

Magnetic Flow Meters

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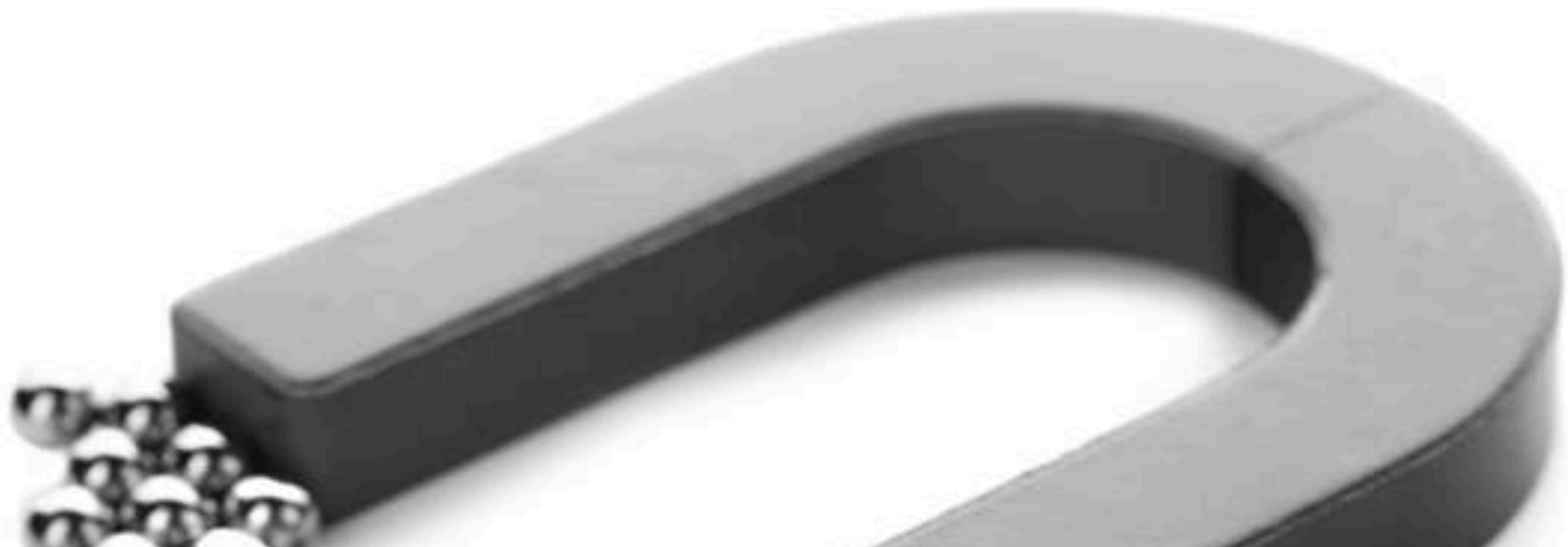
Agenda



- Introduction
- Magnetic flow basics
- MagPLUS introduction
- Applications
- Differentiators
- Other types of metering
- Q&A

i P C *innovative* Process Controls, LLC





The Meter

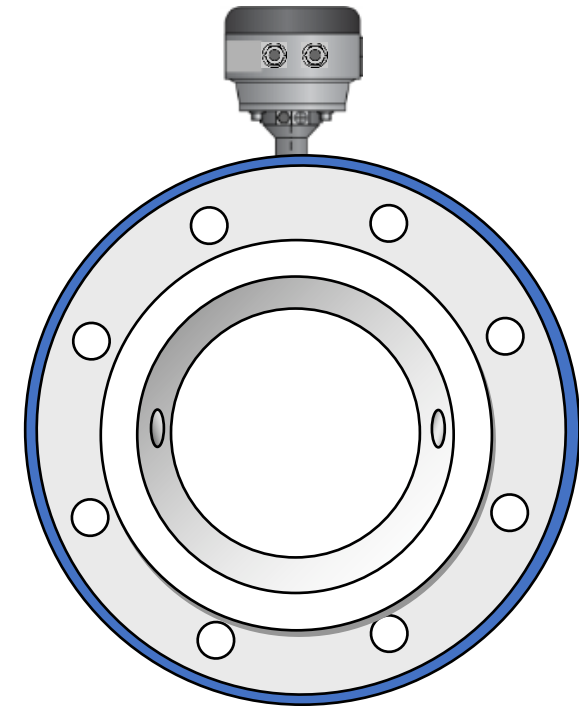
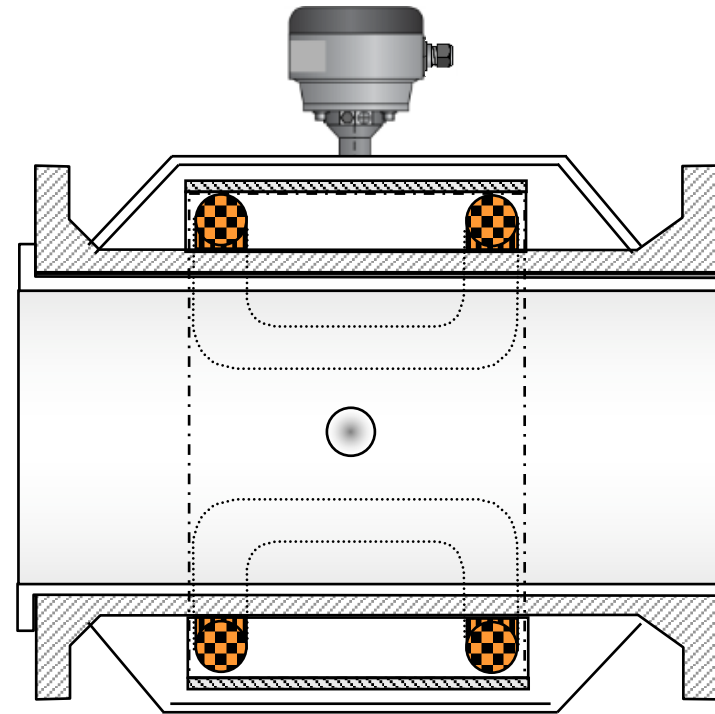
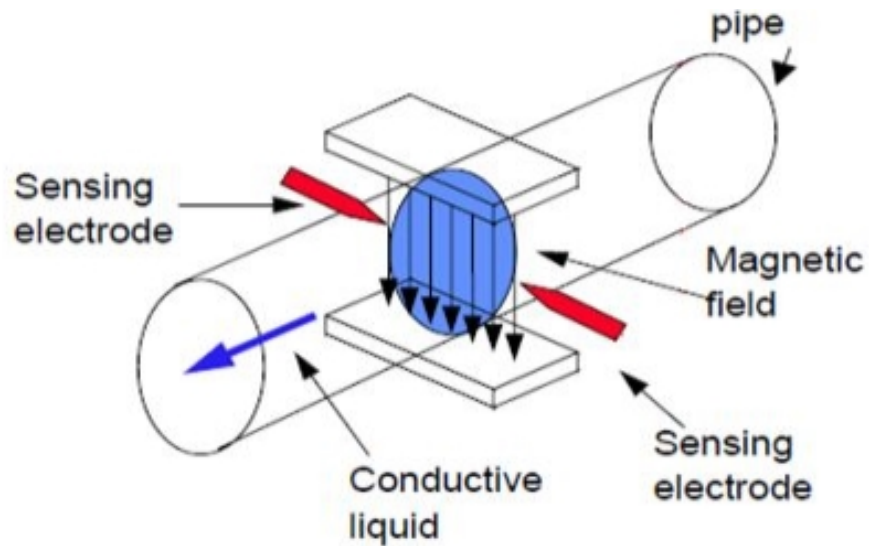


What is a magnetic flowmeter?

Electro-magnetic principle and flowmeter construction

The principle of the Magflow meter is based on **Faraday's law of induction** that states:

“If a **conductor** is moved through a **magnetic field**, a voltage will be induced that is proportional to the velocity of the conductor”



Mag flowmeter construction

- Measuring tube
- Liner or coating
- Pair of electrodes
- Pair of coils
- Magnet-foil
- Coil house
- Connection box



Grounding

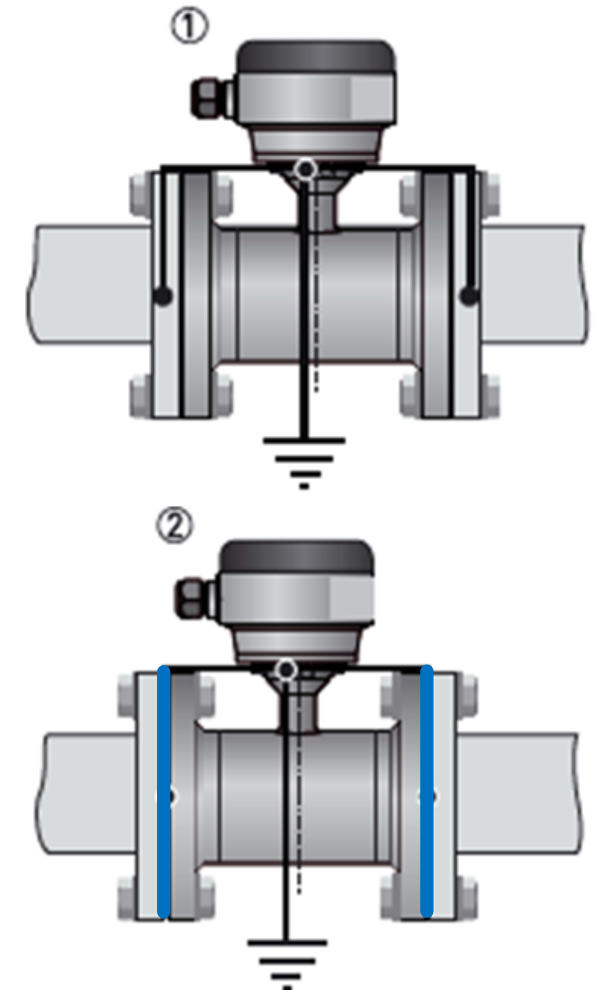


Electro-magnetic Flow Basics

Grounding

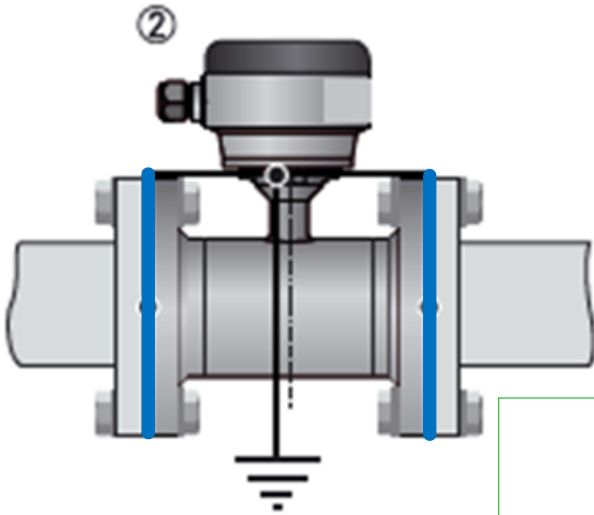
80% of all issues with a Magflow meter are grounding issues since the signals are referenced to the fluid potential rather than earth ground...which could be different.

- (1) When the flowtube is mounted between **unlined/uncoated metal** pipes, the flange bolts provide the electrical connection from the flowtube to the pipeline and, therefore, the fluid.
- (2) When the flowtube is mounted between **non-metal or lined/coated metal** pipe, installation of grounding rings on each pipe flange is required. Continuity is provided by connecting grounding wires from the flowtube to the grounding rings.
- (3) **Virtual reference**, also known as **virtual grounding**: Virtual Reference eliminates need for grounding of process fluid by providing complete isolation of flow converter's input amplifier and coil power circuits.



MagPLUS grounding solutions

Grounding rings



Traditional grounding:

Fluid must have same ground as magflow system to prevent floating potential due to ground loops.

For plastic or coated pipes grounding rings are generally required!

Grounding Ring Styles



Type 1
• 3mm / 0.1" thick



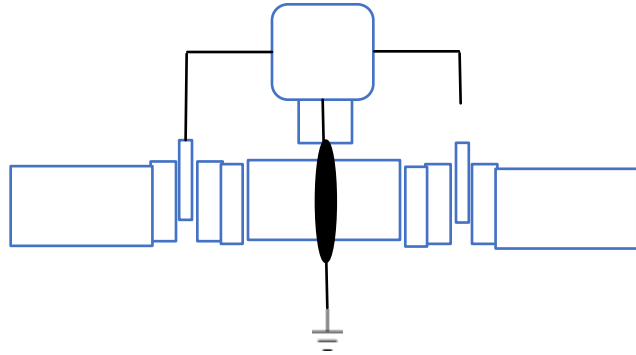
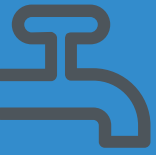
Type 2
• Primarily for PTFE to constrain the liner
• 3mm / 0.1" thick
• Protection during shipment and installation



Type 3
• 3mm / 0.1" thick
• Cylindrical neck
• Prevents damage to the liner when abrasive liquids are used

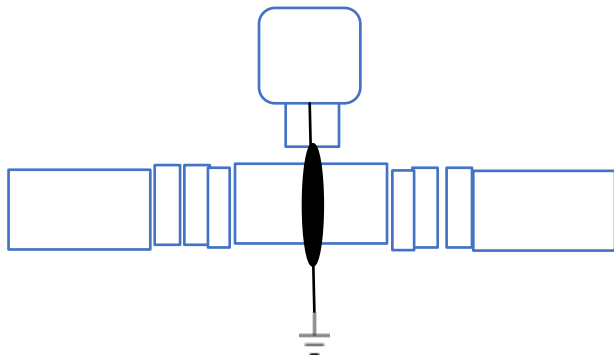


Something new: *Virtual Reference*



Traditional grounding: Fluid must have same ground as magflow system to prevent floating potential due to ground loops. For plastic or coated pipes grounding rings or electrodes are generally required

- Has the possibility of more leak paths
- Very costly for large meters
- Very costly for corrosive fluids which may require titanium, platinum or tantalum



Available with IMT33A

Virtual reference, also known as **virtual grounding**: Measures the potential of the fluid and compensates. No need for costly grounding rings or electrodes for:

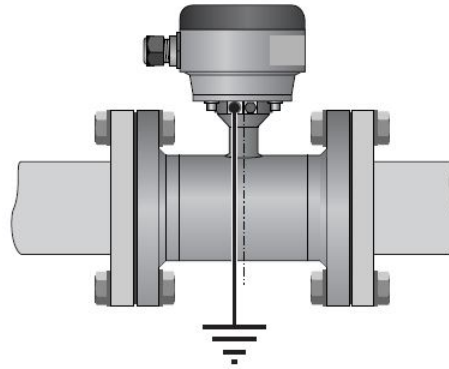
- Fluids with conductivities \geq to 200 microsiemens
- Line sizes \geq DN10, 3/8"

MagPLUS Grounding Solutions

Virtual grounding

Why eliminate grounding rings?

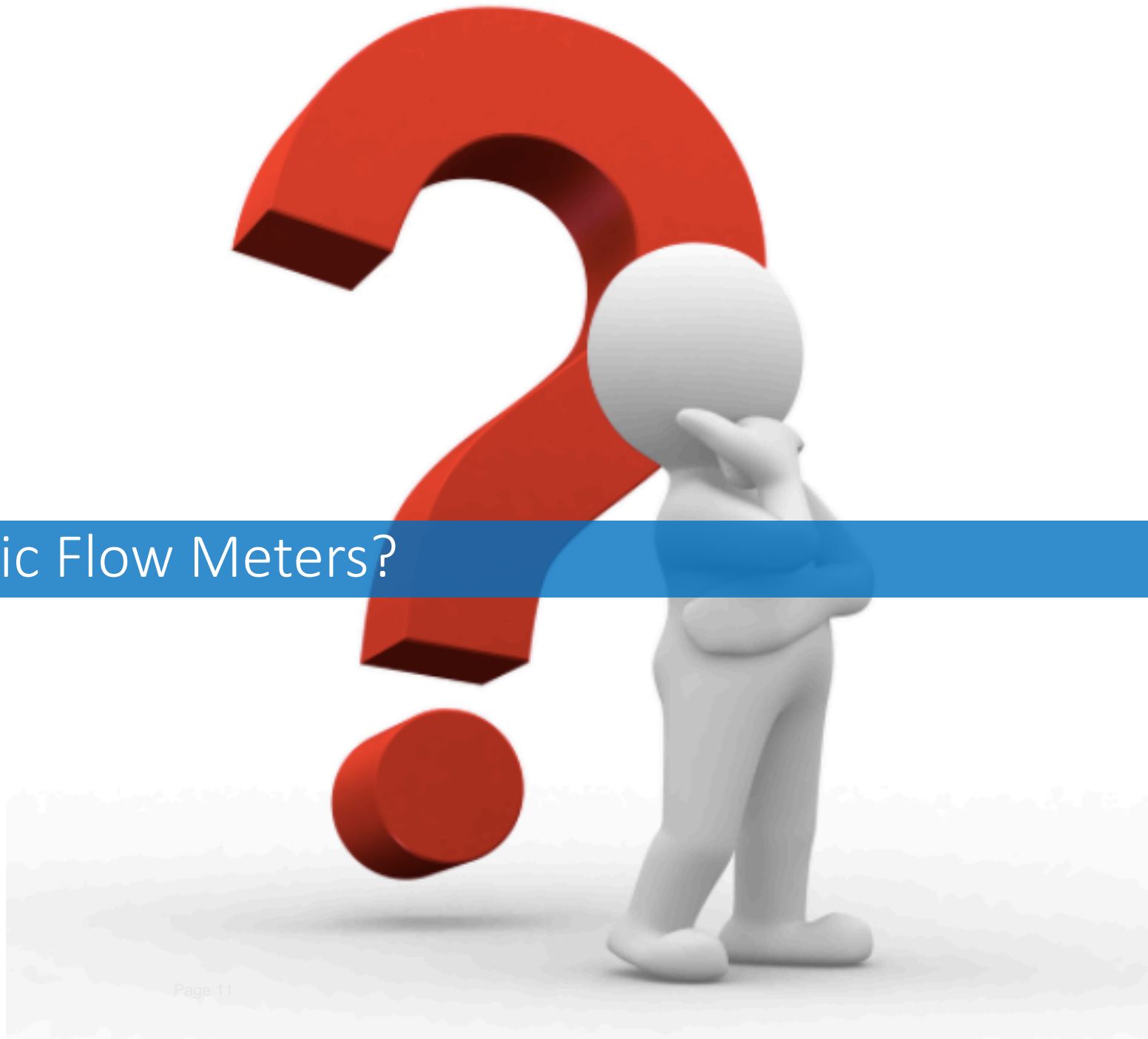
- Very costly for large meters
- Very costly for corrosive fluids which may require: titanium, platinum, tantalum or other
- Has the possibility of more leak paths



How?

- provides complete isolation of flow converter's input amplifier and coil power circuits.
- Measurement circuit 'floats' at liquid's potential, sensing only induced voltage caused by fluid velocity
- no earth connection to liquid is required.
- Simplifies installation and reduces (high) costs of purchasing exotic metal grounding rings or electrodes

Why Magnetic Flow Meters?



Magflow market

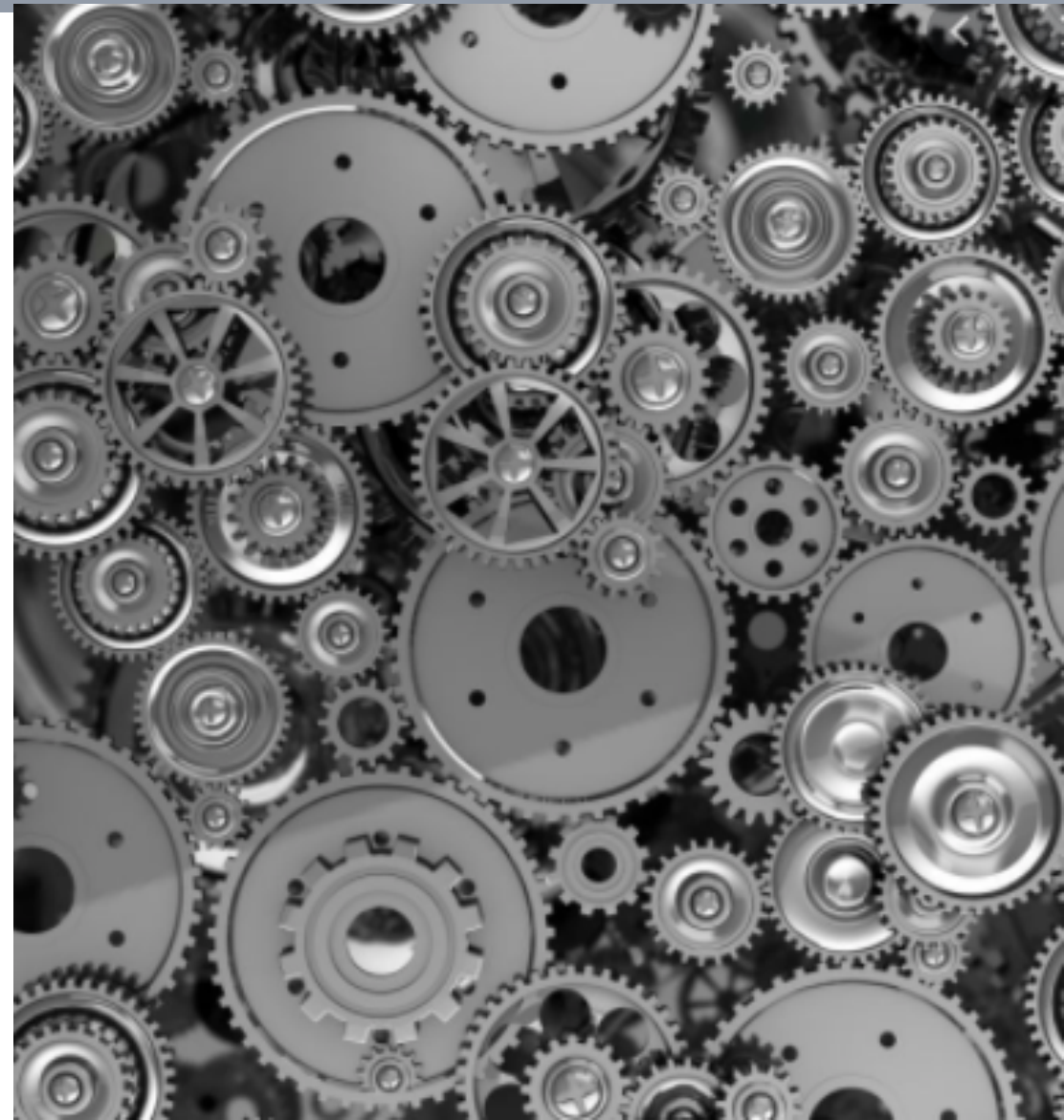
Magnetic Flow Meters make up 24% of all flow meters purchased world wide

Recent studies have predicted a huge future for magnetic flow meters as their use for measurements become common.

This is a result of several factors, the most important ones being the increase in the technology's capabilities as well as rising interest and restrictions in environmental impacts

Considerations

- Incredibly small space required, as small as:
 - 3-5 upstream diameters
 - 0-3 down stream diameter
- NO mechanical parts, NO obstructions
 - Very resistant to wear in abrasive applications
- Full bore
- Multitude of connection types
 - 3A Tri-Clamp
 - Wafer
 - Flanged



MagPlus --- Foxboro Magnetic Flow Meters

MagPLUS Transmitters

Interchangeable transmitters tailored to your application

IMT30A



- Most **economical** solution
- With or without display
- Compact or Wall mount
- 4-20mA, pulse and HART
- Local Total, RS485 Modbus
- Accuracy **0.5%** of rate typical
- Non-Ex device

IMT31A



- **Mid tier** solution
- Large backlit graphic display
- Compact or Wall mount
- Stainless Steel housing opt.
- 4-20mA, pulse and HART
- ATEX, IECEx, FM, CSA
- Accuracy **0.3%** of rate typical

IMT33A



- **Premium** solution
- High power transmitter
- Compact or Field, SST housing
- HART, Modbus, FF, Profibus PA
- Enhanced diagnostics
- **Virtual Grounding** option
- Full suite of certifications, Ex d
- Accuracy up to **0.2% of rate**

MagPLUS

A complete set of features

- Five industry-specific flowtubes
- Innovative design for a reliable solution to increase profitability

Features:

- Sizes 1/10" – 80" | DN2.5 - DN2000
- Liners: PFA, PTFE, ETFE, Polyurethane, Hard Rubber, Ceramic, Soft Rubber
- Electrodes: Hastelloy, SST, titanium, tantalum, platinum
- 4-20mA, HART, Modbus, FF, Profibus (later)
- Most international safety certs including FM, ATEX
- Drinking water approval, EHEDG & 3A certified
- Accuracy:
 - 0.5% ... IMT30A (> 0.5 m/s)
 - 0.3% ± 1 mm/s ... IMT31A
 - 0.2% ± 1 mm/s ... IMT33A
 - 0.15% ± 1 mm/s ... IMT33A + 8500A

W&W



9500A

F&B



9600A

Chemical



9700A



8400A



8500A

Released April 2016

Released January 2018

IMT30A



Low tier

IMT31A



Mid tier

IMT33A



High tier

Released April 2016

MagPLUS

Renew and complete our magnetic flowmeter portfolio

Differentiators

- Virtual reference grounding, reducing installation costs and potential leak points
- Continuous diagnostics with self-test on flow profile, conductivity and noise measurement
- Real solution for noisy application with Low noise electrodes, Spike filter, adjustable coil excitation frequency and higher power transmitter
- High accuracy up to 0.15% of the measured value



MagPLUS

New Converter IMT30A – Basic Feature Set

IMT30A



- Low tier solution
- Most economical solution
- Large graphic display
- 4-20mA, pulse and HART
- Local Total
- Compact or Wall mount
- RS485 Modbus
- Accuracy 0.5% of rate typical

Industries

- Water & Wastewater
- Food & Beverage
- Heating, Ventilation & Air Conditioning (HVAC)
- Agriculture
- Steel

Applications

- Water and wastewater treatment
- Water distribution network
- Irrigation installation
- Water abstraction
- CIP cleaning stations

New Converter IMT31A – Standard Feature Set

IMT31A



- Mid tier solution
- Large backlit graphic display
- HART, Modbus, FF
- Compact or Wall mount
- ATEX, IECEx, FM, CSA
- Accuracy 0.3% of rate typical

Industries

- Water & Wastewater
- Food & Beverage
- Agriculture
- Heating, Ventilation & Air Conditioning (HVAC)
- Machinery
- Power plants

Applications

- Measuring homogeneous media
- Water distribution networks and spray-irrigation systems
- Water treatment
- Environmental technology

New Converter IMT33A – Extended Feature Set

IMT33A



- High Tier solution
- High performance converter
- Compact, Wall or Field mounting
- Enhanced diagnostics
- Modular construction
- HART, Modbus, FF
- Full suite of certifications
- Accuracy up to 0.2% of rate

Industries

- Water & Wastewater
- Chemicals
- Food & Beverage
- Minerals & Mining
- Pharmaceuticals
- Power plants
- Pulp & Paper

Applications

- Products with low conductivity, high solid content or entrained air
- Inhomogeneous, abrasive and corrosive products
- Rapid product change
- Sudden change in pH value
- Pulsating or turbulent flows

Enhanced Diagnostics: IMT33A continuous self tests

Flowtube

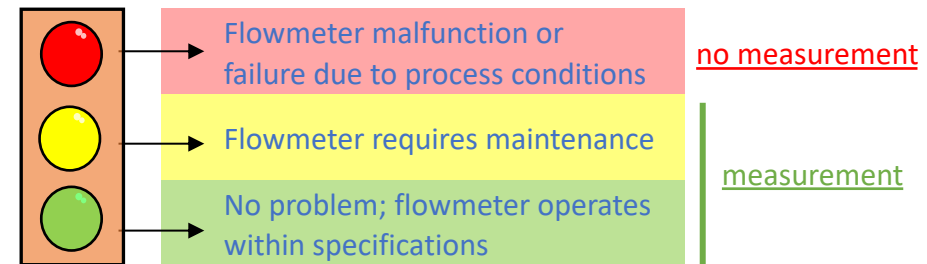
- Electrode fouling or scaling
- Electrode corrosion
- Electrode leakage
- Liner deformation
- Coil performance

Converter/ Transmitter

- Linearity check
- I/O check
- Functioning of converter components

Process

- Gas bubbles & solids
- Liquid conductivity
- Flowmeter temperature
- Partially filled pipe



Enhanced Diagnostics: Some Benefits

- Visibility to instrument and process issues
 - ➔ *Continuous health checking and notification*
- Reduced maintenance costs
 - ➔ *Spend less time checking healthy equipment*
- Reduced operations costs
 - ➔ *Predictive rather than reactive maintenance*



Mounting options

IMT30A



Wall



Compact / Integral

IMT31A



Wall



Compact / Integral

IMT33A



Field



Wall



Compact / Integral

MagPLUS Flowtubes

Five industry-specific flowtubes

W&W



9500A

- 1"-80" DN25-DN2000
- Hard Rubber liner
- Drinking water approvals

F&B



9600A

- 1/10"-6" DN2.5 DN150
- Retained PFA liner
- EHEDG and 3A sanitary certified

Chemicals



9700A

- 3/8"-80" DN10-DN2000
- PFA, PTFE, PU, ETFE, Soft Rubber
- Low noise electrodes

-40...+180°C
-40...+356°F



8400A

- 3/8"-6" DN10-DN150
- PFA liner
- Wafer style
- Economical



8500A

- 1/10"-4" DN2.5-DN100
- Ceramic liner
- Wafer style
- Up to 0.15% accuracy

Liners

- **PTFE (Teflon):** is the most widely used liner material
 - Very high temperature capability -40...+180°C / -40...+356°F
 - Excellent anti-stick characteristics reduce build-up
 - Inert to a wide range of acids and bases
 - **Chemical and process industry**

- **PFA:**
 - A better shape accuracy than PTFE
 - Better abrasion resistance
 - Better vacuum strength
 - -40...+180°C / -40...+356°F
 - Approved in **F&B, Pharma and Cosmetic industry**
 - **Chemical and process industry**

- **ETFE (eq. to Tefzel):**
 - Excellent chemical resistance
 - Better abrasion resistance than PTFE
 - Resistant to full vacuum retained liner
 - -40...+120°C / -40...+248°F
 - **Chemical and process industry**



- **Polyurethane:** Generally, the best choice when extreme resistance to wear and erosion is required;
 - Cannot be used with strong acids or bases
 - Cannot be used at high temperatures since its maximum process temperature is 65°C/149°F
 - **General purpose**

- **Hard rubber:**
 - Inexpensive general purpose liner
 - Wide range of corrosion resistance
 - -5...+80°C / 23...+176°F
 - Main application in the **water and waste water**



- **Ceramic:**
 - Highly recommended for very abrasive and/or corrosive applications
 - High temperatures up to 180°C / 356°F
 - Used extensively in the **chemical and process industry**, possibly **Pharmaceutical** (ed)



- **Soft Rubber (eq. to Linatex) :**
 - Excellent abrasion resistance particularly to large particles
 - Limited chemical resistance
 - -5...+60°C / 23...+140°F
 - Ideal for **mining slurries, drilling applications**

Liners: PFA for Food and Beverage

Why is PFA the perfect choice?

- Sanitary grade
- Retained for liner stability
- Wide temperature range
- Broad range of fluid compatibility



Liner Comparison

- ETFE vs. PTFE

ETFE : generic name of Tefzel® from DuPont™. More economical than PTFE for many applications. PTFE is available when needed since PTFE has wider chemical and temperature capabilities. In addition, ETFE is a roto-molded providing similar vacuum resistance to a screen retained liner. Both ETFE and PTFE are Fluoro-based liners.

→ Use ETFE over PTFE, unless specs require PTFE liner.


- PFA vs PTFE

PFA liner is also a Fluor-based liner with better chemical performance than PTFE and high temperature resistance similar to PTFE. It has a denser molecular compound than PTFE, allowing less diffusion/blistering than PTFE. PFA is molded directly in the flowtube and is reinforced with a stainless steel grid, resulting in an extremely good mechanical performance under vacuum pressure conditions. PFA will take a full vacuum at 180°C / 356°F, whereas PTFE liner can be adversely affected by exposure to vacuum pressure. PFA has a better abrasion resistance than PTFE.

Portfolio Overview

Legacy offer

9100A 4700S



Discontinued

9300A 9200A 8000A



E96 IMT96 2800



Discontinued

MAG2



W&W

F&B

Chemical

P&P

Low Power



9500A 9600A 9700A 8400A 8500A

IMT30A IMT31A IMT33A



Low tier Mid tier High tier

MagPLUS

Summary of Features

- Competitive price and deliveries
- Global certifications
- HART, Foundation Fieldbus, Modbus
- 14 operating languages incl. Russian and Chinese
- Wide variety of end connections
- Virtual reference / grounding
- Enhanced diagnostics for verification
- Modular construction
- Wide variety of transmitter mountings

MagPLUS



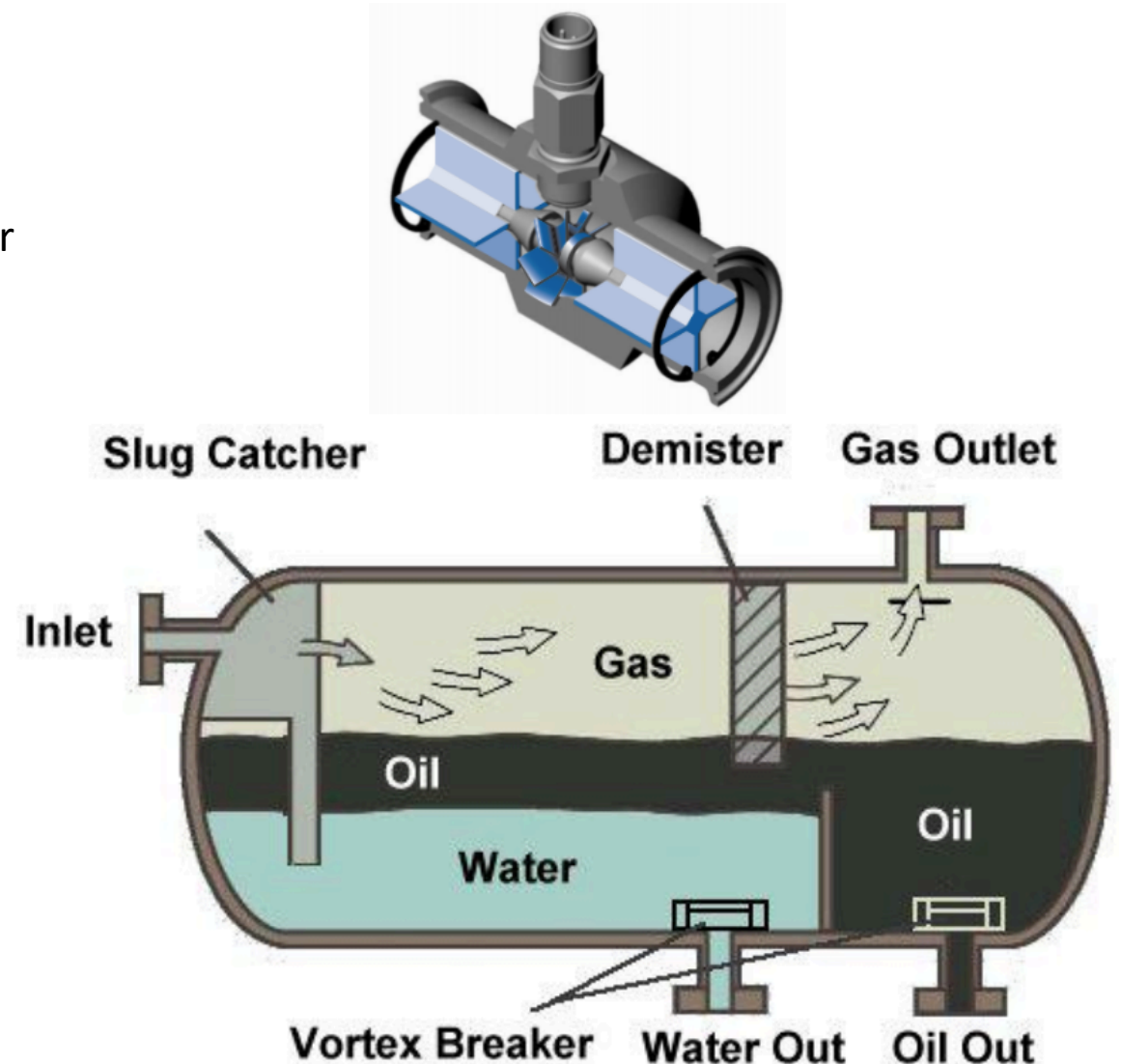
Applications



Upstream Oil & Gas

Costly Separation

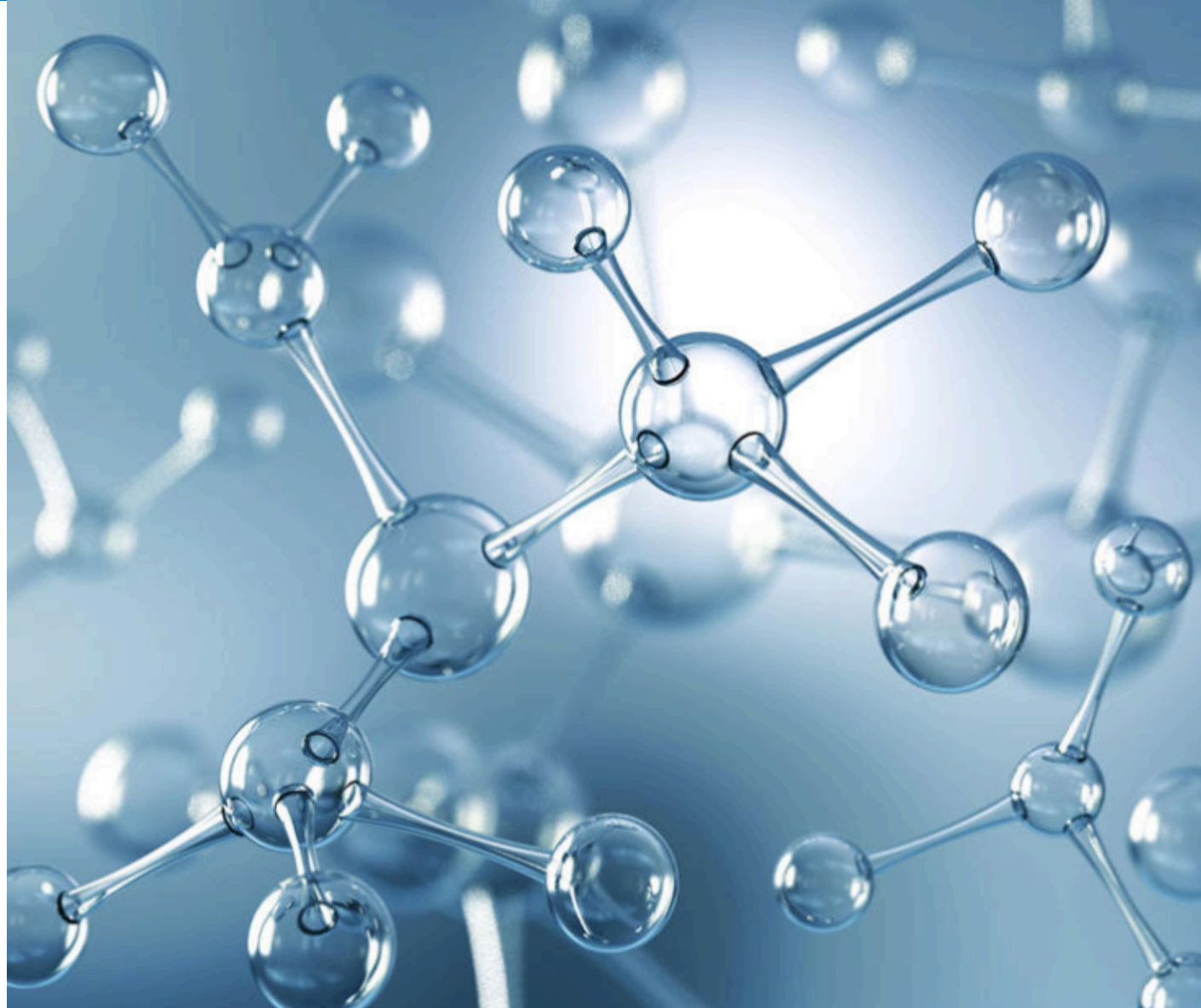
- Oil production has changed!
- Increasing amounts of separation and treatment of water needed
- In some applications there is up to a 4:1 ratio of water to oil
- Considerations; where Mag Meters excel:
 - Slurry
 - Corrosive
 - Accuracy
 - Installation
- Wastewater byproduct from these processes is subject to EPA regulations
- Mag Meters an ideal choice to deal with water contaminants (sands / salts / oils), provide accurate measurement for custody transfer for disposal, adhere environmental regulations and more!



Chemical

Corrosive Applications

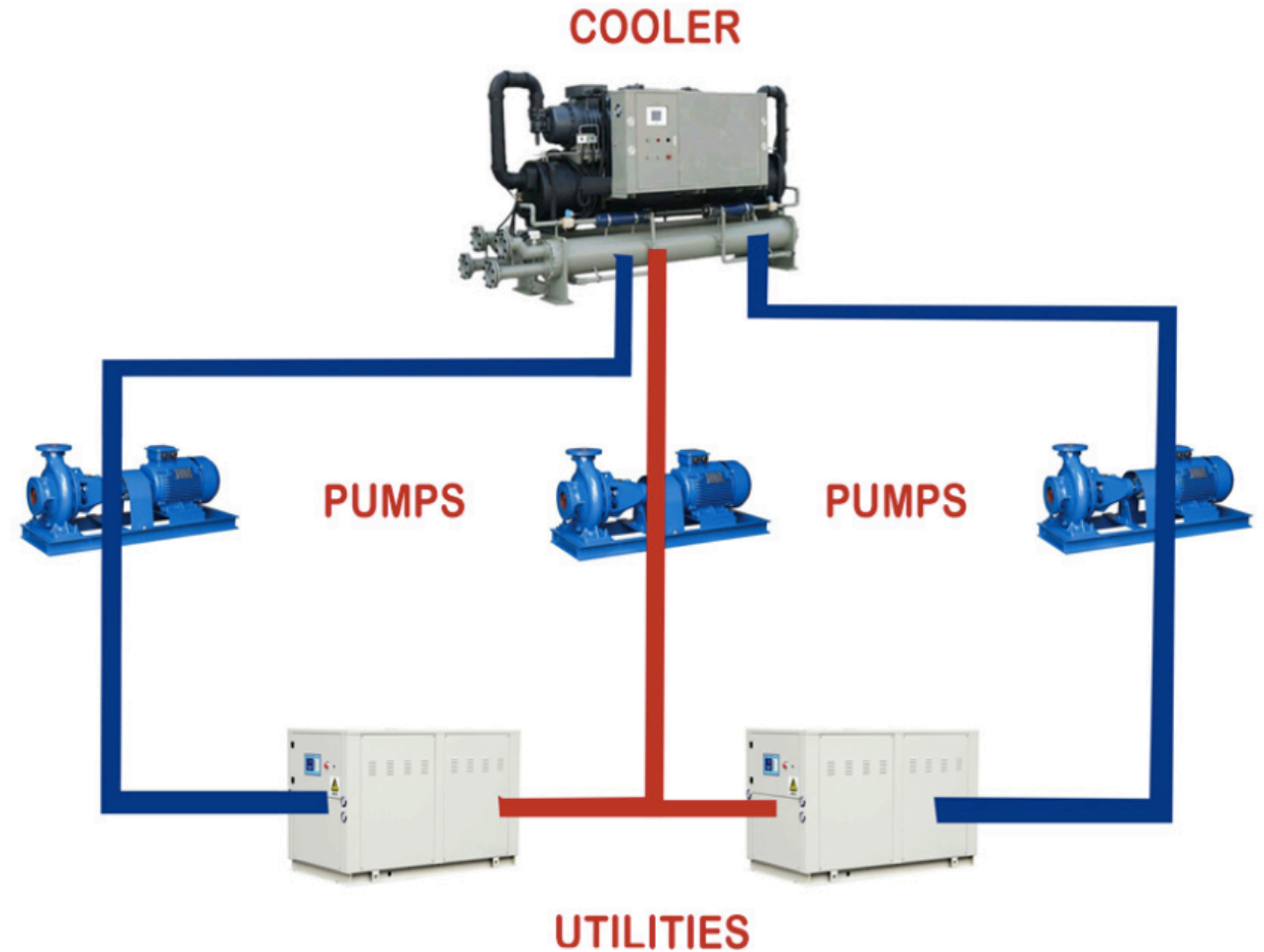
- Chemically compatible liners and wetted parts
- Thermal shock resistance
- Fast response time
- Accurate measurements
- Small piping requirements
- CIP/SIP



HVAC

Energy Monitoring in Buildings

- Energy Consumption and accurate measurement is a focal point across many facilities
 - Greater Efficiency = Reduced Costs
 - Greater Efficiency = Environmentally Friendly
- HVAC systems have the potential for HUGE energy consumption
- Responsibility usually falls on the facility manager
- Measure flow in hot or chilled water systems to provide baseline and load information that is necessary to evaluate efficiency within the system
- Effectively track the exact amount of water flowing from chillers / heaters to various sectors
- Will also measure temperature to account for inlet and outlet flow differences.



Mining

Slurry

- Variety of liners
- Full bore flow tube
- Resistant to wear in abrasive applications
- Ability to measure with high solid contents
 - Up to 70% in some cases
- Volumetric flow



Food & Beverage

Sanitary Applications

- Sanitary connections
- PFA lining
 - Sanitary grade
 - Stable liner
 - Wide temperature range
 - Compatible with most F&B media
- CIP/SIP capabilities
- Swappable transmitter while leaving flow tube in place
- Real time diagnostics give significant information about the process that were hard to track before

- Can handle bubbles, some solids
- Fruit pulp, juices, concentrates
- Batching





- Ease of Use

- The flowmeter design and the user friendly interface simplify installation, start-up and commissioning

- Flexibility

- Wide variety of industry approved end connects. The right product for the application.

- Larger diameters available up to DN150 for large-scale production plants, such as the beer or milk industrial production

- Reliability

- Rugged stainless steel housing for sanitary application. Ease of cleaning and hose down

- Precise overview of the process and advanced reliability thanks to integrated diagnostics

- Certifications

- Global electrical certifications

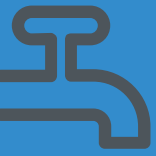
- 3A and EHEDG sanitary certifications for a demanding industry

Waste Water

Environmental considerations

- Arguably the most popular use for magnetic flow meters
- Can be used from untreated sewage all the way to clean water
- Swappable transmitter while leaving flow tube in place, no shut down / draining
- Advanced internal diagnostics give input on sensor life and process, makes for easier planning
- Available in wide range of sizes
 - 0" – 80" Line Size
- Cost Savings with IMT30A base transmitter





- Ease of Use

- The flowmeter design and the user friendly interface simplify installation, start-up and commissioning
- Configuration menus and instructions available in local languages
- With the new virtual reference grounding, the grounding rings can be left out, reducing installation costs

- Flexibility

- Three-tiered transmitters to provide the necessary value; Interchangeable to simplify ordering and stocking
- Complete line of sizes up to DN2000/80": One supplier for all W&W magflow applications

- Reliability

- Suitable for underground installation and constant flooding (IP68), with rugged liners

- Relevant global flow supplier

- Global electrical certifications
- Drinking water approvals including NFS 61, DVGW, WRAS, ACS



Competition



MagPLUS Differentiators

Unique points and value

- Virtual reference grounding, reducing installation costs and potential leak points
- Continuous diagnostics with self-test on flow profile, conductivity and noise measurement
- Real solution for noisy application with Low noise electrodes, Spike filter, adjustable coil excitation frequency and higher power transmitter
- Accuracy to 0.15%
- Very low conductivity readability
- Complete portfolio with differentiated instruments

A glowing lightbulb is the central focus, set against a dark blue background filled with futuristic digital elements. The floor is covered in a complex, glowing orange circuit board pattern. Above the lightbulb, there are several glowing orange network nodes connected by thin lines, forming a web-like structure. The background also features faint, glowing blue lines and nodes, suggesting a larger network or data flow. The overall atmosphere is one of high-tech innovation and digital connectivity.

Other types of flow meters

Coriolis Flow Meter

Working Principle

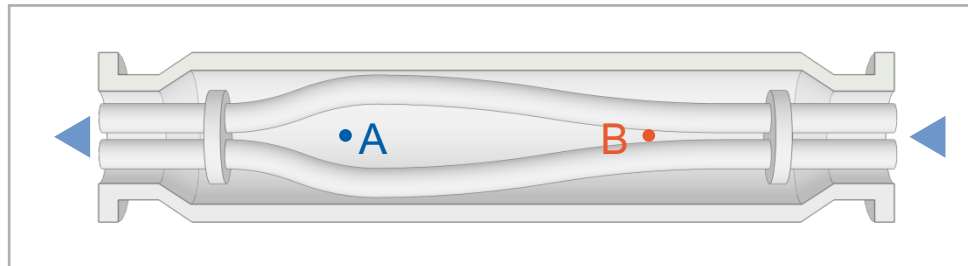
Flow + Driver Oscillation



As Mass flow rate increases
Time shift increases



The Coriolis mass flowmeter
is a bi-directional instrument



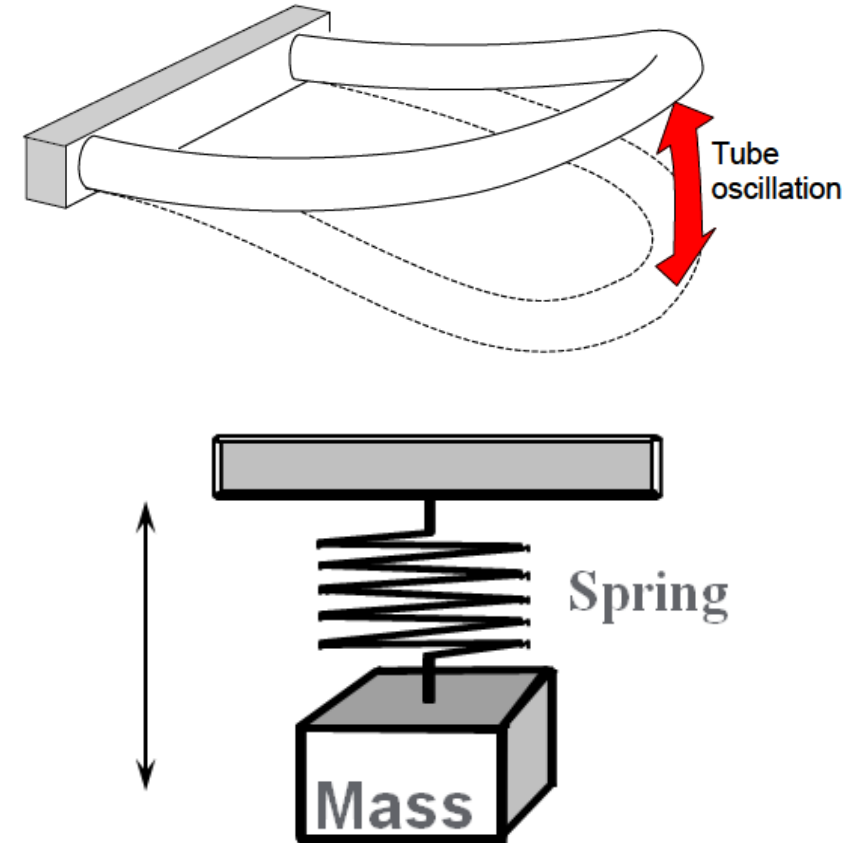
Coriolis Flow Meter

Density Measurement

- But there is more! **Density**
- Coriolis sensor tube is a cantilevered spring and mass assembly
- This is similar to **the single spring, single-mass dynamic system** shown here
- This dynamic system has a **natural oscillation frequency** described by:

$$f_n = \frac{1}{2\pi} \sqrt{\frac{k(\text{spring})}{m(\text{tube}) + m(\text{fluid})}}$$

Coriolis flowmeters can be used as Density meters



Coriolis Flow Meter

Best Accuracy & Reliability

Model CFS300A

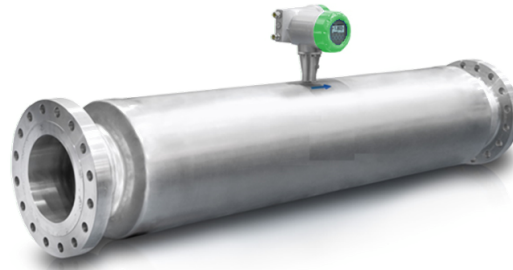
General Purpose



- Twin straight tube flowmeter
- 1/2", 1", 1.5", 2" / SST
- Accuracy $\pm 0.15\%$ of MV + zero stab.
- Max pressure 100 bar / 1450 psi
- Max temperature 130°C / 266°F
- Hazardous area, hygienic, and custody transfer approvals
- FF, Profibus, Modbus, HART 7
- Best price / performance ratio

Model CFS400A

Large Sizes



- Twin or quad straight tube
- 4", 6", 10" and 16"
- Duplex and Super Duplex
- Accuracy $\pm 0.10\%$ of MV + zero stab.
Superior Cal: $\pm 0.05\%$ of MV
- Max pressure 180 bar / 2610 psi
- Max temperature 130°C / 266°F
- Hazardous area, hygienic and custody transfer approvals

Model CFS700A

Exotic Material

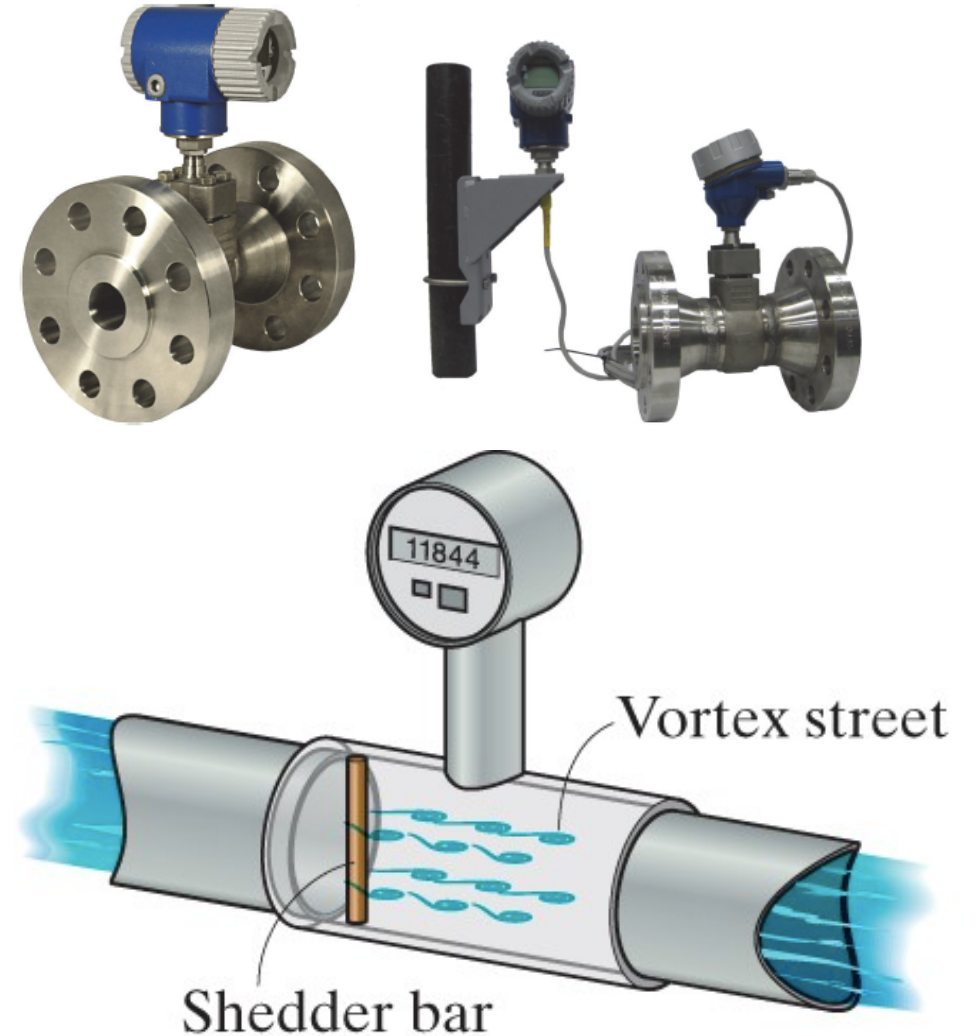


- Single straight tube flowmeter
- Duplex SS, Hastelloy C, Titanium, Tantalum
- 7 sizes: 1/8" ...3"
- Max pressure 100 bar / 1450 psi
- Max temperature 150°C / 302°F
- Accuracy $\pm 0.10\%$ of MV + zero stab.
- Hazardous area, hygienic and custody transfer approvals
- Best for demanding applications

Vortex Meter

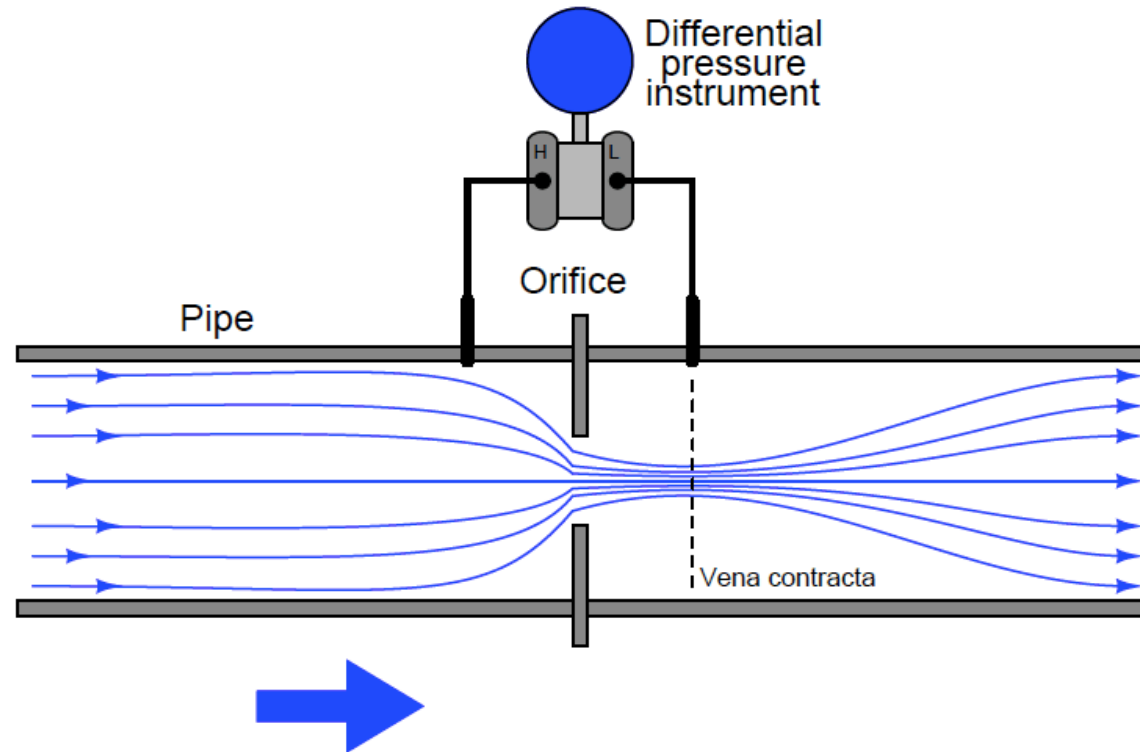
Best Steam measurement

- Liquid, gas or steam applications
 - Best technology for steam applications
- Model 84C, Flanged or Wafer
 - $\pm 0.5\%$ of reading in liquids.
 - $\pm 1.0\%$ of reading in gas and steam.
 - Low power versions available for use in battery or solar power applications.
 - HART communication protocol, 4 to 20 mA, and pulse outputs.
 - High reliability backed by lifetime sensor warranty.



Orifice Plate w/ DP Measurement

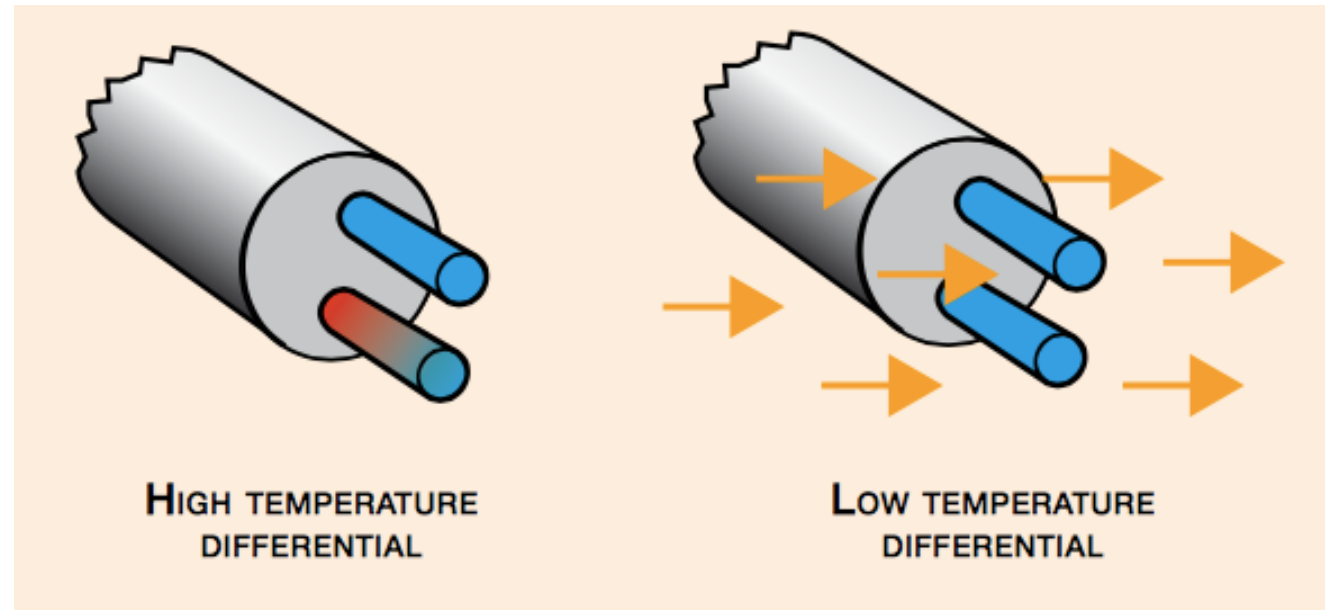
- Used with orifice plates that create artificial constriction
 - Based off Bernoulli's principles
- Oil and Gas applications
 - Compressors
 - Gas Lift
 - Injections
 - Wellheads
 - Wet Gas & many more



Thermal Dispersion Flow Meter

Gas Flow

- Based on heat transfer principles
- GAS ONLY
- Uses RTDs, one at process temp and another being constantly heated
- As flow rate increase, temperature difference decreases
 - The amount of power required to heat the RTD is directly related to the flow rate



Common Applications:

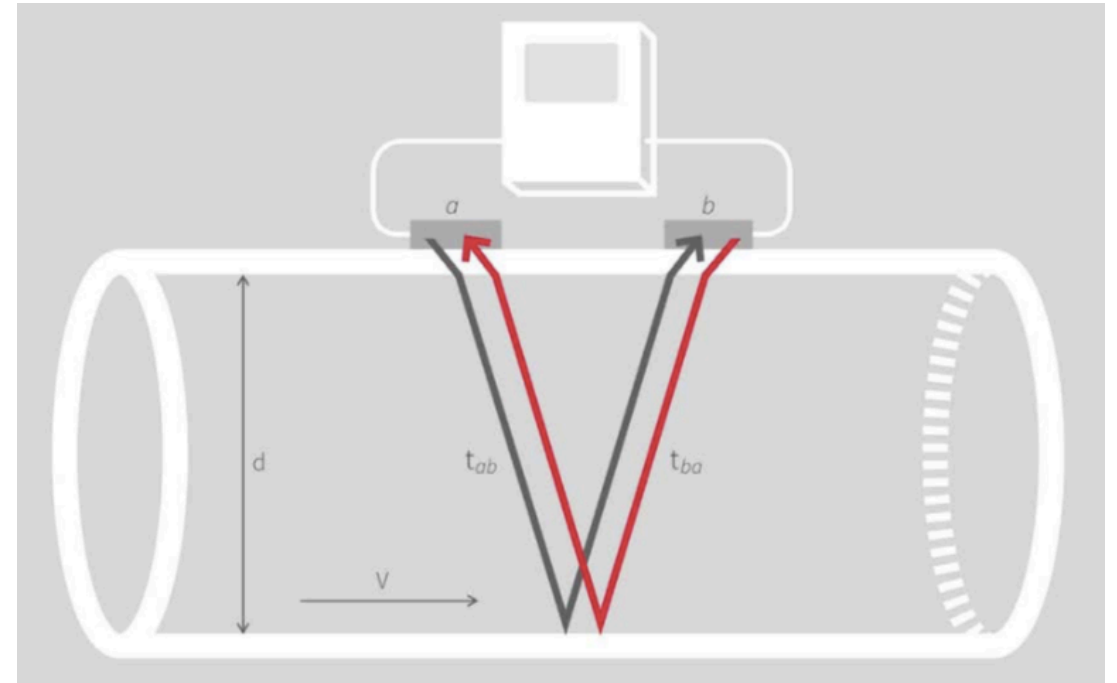
Combustion air, compressed air, natural gas, digester/bio-gas/landfill gas, vent lines/flares, Hydrogen lines, Nitrogen blanketing



Ultrasonic Meter

Non-intrusive, mobile

- Time of flight measurement between transducers
- Sound waves move faster with flow than against it, the comparison of the times generates the flow measurement
- LIQUID ONLY
- Applications:
 - Pump testing, in-line flow meter verification, leakage/blockage detection, CIP testing, clean room applications



Nuclear Flow Measurement

Bulk Flow

- Radiometric belt scales
 - Used to measure flow rates and throughputs on conveying systems
- Combining the measured conveyor load with the velocity signal, the mass flow rate can be determined very accurately
 - Not affected by dust, temperature, vibrations, varying particle size or chemical properties
- Mostly used in mining applications



Conclusion

- Magnetic Flowmeters are an essential part of the flow measurement world and the advancing technology is bringing about new viability across industries
- Innovative Process Controls is an educated, well equipped team that prides itself on its effectiveness and fast response times
- We have deep seated industry knowledge and are willing to go the extra mile to facilitate customer requirements
- Broad range of instrumentation offerings

Questions?