Water flow measurement in the oil and gas industry

The importance of selection
Proper selection of the flow technology

Why is it important

In oil and gas we are seeing a drop in crude prices and the biggest challenge for producers offshore and onshore is finding ways to cut cost during this period.

A large focus in regards to environmental regulations and the increase in water has forced many producers to reevaluate their water management process whether it is for fresh water or produced water.

The cost of water management has become a major cost for the oil and gas industry. Proper selection of flow measurement instruments can help negate some of this cost but also improve overall performance.
Agenda

• Turbine flow meter
• Coriolis
• Ultrasonic flow (Clamp-on)
• Electromagnetic flow meters.
Turbine flow meters

### Turbine meter: Inferential technology

A very simple mechanical - inferential technology. Fresh or produced water impinging on the blades of the turbine cause the blades to rotate and with magnets fitted in the rotor assembly. Calibration to the liquid being measured a K-factor of the liquid is entered into the operating parameters of the unit. To remain repeatable the viscosity of the water must remain constant. For fresh water, the viscosity remains constant; with produced water, a slight change in viscosity occurs causing errors in measurement.

This technology is suitable for fresh water applications but should not be considered as the best technology unless the source of fresh water is free of particulates. Due to sand, paraffin and other particulates found in produced water the turbine meter is not the best technology for measuring flow of produced water.
## Turbine flow meters

<table>
<thead>
<tr>
<th><strong>Pros:</strong></th>
<th><strong>Cons:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low purchase cost.</td>
<td>• Preventive maintenance is key to maintaining accuracy and repeatability</td>
</tr>
<tr>
<td>• Operators are very comfortable using this technology</td>
<td>• Maintenance may not be needed at the time of scheduled maintenance</td>
</tr>
<tr>
<td>• Accuracy +/- 0.2% to 0.5% and repeatable at +/- 0.5% to 1% <strong>if maintained properly</strong></td>
<td>• Keeping an inventory of replacement parts is required</td>
</tr>
<tr>
<td>• Easily repairable</td>
<td>• An improperly maintained unit will have increased inaccuracies that will go unnoticed, causing loss revenue</td>
</tr>
<tr>
<td>• Easy setup and calibration</td>
<td>• Uns suited for dirty liquids</td>
</tr>
<tr>
<td></td>
<td>• Long inlet/outlet sections (10D/5D) required</td>
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</table>
For water applications, the Coriolis effect does provide a higher accuracy than most other technologies. The largest advancement is the compactness of the unit, allowing the unit to be mounted in tight areas and on skids that are key to the treatment of produced and waste water.
## Coriolis flow meter

### Pros:
- Mass-flow measurement ranges cover from less than 5 g/m to more than 350 tons/hr
- Liquid or gas mass-flow measurement
- Direct, in-line and accurate mass-flow measurement of both liquids and gases
- Accuracies as high as 0.1%
- Measurement is independent of temperature, pressure, viscosity, conductivity and density of the medium
- Direct, in-line and accurate density measurement of both liquids and gases
- Mass-flow, density and temperature can be accessed from the one sensor, and can be used for almost any application irrespective of the density of the process

### Cons:
- Expensive; the larger the size, the greater the price difference between electromagnetic and turbine meters
- Many models are affected by vibration (Siemens FC430 Coriolis flow meter has been field proven to be less susceptible to vibration)
Ultrasonic clamp-on flow meter

The two technologies used in ultrasonic Clamp-on flow metering are Doppler and Transit-time, allowing for the measurement of most liquids. It is a non-intrusive technology that can be mounted for temporary or permanent measurement. Clamp-on flow meters are ideal for upgrading any water flow line without having to cut the line or stop the process to install.

The advancement of ultrasonic Clamp-On systems with wide beam technology harmonizes the ultrasonic transducers to the pipe producing a stronger, stable, and coherent signal independent of the flowing medium and velocity providing improved accuracy and repeatability.
Principles of operation – Transmit / receive

Transmit / receive and zeromatic path

Transmit / receive

• Each sensor alternately transmits and receives
• “Wide beam” signal uses pipe wall as waveguide
• Pipe wall resonation generates signal into liquid
• Match of sensor to pipe ensures stable signal

Zeromatic path

• Continuous zero check
• No need to stop flow to zero
### Ultrasonic Clamp-on flow meter

#### Pros:
- Easy installation; no need to cut pipe or stop flow
- Can be installed in harsh environments
- No pressure drop or energy loss
- Minimal maintenance; external transducers that do not require periodic cleaning
- Bidirectional flow
- Detects reverse flow and empty pipe
- Insensitive to outside noise with wide beam technology
- Field installation accuracy: ±0.5 to 1.0% at ≥0.3 m/s (1ft/s). Other manufacturers the accuracy could be high as ± 3.0%
- Custody transfer capability

#### Cons:
- Not all manufacturers use wide beam technology
- Accuracy fluctuate between manufactures.
- Installation is critical to obtain the best accuracy
Electromagnetic flow meter

The electromagnetic flow meter is a proven technology and is the primary flow element for the water and wastewater industry. It is now aggressively growing in the oil and gas industry.

The base of the technology is Faraday’s law. The coils in the sensor generate a consistent magnetic field. The liquid flowing through the sensor induces a voltage proportional to the flow velocity. With no moving parts the technology is virtually maintenance-free.
### Electromagnetic flow meter

<table>
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<tbody>
<tr>
<td>• No pressure drop</td>
<td>• Conductive fluids liquids only</td>
</tr>
<tr>
<td>• Short inlet/outlet sections (5D/2D) or less</td>
<td>• If coil or electrodes fails or do become damaged, the unit is beyond repair and will have to be</td>
</tr>
<tr>
<td>• Insensitive to flow profile changes (laminar to turbulent)</td>
<td>replaced.</td>
</tr>
<tr>
<td>• Accuracy of better than ±0.2% of actual flow over full range.</td>
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<td>• No recalibration requirements.</td>
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<td>• Flow verification and calibration can be done in the field</td>
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<tr>
<td>• No obstruction to flow</td>
<td>without interfering with the process</td>
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<tr>
<td>• Not limited to clean fluids</td>
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<tr>
<td>• High temp and harsh environment conditions</td>
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<tr>
<td>• Volumetric flow</td>
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Conclusion

For most water applications this technology will be overpriced and overkill. However, in water treatment (chemical blending) applications or CT requirements this unit would be the correct choice.

For existing applications the non-intrusive installation prevents cutting into pipes and stopping the process. This technology would be the correct choice.

For the majority of water, produced water and waste water applications this proven technology is the logical and smart choice.
Conclusion

Sticking to the old field standard of “if it’s not broke don’t fix it” – and not utilizing the best available technologies - could actually be costing producers and other support companies millions of dollars. The best way to ensure you are using the best technology to meet all the requirements of the water flow applications and still provide a return on the investment is to evaluate the who, what, where, when and how’s of the flow technologies. The best source to help in making the right choice is the manufacturer of these technologies, but do remember the same consideration is important for the manufacturers. Choose wisely.
We are happy to answer your questions!