Flexim

Non-intrusive Ultrasonic Flow Meters for Liquids

How to Participate Today

- Audio Modes
  - Listen using Mic & Speakers
  - Or, select “Use Telephone” and dial the conference (please remember long distance phone charges apply).
- Submit your questions using the Questions pane.
- A recording will be available for replay shortly after this webcast.
Today’s Speaker

John Van Nostrand
Southeast Regional & Municipal Manager

Agenda

• Where we are today
• Outside influences
• Common Flow metering technology
• Recent Ultrasonic Technology Developments
• Applications
**Covid–19 Concerns**

Long lasting consequences
- Loss of Tax revenue due to job loss
- Closures
  - Restaurants, Manufacturing facilities, Dental/Medical offices, Theaters & Universities
- Declining sales
- Late Payments

Water is essential
- Suspend water shut off for non-payment

Could see a loss as much as $12.5 billion in revenue

Could Rate Increases be on the Horizon?
- Will have a lasting effect on Operations.

**Market trend is Regulation and more Regulation**

Regulation is driving the need for metering

Only 3% of the water on the plant is fresh, and regulators are pushing for better resource management.

In 2010 the US consumed 355,000,000 per day
What’s Most Important?

Level 1 Measures
• Universal metering
• Water accounting and loss control
• Costing and pricing
• Information and education

Level 2 Measures
• Water-use audits
• Retrofits
• Pressure management
• Landscape efficiency

Level 3 Measures
• Replacements and promotions
• Reuse and recycling
• Water-use regulation
• Integrated resource management

Typical Measurement Technologies
The Use of Primary Elements

Figure 1
- Square-welded Orifice Plate
- Flange Pressure Taps
- Insulated and heat trace
- Lines don’t freeze in winter shutdowns
- Transmitter is under the pipe to retain wet legs
- Filled wet legs (water, glycol) protect sensor from being exposed to excessively high temperature

Figure 2
- Convergent Entrance
- Cylindrical Inlet
- Throat
- Divergent Outlet

Square Root Law

Actual Flow meter curve 0-100% under sq root law

Calibration curve of a typical dp transmitter
Magmeters

Magmeter low flow

Mfr B Magnetic Flow Meter Data

Percent Deviation vs Water Velocity (fps)

- Mfr Accuracy Specification: ±0.25% @ 50
Ultrasonic Introduction

The Old Days

Doppler meters had Varying levels of success.

Today

No other meter on the Planet works as well as a Flexim meter in Water and Wastewater applications.

Technology is changing in water and wastewater
Improved Monitoring

- Extreme low flow measurements with ultrasound
- Measuring low flows with ultrasound technology has always been a strength of FLEXIM
- Even the slowest flow velocity of the media measured leads to transit time differences of the ultrasound signals
- FLEXIM has now developed a flow meter with even greater accuracy in the measurement of extremely low flows

Piezoelectric Crystal

Creating Ultrasonic Sound
Piezoelectric Phenomenon

Voltage

Crystal Rings to Produce Ultrasound – 0.5 to 2 MHz
Doppler meters use sound pulse reflection principle to measure liquid flow rate, solids or bubbles in suspension in the liquid reflect the sound back to the receiving transducer. **Assumption** - Reflected particle representative of average flow.

**Doppler in Flow Measurement**

**Operation Principle**

**Meter formula**

\[ v_i = k_a \frac{\Delta t}{2t_F} \]

**Acoustic calibration factor**

\[ k_a = \frac{c_a}{\sin \alpha} \]

**Snell's Law**

\[ \frac{c_a}{\sin \alpha} = \frac{c_b}{\sin \beta} = \frac{c_c}{\sin \gamma} \]

**Fluid mechanical calibration factor**

\[ Q = A k_{Re} v_i \]
No Zero Drift

- Unlimited Flow Range
- No Drift!!! No Deadband!!! – measure to zero flow!!!

Flexim Meter

Temperature change is 70°F to 115°F
Holds Zero
Leading Brands

Drift of 2cm/sec = .07 ft/sec = 6 GPM on a 6” pipe

Drift of 3cm/sec = .1 ft/sec = 9 GPM on a 6” pipe

Leading Brand signal processing

- Entire signal is used – each marker on the signal is a digital point used to calculate time difference measurement
17025 NIST Traceable Calibration

Calibration Station
traceable to national standards
(DKD, PTB / Alden labs NIST)
all transducers sets are hydraulically calibrated

Technology is changing in water and wastewater

40°F to 80°F
1425 to 1485 m/sec
NaOCl

![FluxFlow report](image)

**sound speed versus concentration at different temperatures**

- 40 °C
- 50 °C
- 60 °C
- 70 °C
- 80 °C
- 90 °C
- 100 °C

**... external measurement of internal flow**
Approvals for water and Wastewater Industry

ISO17025 - Calibration Certification

AWWA C50-19 – AWWA Approval
C750 - Transit-Time Flowmeters in Full Closed Conduits

ASME MFC5M

NSF is not a requirement for Clamp-On technology

No meter left behind – Customer Approval

AWWA is there to help
Where FLEXIM Fits

Water Plant Flow

Wastewater Treatment Metering Points
Water Balance

**Flexim can help**

<table>
<thead>
<tr>
<th>Water Loss balance</th>
<th>System Input Volume</th>
<th>Water Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billed Authorized Consumption</td>
<td>Authorized Consumption</td>
<td>Apparent Losses (Commercial Losses)</td>
</tr>
<tr>
<td>Billed Un-metered Consumption</td>
<td>Billed Un-metered Consumption</td>
<td>Real Losses (Physical Losses)</td>
</tr>
<tr>
<td>Unauthorized Consumption</td>
<td>Unauthorized Consumption</td>
<td>Leakage in Transmission and Distribution Mains</td>
</tr>
<tr>
<td>Customer Meter Inaccuracies</td>
<td>Systematic Data Handling Errors</td>
<td>Storage Leaks and Overflows from Water Storage Tanks</td>
</tr>
<tr>
<td>Non Revenue Water (NRW)</td>
<td></td>
<td>Service Connections Leaks up to the Meter</td>
</tr>
</tbody>
</table>

**Convert to metered consumption**

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Water Loss

**Growing political pressure to reduce water loss**

- Political issue on municipal level
- Competition among municipalities for low water loss rates and increase revenue
- Municipalities with high loss rates are regarded as badly managed,
- EPA pressures municipalities to reduce water loss by pushing them to feel the revenue loss.
- Utilities must monitor their networks more precisely
Lead and Copper

The Lead and Copper Rule, LCR, was originally established in 1991
• encouraged putting anti-corrosion additives into drinking water to coat the insides of the pipes to prevent metals from leeching into the drinking water.

The Action Level (AL) for lead in drinking water is fifteen parts per billion (15 PPB).
• Lead is particularly dangerous to children: their growing bodies absorb more lead than adults and their brains and nervous systems are more sensitive to the damaging effects of lead.

The LCR is evolving to include enforcement of Lead and Copper reduction.
• Corrosion Control Treatment (CCT). Those that serve fewer are not required unless they exceed the Lead and Copper Action Level of 15PPB

Chemical and Mineral Induced Fouling

Injecting chemicals have unintended consequences on magnetic flowmeters.

The coating fouls the electrodes and renders the Magmeter useless.

Flow comparison FLEXIm vs. Magmeter

![Graph showing flow comparison between FLEXIm and Magmeter](image)
Another Important Consideration.

**Magnetite** is a mineral and one of three common naturally-occurring oxides of iron. Its chemical formula is Fe₃O₄ and it is a member of the spinel group. Magnetite is ferrimagnetic; it is attracted to a magnet and can be magnetized to become a permanent magnet itself. It is the most magnetic of all the naturally-occurring minerals on Earth.

What about maintenance?

Since electromagnetic flow meters have no moving parts, maintenance is typically very minimal. Expected service life is 30 years. Depending on your fluid media and/or water quality, the electrodes may need to be periodically cleaned according to the manufacturer’s recommendations.

To clean electrodes:
- The meter must be removed from the line and the inside of the meter must physically cleaned.
- Electrode cleaning circuits DO NOT WORK on minerals build up!

Still considering Magnetic Flow Meters where Iron Oxide is present in the water?

**Magnet is in the name!**
Identifying the problem

Magnetic flowmeters contribute to water loss when water is wells high in iron and when chemicals like orthophosphate are injected.
Improved Monitoring

Low flows are Normal flows
- Most municipal water systems are designed for future growth. Working with our customers has helped us realize that flow velocities in drinking water pipes 6” – 12” seldom exceed 3 ft/sec
- A further realization is that in these pipes the minimum nightly flow velocity is usually below 0.26 ft/s
- Flow velocities into DMAs are much lower than assumed

• In a considerable amount of cases it was also discovered, to the great surprise of the operator, that during the times of minimum consumption the flow direction changed

What accuracies for flow velocities < 1 m/s?
- The inaccuracy of magmeter flow measurement increases dramatically for flow velocities below 3 ft/sec
- But flow velocities below 3 ft/sec are prevalent when monitoring DMAs
<table>
<thead>
<tr>
<th>Differences</th>
<th>721</th>
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<th>721</th>
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<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>±1.0%</td>
<td>±1.0%</td>
<td>±1.5%</td>
<td>±1.5%</td>
<td>±1.0%</td>
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<tr>
<td>Wet line</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Calibration with NIST traceable certificate</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature compensation in transducers</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>×</td>
<td>✓</td>
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<td>FM Approval</td>
<td>Can be C1 D2 or C1 D1</td>
<td></td>
<td>Can be C1 D2</td>
<td>Can be C1 D2</td>
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<tr>
<td>100,000 point data logger</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Software compatibility</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>Outputs</strong></td>
<td>4-20mA, HART, Modbus, BACnet, Fieldbus,</td>
<td>4-20mA passive</td>
<td>4-20mA passive</td>
<td>4-20mA passive</td>
<td>4-20mA passive</td>
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<td>2-4-20mA Passive/Active</td>
<td>3 Binary</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Stainless steel option</td>
<td>Stainless steel or PVC int. IP68</td>
<td>Stainless steel</td>
<td>PVC Integrated IP67</td>
<td>PVC Integrated IP67</td>
<td>Up to 2” pipe</td>
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<td>Transducers and cables</td>
<td>Optional</td>
<td>IP 68</td>
<td>Optional</td>
<td>Optional</td>
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<td>Pressure and temperature limits</td>
<td>-40 to +110°F</td>
<td>-40 to +110°F</td>
<td>Max 212°F</td>
<td>Max 212°F</td>
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<td>Single and dual channel</td>
<td>✓</td>
<td>✓</td>
<td>×</td>
<td>×</td>
<td>×</td>
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<td>Doppler capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Transducers selection</td>
<td>All</td>
<td>All</td>
<td>P, M and K</td>
<td>Q, M and K</td>
<td></td>
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<td>Multi-function</td>
<td>✓</td>
<td>✓</td>
<td>3 keys only</td>
<td>3 keys only</td>
<td>✓</td>
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<td>Coupling pads for maintenance free operation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tbody>
</table>
Portables

Mounting Configurations

- Direct Mount
- Reflect Mount – 2 beams
- Direct X Dual Beam
- 2 Path - 4 Beams
- 4 Path – 8 beams
Permanent Mounting solutions - PIOXS

PermaLok
PermaRail
PermaStrap

Stainless Steel Clamp on
4-wire RTD
Thermowell Options Available

Solid Coupling Pad for Permanent installations

Where is FLEXIM?

Water Production
Water Distribution
Water Treatment
### Where is FLEXIM?

<table>
<thead>
<tr>
<th>Wastewater Collections</th>
<th>Wastewater Influent and Effluent</th>
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</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image of wastewater" /></td>
<td><img src="image2.png" alt="Image of wastewater" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Wastewater Treatment</th>
<th>Pollution Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Image of wastewater treatment" /></td>
<td><img src="image4.png" alt="Image of pollution control" /></td>
</tr>
</tbody>
</table>

### Chemical Injection

<table>
<thead>
<tr>
<th>Odor Control</th>
<th>Disinfection</th>
<th>Nitrate removal</th>
<th>ALL Chemical feed applications</th>
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</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Image of odor control" /></td>
<td><img src="image6.png" alt="Image of disinfection" /></td>
<td><img src="image7.png" alt="Image of nitrate removal" /></td>
<td><img src="image8.png" alt="Image of chemical feed application" /></td>
</tr>
</tbody>
</table>

Flexim can manage pulsating flow and very low velocities to 0.03 ft/sec.
Tough Applications

Installed 4-2007
The meter are in perfect condition

14 Years later – No wear
Pump Station – Raw Sewage

... external measurement of internal flow

48” Ductile Iron Wastewater
**Really tough application – 30% solids**

Cincinnati WWTP, sludge line to the incinerator have no meters and have to do yearly testing/calibration for the EPA
30% solids using transit-time and it worked perfectly
They use Schwing concrete pumps to pump this sludge.

notice the flow velocities 0.02 to 0.35, no other meter could do this.

**Aquarian Water**

- **Billing meter**
  - Aquarian supplies water to United water
- **Installation of Dual Beam meter in place of Turbine meter**
  - Turbine would not capture low velocities

- **Flexim meter**
  - No more lost revenue during off peak hours in this station.
Subterranean Install

Submerged
Flying blind under low flow conditions
Location: Wastewater Treatment Plant East Burlington, NC

- This is an 18 inch DIP
How can it be?

- Flow Velocity 0.01 ft/sec
- Volume Flow 5 GPM

Existing meter

Just like ultrasonic meters
Not all Magmeters are the same
Varying quality means varying results

The sweet spot for a magmeter
3 to 33 ft/sec
The customer was more than impressed

When our local representative Vinny Bryant went in to the vault and installed the transducers, we immediately attained good signal, and appropriate sound speed.

When the operator took the system out of automatic control and bumped the valve positioner, we immediately began to detect flow - 0.01 ft/sec. Each time he bumped the positioner, the FLEXIM F601 tracked the velocity, 0.05 ft/sec, then 0.1, then 0.2, then 0.3 and at 0.3 ft/sec the magmeter began to detect flow.

By now the valve is open 14%, and the maximum travel is 20% twenty percent.
The NTMWD at the Frisco McKinney Pump Station needed a metering solution for their outgoing water flow. The line is a 63" steel reinforced concrete line (PCCP). Previous metering solutions have failed and they wanted to avoid having to go the costly route of installing an in line mag meter.

**Application**

1. Measure OD using extra long measuring tape
2. Wall thickness estimate initially received from customer or obtained from previous experience
3. Once a test signal is obtained pipe preparation can begin
   - Using a belt sander prepare a transducer mounting surface that is as flat and smooth as possible (use a 3" x 18" sander)
   - Apply a layer of Bondo by squeezing it onto the surface so as to fill in as many air pockets as possible
   - Apply a second layer to provide an even surface. (Let set overnight)
   - Once set, use the belt sander to smooth it out

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**Meter diagnostics**

<table>
<thead>
<tr>
<th>Physical quantity</th>
<th>Unit</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCNR</td>
<td>dB</td>
<td>32.17</td>
<td>37.48</td>
</tr>
<tr>
<td>SNR</td>
<td>dB</td>
<td>20.85</td>
<td>22.77</td>
</tr>
<tr>
<td>Gain</td>
<td>dB</td>
<td>95.60</td>
<td>89.04</td>
</tr>
<tr>
<td>Amplitude</td>
<td>%</td>
<td>35.90%</td>
<td>40.30%</td>
</tr>
<tr>
<td>Quality</td>
<td>%</td>
<td>49.39%</td>
<td>77.86%</td>
</tr>
<tr>
<td>Vari. time</td>
<td>%</td>
<td>0.02%</td>
<td>0.80%</td>
</tr>
<tr>
<td>Vari. amplitude</td>
<td>%</td>
<td>5.11%</td>
<td>6.43%</td>
</tr>
<tr>
<td>Sound speed</td>
<td>m/s</td>
<td>1457.79</td>
<td>1442.65</td>
</tr>
<tr>
<td>Flow velocity</td>
<td>fps</td>
<td>2.17</td>
<td>3.05</td>
</tr>
</tbody>
</table>
Application

- Readings within 0.15 MGD of calculated expected flow

Why measure polymer?

Polymer is a flocculant and is necessary in wastewater treatment; it greatly reduces sludge volume in the process.

A dosing pump delivers the Polymer at a known volume; typically to a full basin of sewage.
Application

• The dosing pump measures volume by counting the number of strokes or pump cycles and assumes a predetermined volume per stroke. It’s really more of an estimate than a known volume.

  Peristaltic – hose pump

  Hydraulically activated - oil

• Regardless of the dosing pump selected, it’s a tough measurement.
  Pulsating flow
  Small lines
  Wide range of velocity
  Very low flow conditions
  Very thick viscous fluid

• FLEXIM is a very good choice for these applications.
This was a temporary setup to inject polymer and to test the FLEXIM meter. A simplex metering skid delivers the polymer from a tote. The flow range was from 0.02 to 1.0 GPH.

CDM, CDQ, GSM were tested with varying results.

The FLEXIM meter performed well with P transducers.

The XLF version was selected due to the very low velocity.

The results of the flow test were in line with the expected values despite pulsating flow and very low velocity.
**Sodium Hypochlorite in Water Production and Distribution**

**Sodium Hypochlorite Meter**
for dosing applications

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**Customer and Case**

- A high level Cl2 Slug found its way
- in to the Water Distribution Network
- Pump Check Valve stuck open

- Chemical Burns a person taking a shower

Immediate action taken
Can not happen again

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Background

NaOCl must be precisely delivered.
Water plants are in full capacity from 6am to 9am, 12pm to 1pm and 6pm to 9pm.

At peak times Water Distribution pumps are running full speed to meet the demand
Chemical feed can easily be measured by magnetic flowmeters.

Off peak times the magmeter can’t measure the Hypochlorite because the velocity is too low.

Problem Detected

The tank must be lower than the feed pumps.
When the check valve fails, the tank will empty in to the distribution system.

Danger!
Epic Failure.

Sediment builds inside the tank which finds its way in to the check valves causing them to stick open.
Magmeter could not read the low feed rate

The magmeter did not register below 0.5 ft/sec.
1" Sched 80 PVC  2.82 GPH = 0.013 ft/sec

Wooden Pipe
Conclusion

Most Applications in the Water and Wastewater Industry are tough Applications.

FLEXIM has invested in the Sensing Technique and the Ruggedness of the equipment for Water and Wastewater applications

FLEXIM has experience in Water and Wastewater applications

FLEXIM guarantees the meter will work in the application for which it is intended.

Please look for assistance from your local FLEXIM representative.

References

