Benefits and Boundaries

Benefits:

- Wide range of affordable materials of construction to measure aggressive acids and chemicals
- Independent of pressure, temperature, and viscosity
- Works with entrained solids
- High accuracy
- Diameter range from 1/4” to 96”
- No moving parts
- No pressure losses

Boundaries:

- Only conductive liquids can be measured
- Coating of liner or on electrodes can cause errors

Mag meter applications

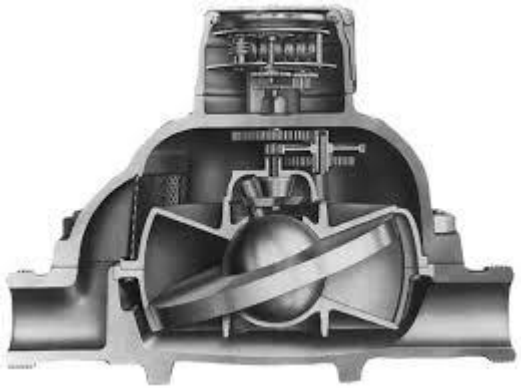
- Water
- A variety of industrial effluents
- Paper pulp
- Mining slurries
- Brine
- Liquid food products
- Sewage
- Corrosive acids
- Process chemicals
- Engine coolant

Positive Displacement (PD) flow meters

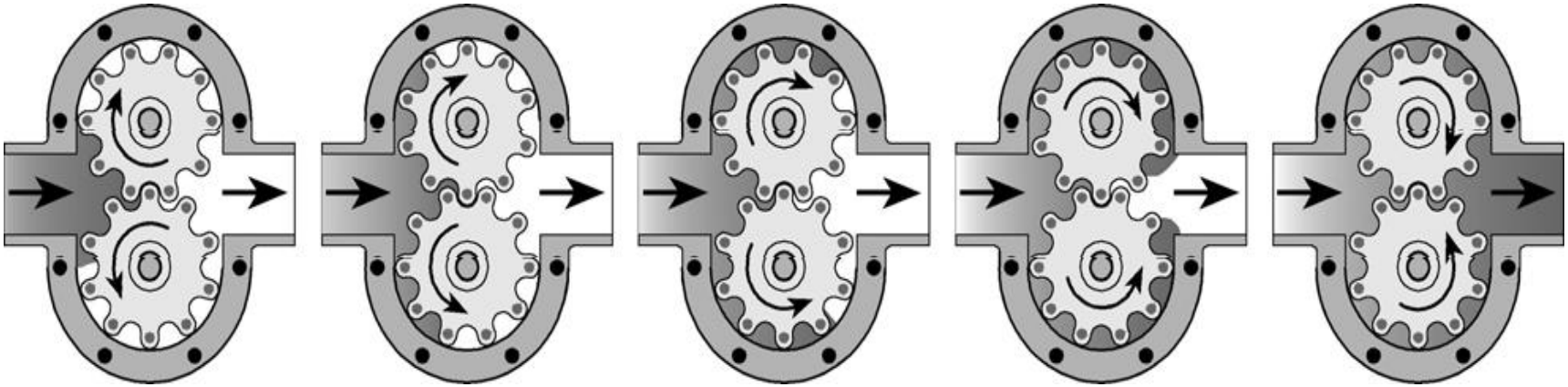
- Positive displacement flow meters, also know as PD meters, measure volumes of fluid by counting the filling and discharging of known fixed volumes.
- A typical positive displacement flow meter includes a chamber that obstructs the flow and a rotating or reciprocating mechanical device that allows fixed-volumes of fluid to repeatedly pass.
- The rate of revolution or reciprocation determines the flow rate.

PD meter types

- Nutating disc
- Oscillating piston
- Oval gear
- Rotating lobe
- Rotating Impeller
- Reciprocating piston meter



Rotating Impeller meter



- Two rotating impellers are driven by the flowing liquid.
- Magnets imbedded in the impeller lobes activate a non-intrusive sensor.
- Each pulse represents a known volume of liquid that is captured in between the lobes of the impellers.

PD meter Benefits and Boundaries

Benefits:

- Low to medium initial set up cost (typically no straight pipe run required)
- Can be used in viscous liquid flow - 1,000,000cP+ (rotating impeller)
- Very high turndown with viscous liquids – up to 1000:1(rotating impeller)
- Easy to clean and maintain (Gear style)

Boundaries:

- High pressure drop due to its obstruction of the flow path
- Very low tolerance to suspension in flow

PD meter applications

- Chemical and additive injection
- Adhesives
- Resins
- Heavy fuel oil
- Food ingredients: oil, syrups, sauces, chocolate, sweeteners
- Iso/Poly blending
- Ingredients for: Shampoos, gels, creams
- Dyes
- Waxes
- Lube oils

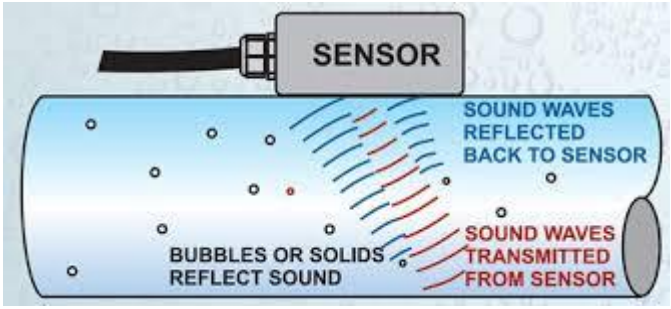
Ultrasonic Flow Meters

UFM: Theory of operation

There are two basic technologies:

Doppler

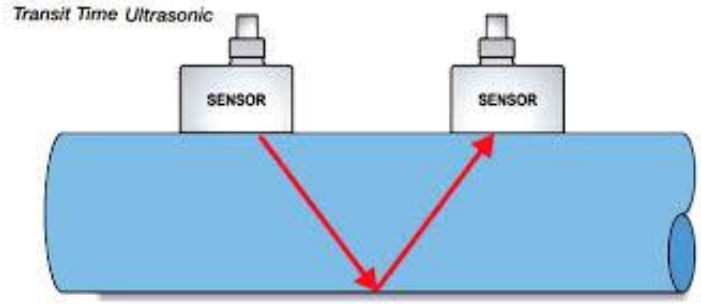
Requires suspended particles in the liquid to give a reading.



Transit time

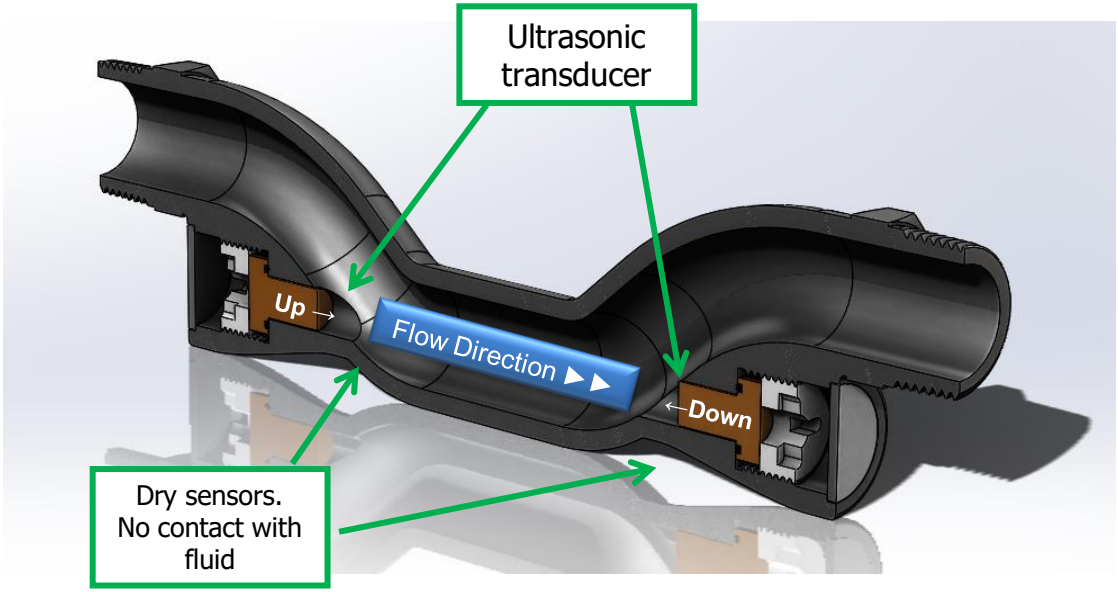
Requires clean fluids with no more than 10% solid.

This is the basis of FTI's range of Ultrasonic flow meters

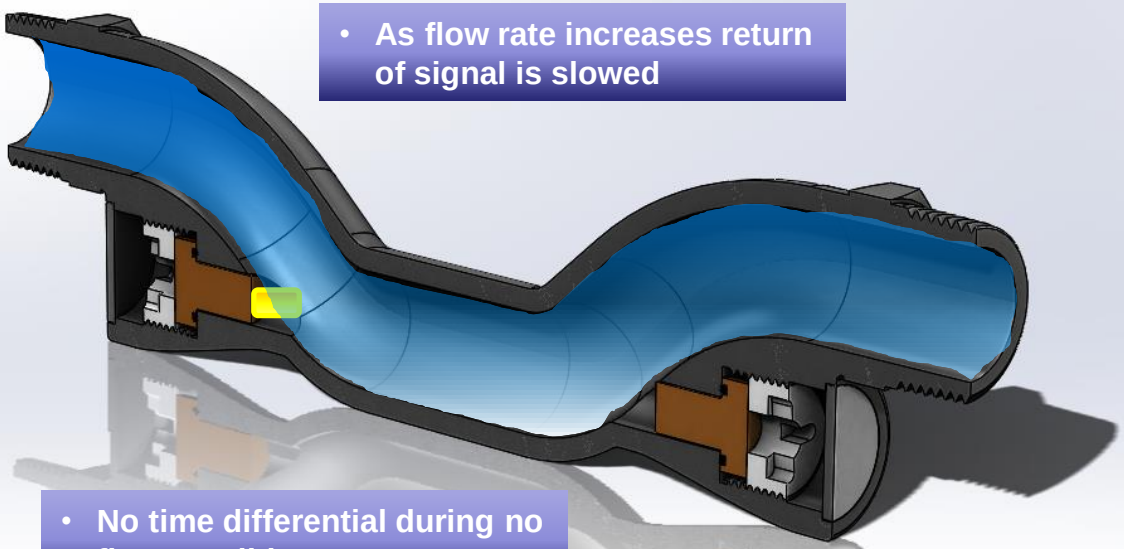


Transit Time Inline Ultrasonic

- Using sound waves to determine fluid velocity
- No moving parts
- Use two ultrasonic transducers to talk to each other
  - Measure the time to receive a signal in the upstream and downstream directions
  - Δt is proportional to flow velocity (therefore flow rate)
- The transducers are embedded in the flow path (non-wetted)
- The trick: Δt is in nanoseconds!



Operating Principle-Ultrasonic



- As flow rate increases return of signal is slowed
- No time differential during no flow condition

Clamp on Ultrasonic

Features:

- Bi-directional flow capability
- No moving parts
- Low cost of ownership
- Easy installation with clamp-on sensor
- No cutting pipes
- No intrusion into the process line
- No pressure drop
- Zero maintenance requirements
- Wide rangeability with a single unit

Clamp on Ultrasonic

Easy and quick set up:

1. Fluid type
2. Pipe diameter
3. Pipe thickness
4. Pipe material

Apply dielectric gel and mount sensors on pipe.

Ultrasonic flow meters
Benefits and Boundaries

Benefits:

- No obstruction in the flow path, no pressure drop
- No moving parts, low maintenance cost
- Inline and Multi-path models have higher accuracy
- Can be used in corrosive or slurry fluid flow
- Portable models available for field analysis and diagnosis

Boundaries:

- Clamp-on requires long straight run
- Susceptible to upstream disturbances
- Typically not as accurate as in-line flow technologies
  - Inline and multi-beam model provide higher accuracy

Ultrasonic flow meters
Applications

- Water
- DI Water (high purity)
- Chemicals
- Acids
- Fuels
- Coolant
- Low viscosity liquids

Summary

	Coriolis	Precision Turbine	Mag	PD	Vortex	Thermal Mass	DP	Ultrasonic
Water	✓	✓	✓	✓	✓		✓	✓
DI Water	✓	✓		✓	✓		✓	✓
Acids	✓		✓				✓	✓
Food Ingredients	✓		✓	✓				
Fuels	✓	✓		✓	✓		✓	✓
Hydraulic oil	✓	✓		✓				
Lube Oil	✓	✓		✓				
Air	✓	✓			✓	✓	✓	
Industrial gases	✓	✓			✓	✓	✓	
Steam and vapor					✓		✓	
Slurries	✓		✓				✓	

Any Questions?

Thank you for your time.

Scott Spencer
Regional Market Manager
FTI Flow Technology, Inc.
ph. (480) 240-3409
cell (602) 370-0110
email: sspencer@ftimeters.com

WORLD CLASS FLOW SOLUTIONS

PRODUCT SUMMARY

TURBINE FLOW METERS *High accuracy, fast speed-of-response*

Flow Technology turbine flow meters are commonly used in mission critical applications demanding superior accuracy, quality and reliability.

Ideal for clean liquids and gases, such as fuels, hydraulic fluid, lubricating oils, DI water, industrial gases, process chemicals, etc.

Features:
- High accuracy over a wide turndown
- 4-5mS response time
- Compact size
- High pressure
- Custom meters available on request
- High shock designs for water hammer effect
- Linearization & temperature compensation

ELECTROMAGNETIC FLOW METERS *Extended turndown, low cost-of-ownership*

FTI mag meters have an innovative magnetic flux path that ensures accuacy over a wide turndown. The EL Series meters are ideally suited for accurately measuring the flow rate of conductive liquids and slurries.

Magnetic flow meters are used in virtually every processing industry and represent a very cost effective solution: Food and Beverage, Chemical, Water & Waste, Mining, etc.

Features:
- Potted & sealed electrode housing (IP68)
- No moving parts
- Sanitary units
- Grounding rings not required
- Hastelloy C22 Electrodes std.
- No pressure drop

POSITIVE DISPLACEMENT FLOW METERS *Easy maintenance, rugged performance*

Positive displacement (PD) flow meters are the meter of choice for high viscosity or high pressure applications, and for environments ranging from adhesive dispensing to methanol injection. Only two moving parts ensures reliability for critical appilcations.

Suited for high viscosity applications such as resins, polyurethanes, adhesives, paints, liquid sugars, syrups, etc.

Features:
- High viscosity >1,000,000cP
- Low installation costs – no upstream or downstream piping requirements
- Wide turndown: 1000:1 at high viscosity
- Easy maintenance, only two moving parts
- Simple & rugged design
- High resolution

IN-LINE ULTRASONIC FLOW METERS *Compact and lightweight design, no moving parts*

The Q Series of in-line ultrasonic flow meters are designed for applications that require excellent accuracy and reliability at an economical price point.

Their small footprint and lightweight design make these meters ideal for low viscosity liquid applications like water, water-based products, oils and many corrosive fluids.

The QLF measures low flow down to 0.001GPM.

Features:
- High accuracy
- No moving parts
- Compact & lightweight design
- Low pressure drop
- Outstanding repeatability
- All plastic construction

SPECIFICATIONS

TURBINE FLOW METERS

Accuracy:	± 0.25% of reading
Repeatability:	± 0.05% of reading (liquid) ± 0.1% of reading (gas)
Linearity:	Up to ± 0.1% of reading
Turndown:	Up to 100:1
Flow Range:	0.001 to 1500 GPM
Line Sizes:	3/8" to 4"
Temperature Rating:	Up to 750° F
Pressure Rating:	250 to 5,800 PSI (up to 30,000 PSI available)
End Connection:	NPT, AN, RF Flange, SAE Code 62, Tri-Clamp J1453 Flat Face O-ring, Tri-Clamp
Outputs:	Various electronic options are available that provide frequency, scaled frequency, temperature compensation, 4-20mA, 0-5 VDC, 0-10 VDC, RS232, CANbus

POSITIVE DISPLACEMENT FLOW METERS

Accuracy:	± 0.25% of reading
Repeatability:	± 0.05% of reading
Linearity:	Up to ± 0.1% of reading
Turndown:	Up to 1000:1
Flow Range:	0.001 to 100 GPM
Line Sizes:	1/8" to 4"
Temperature Rating:	250° F to 450° F
Pressure Rating:	250 to 10,000 PSI
End Connection:	FNPT, RF Flange, Tri-Clamp Autoclave
Outputs:	Various electronics options available that provide square wave pulse, 4-20mA

ELECTROMAGNETIC FLOW METERS

Accuracy:	± 0.20% of reading plus zero stability
Repeatability:	± 0.10%
Flow Range:	33 ft./sec. max. (.022 to 18779 GPM)
Line Sizes:	1/8" to 16" (larger sizes available) Insertion 1.5" to 60"
Temperature Rating:	Dependent on liner material
Ebonite	-40° F (-40° C) to 176° F (80° C)
Teflon	-40° F (-40° C) to 320° F (180° C)
Electrodes:	Hastelloy C22, 316L, Titanium, Tantalum, Platinum
Pressure Rating:	Dependent on fitting
End Connection:	RF Flange, DIN Flange, Tri-clamp, DIN 11851 DIN11851, Hose Barb, Wafer
Environmental:	IP68 continuous immersion to 1.5 meters
Transmitters Power Supply:	90 to 264 VAC or 12 to 24 VAC/DC
Outputs:	
Analog	4(0) to 20 mA
Digital	24 VDC scaled pulse, 24 VDC alarm
Serial	RS 485, MODBUS
Protection:	IP67 / IP65 / IP44

IN-LINE ULTRASONIC FLOW METERS

Accuracy:	±0.5% of reading plus zero stability
Repeatability:	±0.2% of reading over 10:1 turndown
Turndown:	100:1
Line Sizes:	1/8" to 1"
Temperature Rating:	Up to 176° F
Pressure Rating:	Up to 275 PSI
End Connection:	NPT, Hosebarb, DIN 11864-1
Outputs:	
Analog:	4-20mA
Scaled Frequency:	10 to 5000K Hz
Communications:	Modbus RTU over EIA485

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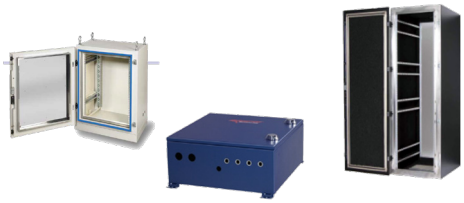

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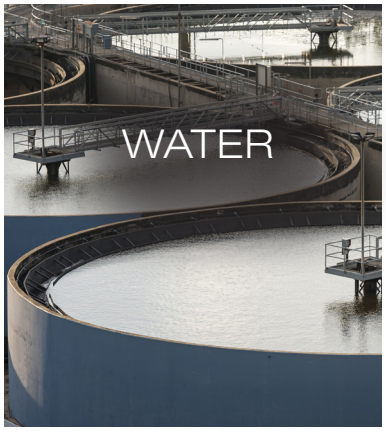

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