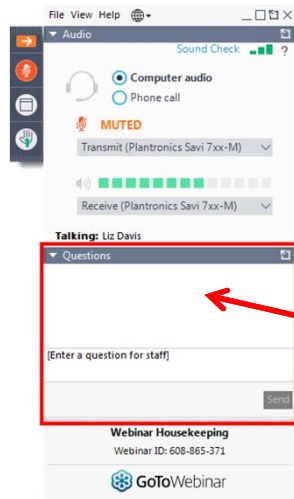


Non-intrusive Ultrasonic Flow Meters for Liquids



1

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.**

2

Today's Speaker



John Van Nostrand

Southeast Regional &
Municipal Manager

3

Agenda



- Where we are today
- Outside influences
- Common Flow metering technology
- Recent Ultrasonic Technology Developments
- Applications



4

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.

5

5

Market trend is Regulation and more Regulation

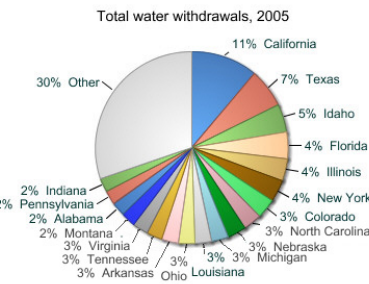
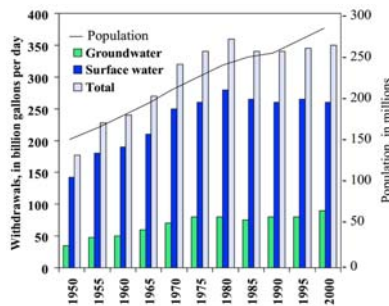


Regulation is driving the need for metering



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

In 2010 the US consumed 355,000,000 per day



6

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

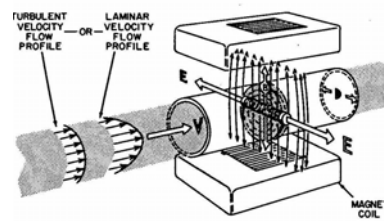
- Replacements and promotions
- Reuse and recycling
- Water-use regulation
- Integrated resource management



7

7

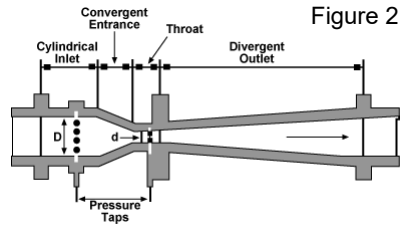
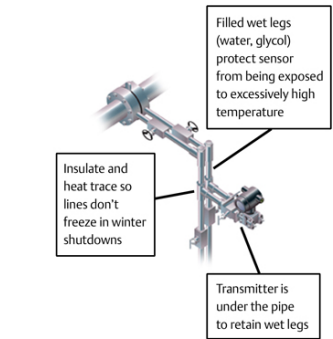
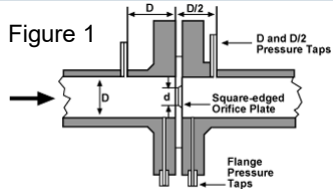
Typical Measurement Technologies



8

8

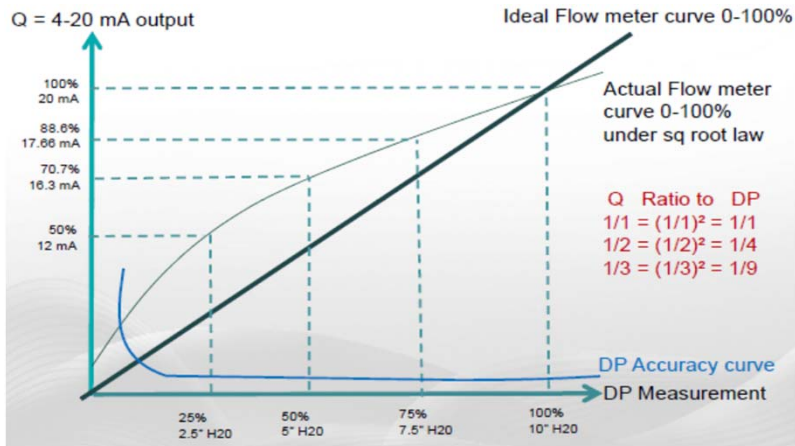
The Use of Primary Elements



9

9

Square Root Law

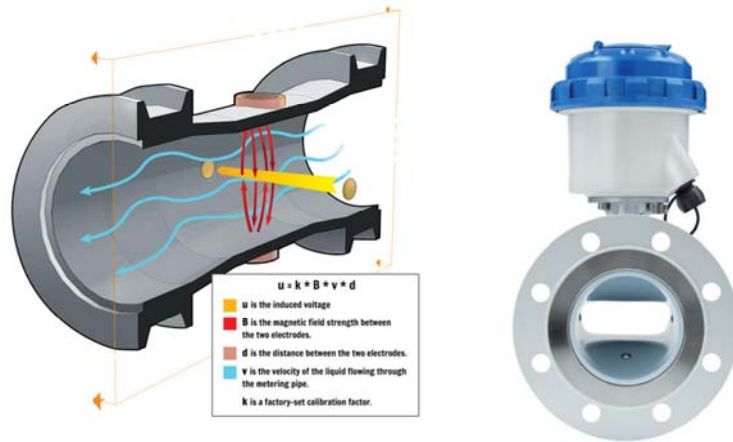


Calibration curve of a typical dp transmitter

10

10

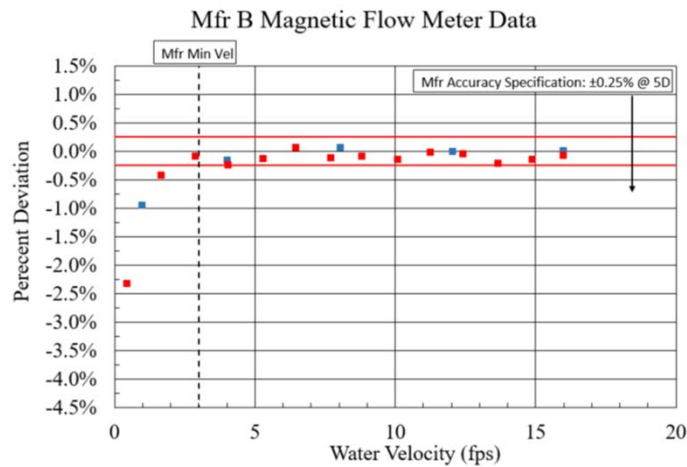
Magmeters



11

11

Magmeter low flow



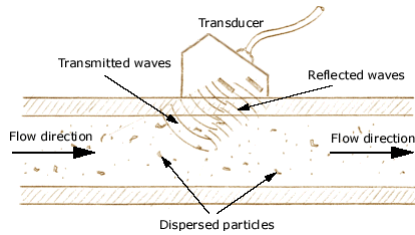
12

12

Ultrasonic Introduction

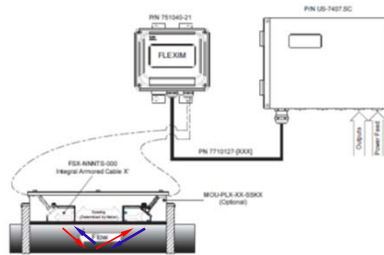


The Old Days



Doppler meters
had
Varying levels of
success.

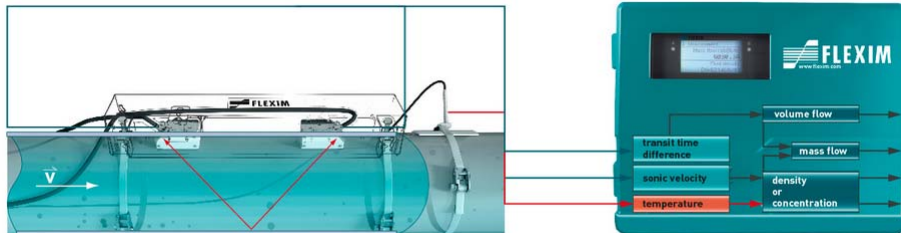
Today



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

13

Technology is changing in water and wastewater



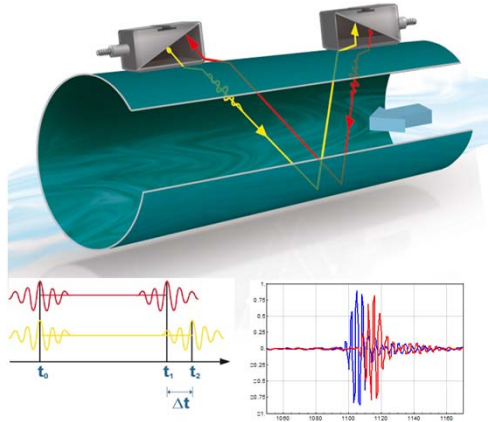
14

14

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



15

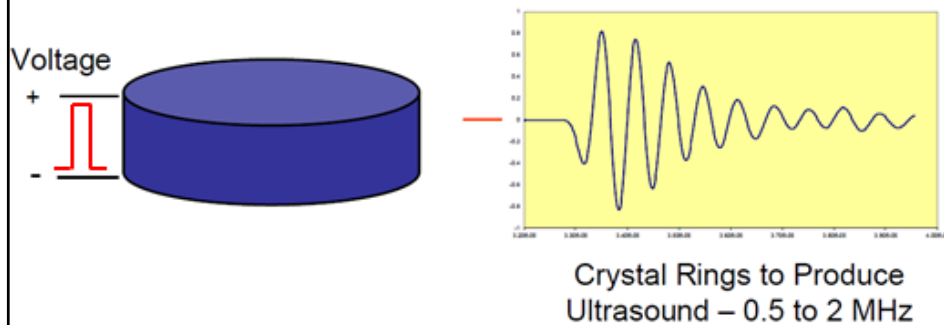
Value proposition

15

Piezoelectric Crystal

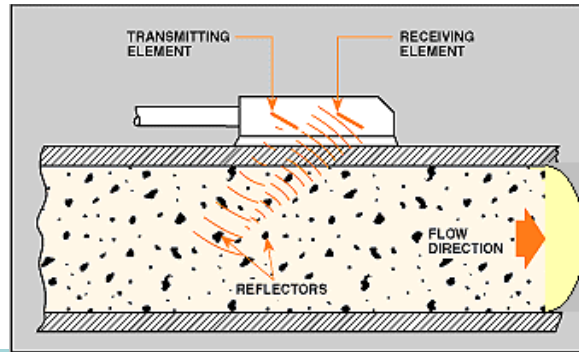


Creating Ultrasonic Sound Piezoelectric Phenomenon



16

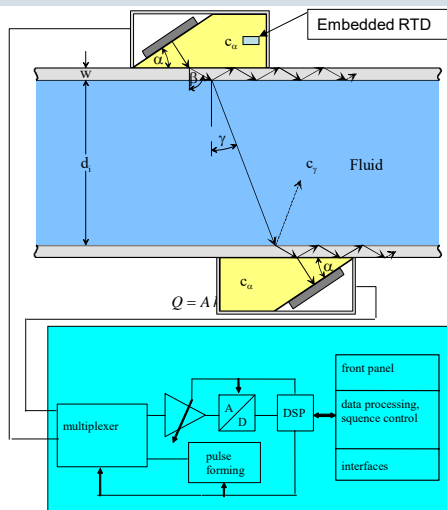
Doppler in Flow Measurement



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

17

Operation Principle



Meter formula

$$v_l = k_\alpha \frac{\Delta t}{2 t_F}$$

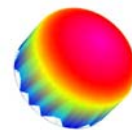
Acoustic calibration factor

$$k_\alpha = \frac{c_\alpha}{\sin \alpha}$$

Snells Law: $\frac{c_\alpha}{\sin \alpha} = \frac{c_\beta}{\sin \beta} = \frac{c_\gamma}{\sin \gamma}$

Fluid mechanical calibration factor

$$Q = A k_{Re} v_l$$



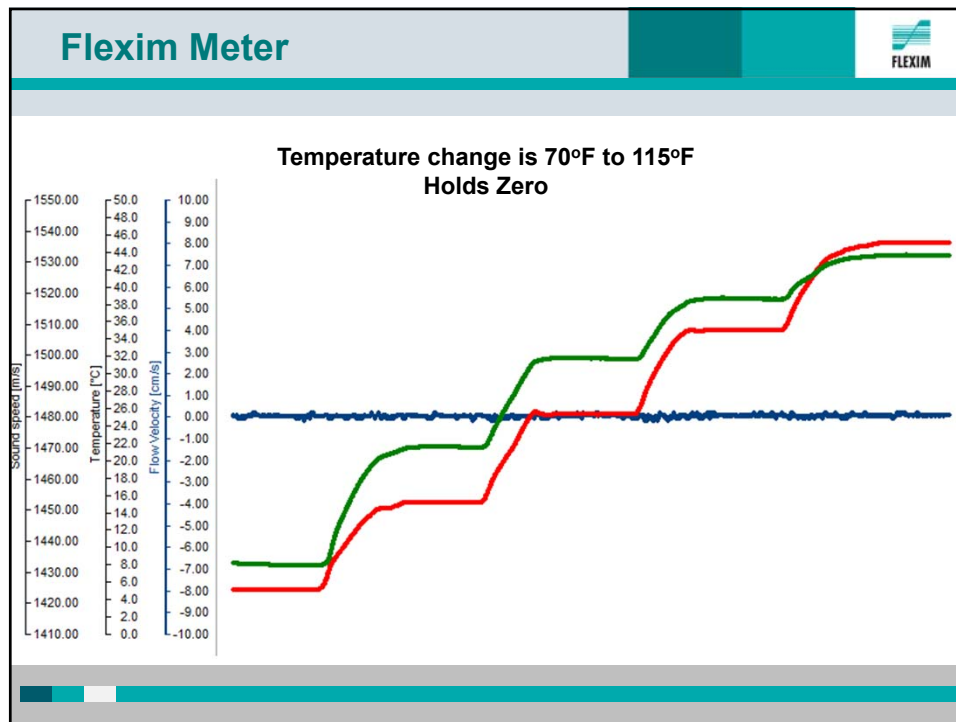
18

No Zero Drift

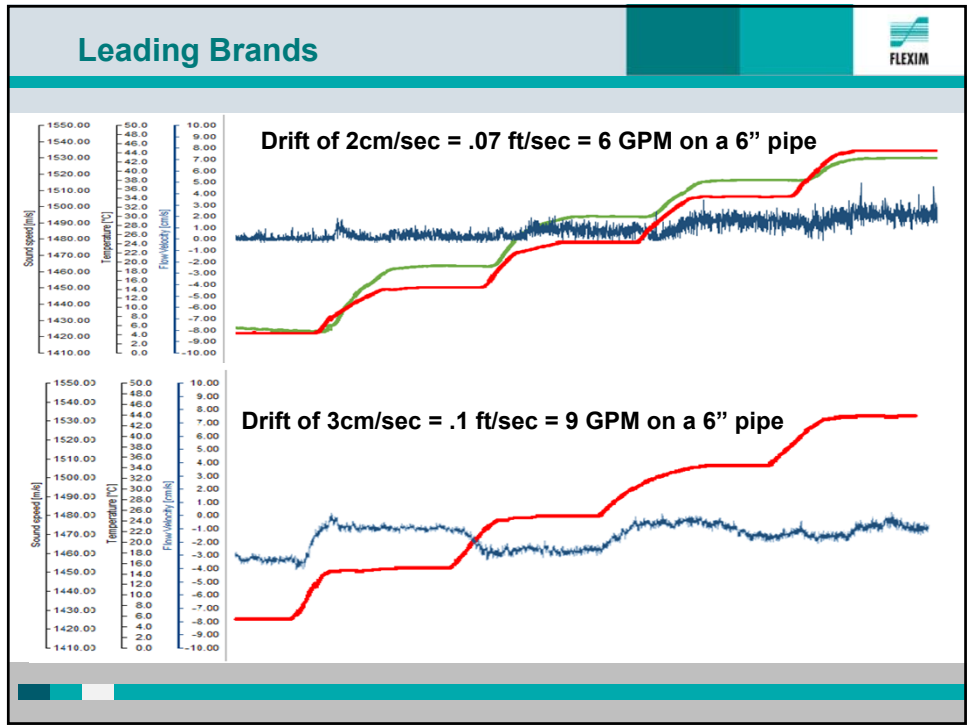


19

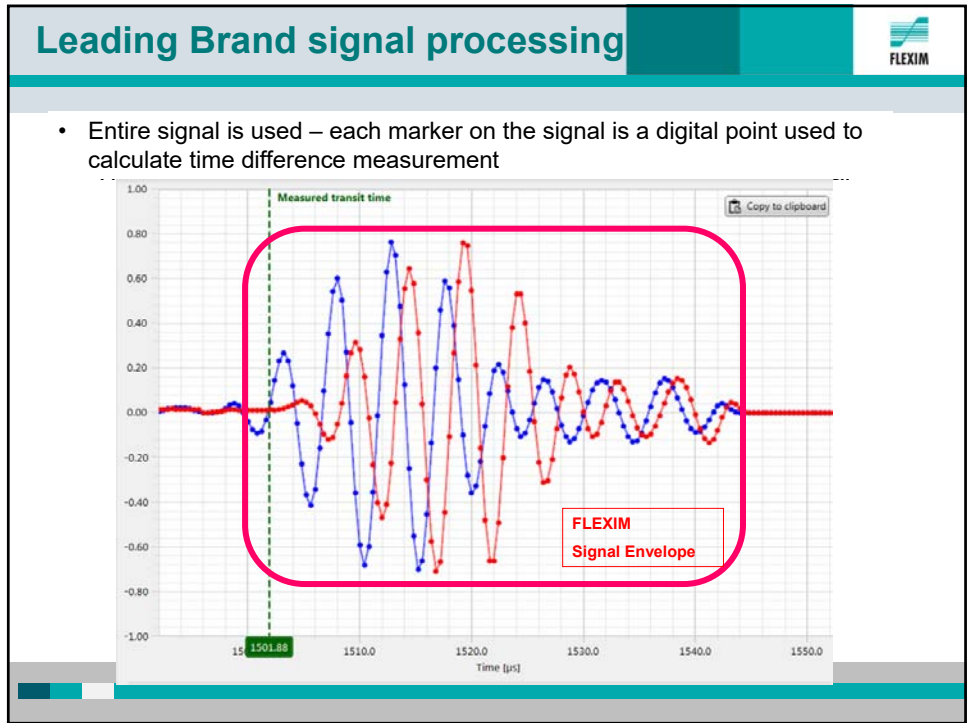
Flexim Meter



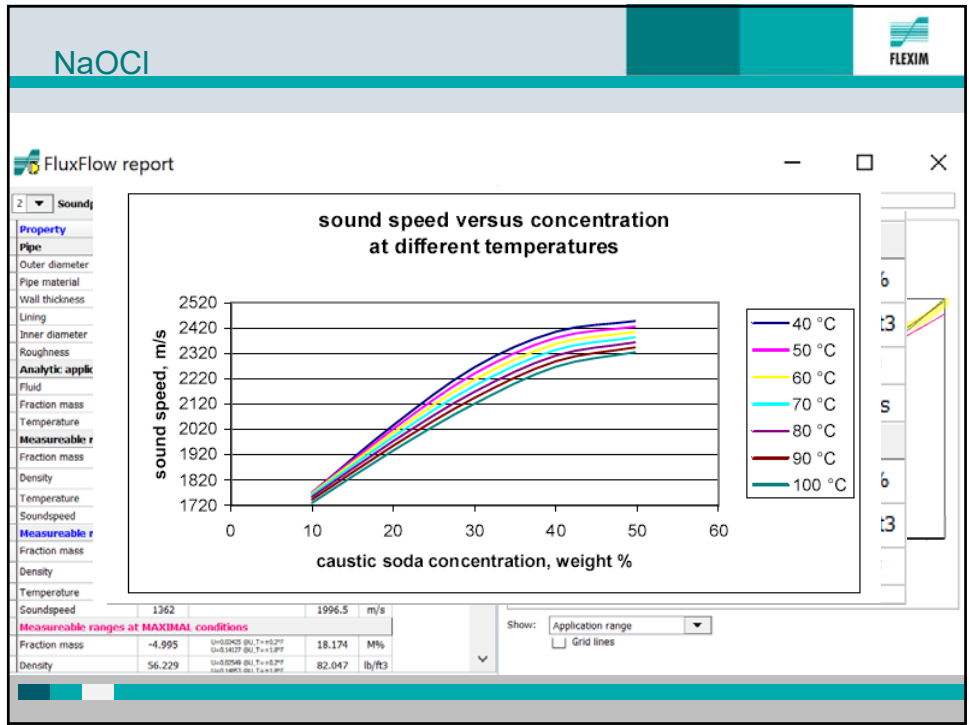
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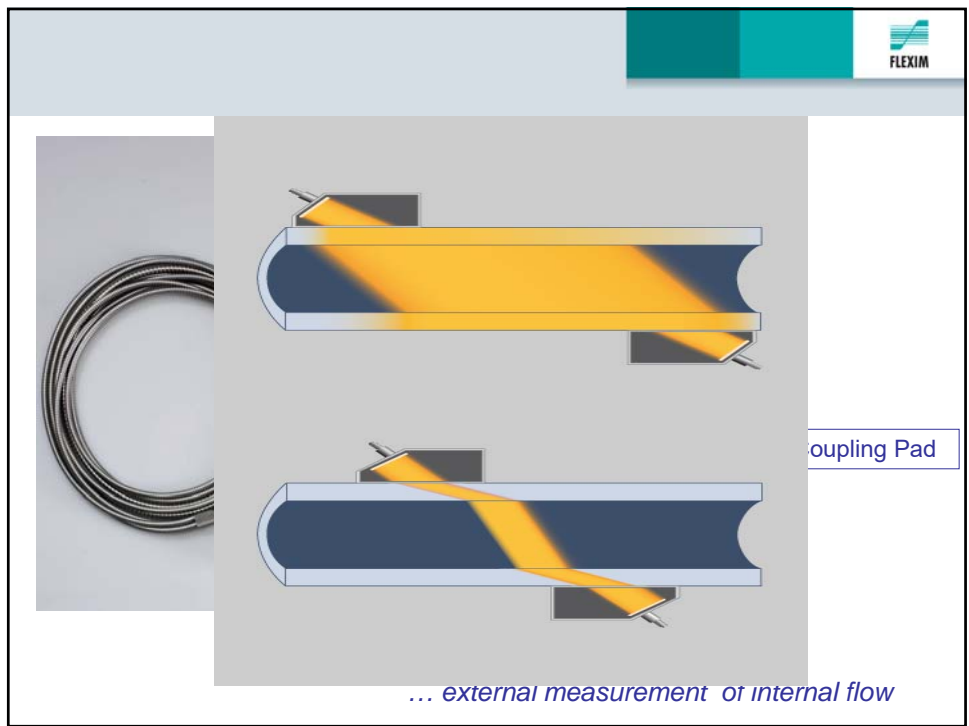
21



22



25



26

Approvals for water and Wastewater Industry

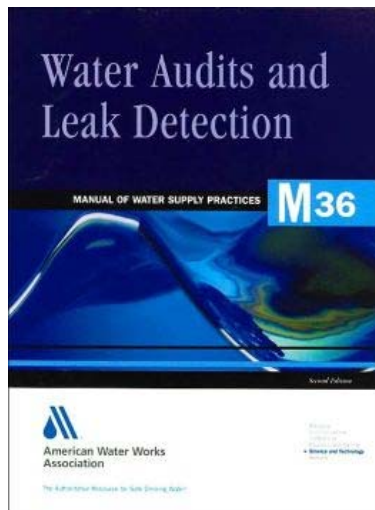
ISO17025 - Calibration Certification

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

ASME MFC5M

NSF is not a requirement for Clamp-On technology

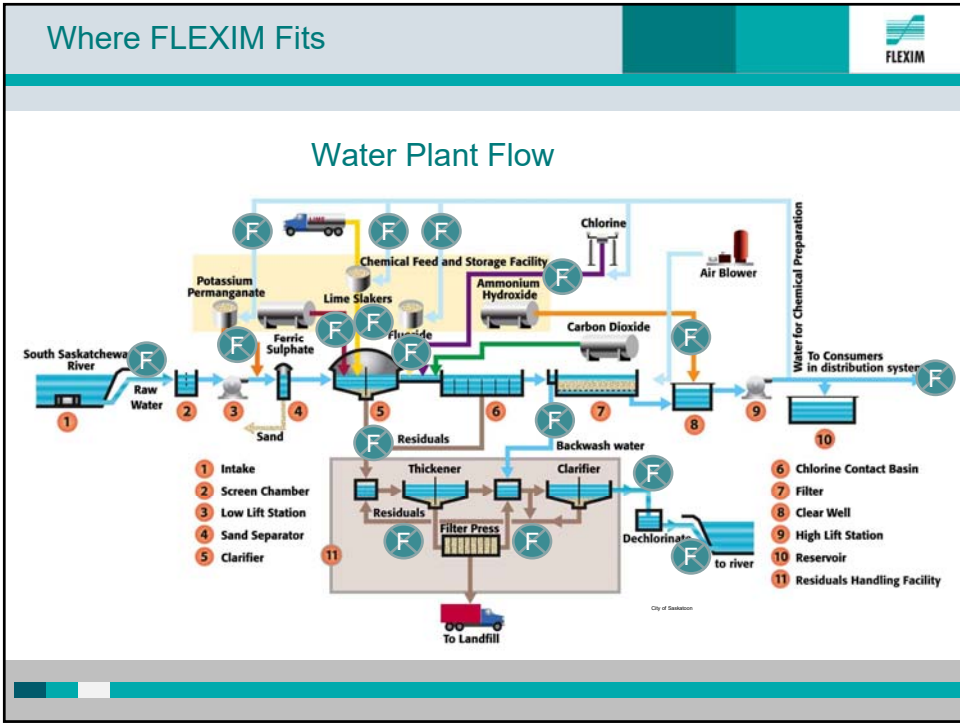
No meter left behind – Customer Approval



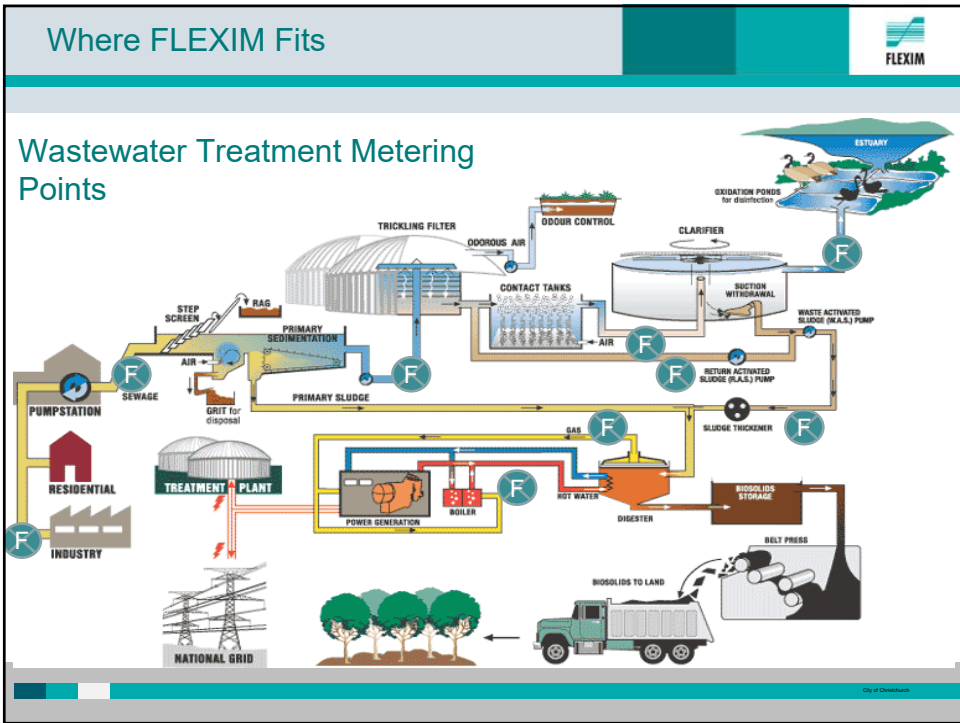
Transit-Time Flowmeters in Full Closed Conduits

Effective date: March 1, 2020.
First edition approved by Board of Directors June 18, 2003.
This edition approved Oct. 24, 2019.
Approved by American National Standards Institute Sept. 9, 2019.

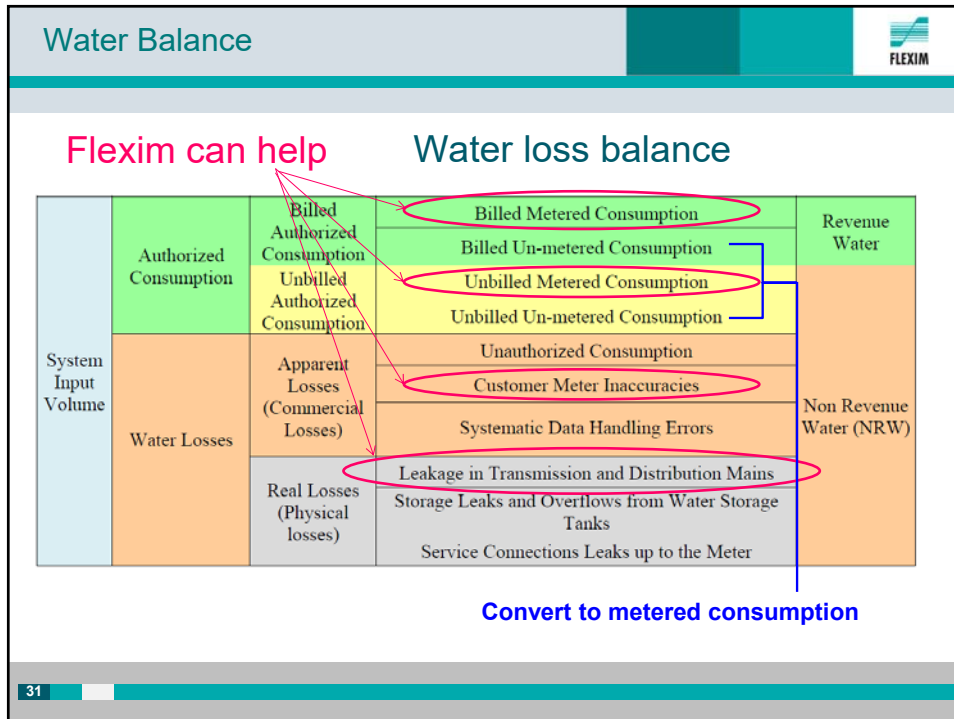




29




30





31


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



32
Warmer

32

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

33

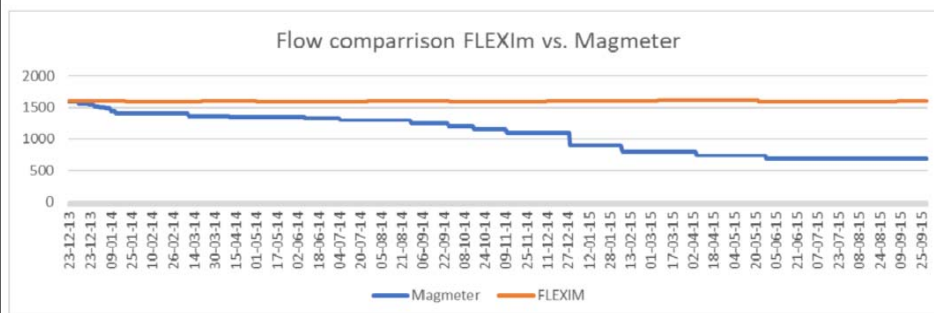
33

Chemical and Mineral Induced Fouling



Injecting chemicals have unintended consequences on magnetic flowmeters.

The coating fouls the electrodes and renders the Magmeter useless.



34

34

Another Important Consideration.



Magnetite is a mineral and one of three common naturally-occurring oxides of iron. Its chemical formula is Fe_3O_4 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

35

What about maintenance?



Since electromagnetic flow meters have no moving parts, maintenance is typically very minimal
Expected service life is 30 years

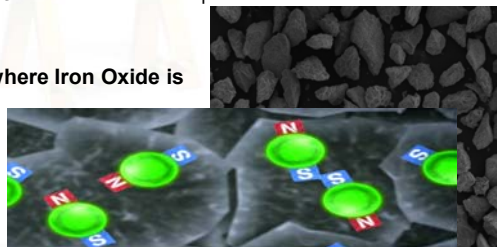
Depending on your fluid media and/or water quality,
The electrodes may need to be periodically cleaned according to the manufacturer's recommendations.

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!



36

Identifying the problem

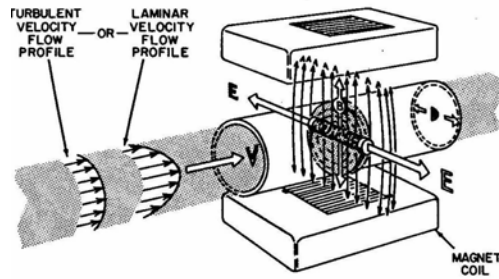
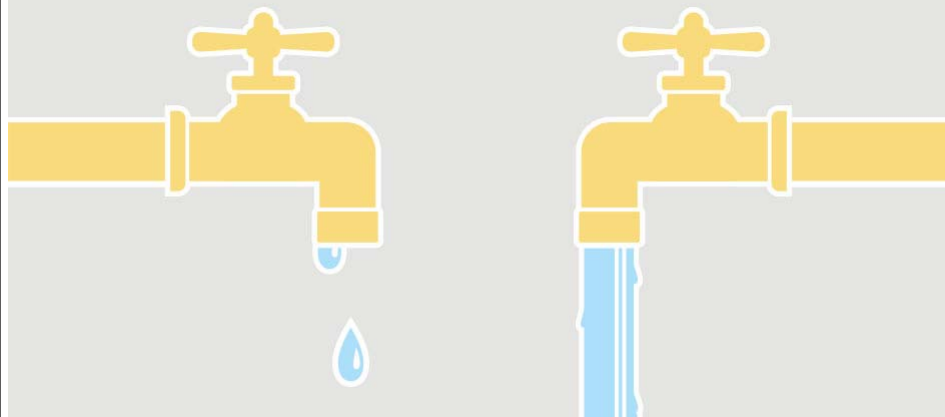


FIG. 9.9a

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

37

FLEXIM



38

38

Low flows are Normal flows

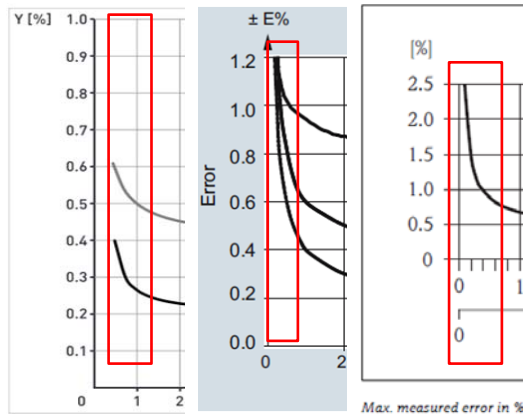
- Most municipal water systems are designed for future growth. Working with our customers has helped us realize that flow velocities in drinking water pipes 6" – 12" seldom exceed 3 ft/sec
- A further realization is that in these pipes the minimum nightly flow velocity is usually below 0.26 ft/s
- Flow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



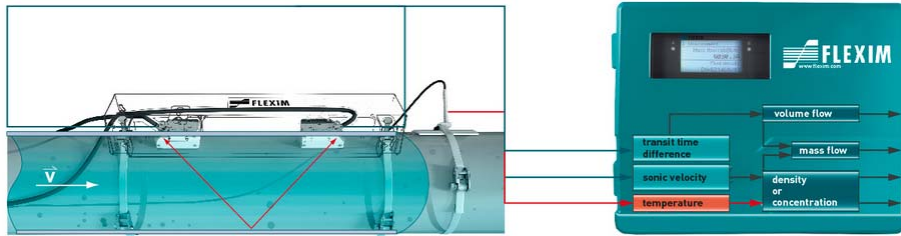
- In a considerable amount of cases it was also discovered, to the great surprise of the operator, that during the times of minimum consumption the flow direction changed

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



Solution

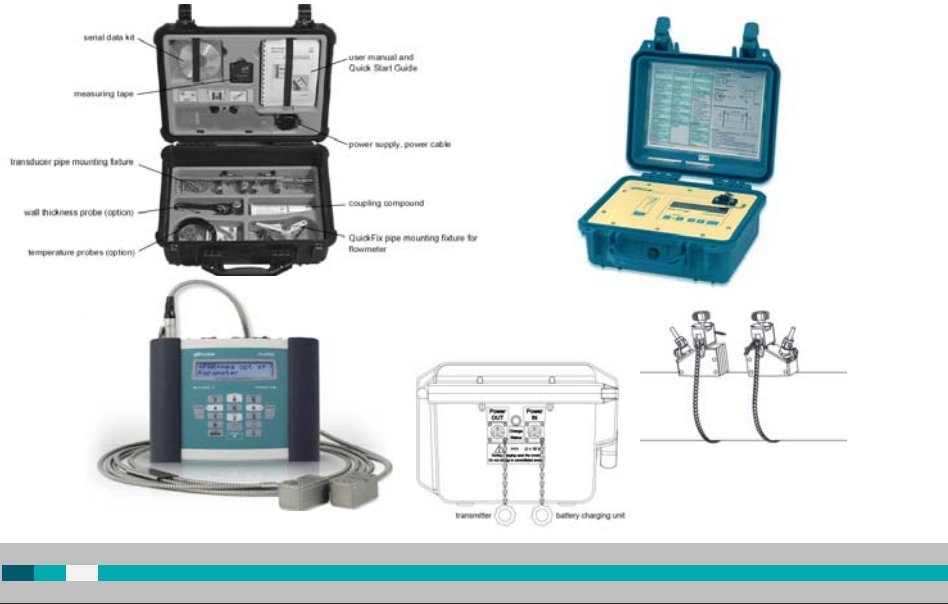


41

Differences	721	721	721	F501	F501
Accuracy	±1.0%	±1.0%	±1.5%	±1.5%	±1.0%
Wet flow calibration with NIST traceable certificate	✓	✓	✓	Optional	✓
Temperature compensation in transducers	✓	✓	✗	✗	✓
FM Approval	Can be C1 D2 or C1 D1	608	✗	Can be C1 D2	Can be C1 D2
100,000 point data logger	✓	✓	✓	✓	✓
Software compatibility	✓	✓	✓	✓	✓
Outputs	4-20mA, HART, Modbus, BACnet, Binary Ethernet, Fieldbus,	2 4-20mA Passive/Active 3 Binary NA GP	1 4-20mA passive	4-20mA only	4-20mA, HART, Modbus, BACnet, Binary Ethernet, Fieldbus,
Stainless steel option	✓	✓	NA IP67	✗	✓
Transducers cables	Stainless steel or PVC int. IP68	Stainless steel armored	PVC integrated IP67	PVC integrated IP67	Up to 2" pipe
Submersible transducers	Optional	✗	IP 68	Optional	Optional
Process temperature limits	-40 to +1100°F	-40 to +1100°F	Max 212°F	Max 212°F	
Single and dual channel	✓	✓	✗	✗	✗
Doppler capability					
Transducers selection	All	All	P, M and K	Q, M and K	Q
Multi-function Keyboard	✓	✓	3 keys only	3 keys only	✓
Coupling pads for maintenance free operation	✓	✓	✓	✓	✓

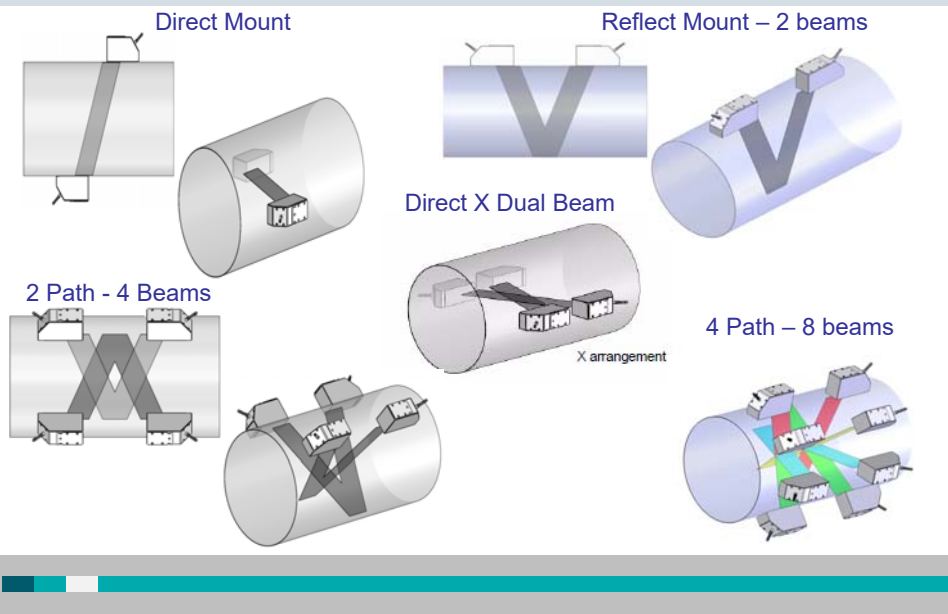
42

Portables



43

Mounting Configurations



44

Permanent Mounting solutions - PIOXS



PermaLok



PermaRail



PermaStrap



Stainless Steel Clamp on
4-wire RTD
Thermowell Options Available



Solid Coupling Pad for Permanent installations

45

Where is FLEXIM?



Water Production



Water Distribution



Water Treatment

46

Where is FLEXIM?



Wastewater Collections



Wastewater Influent and Effluent



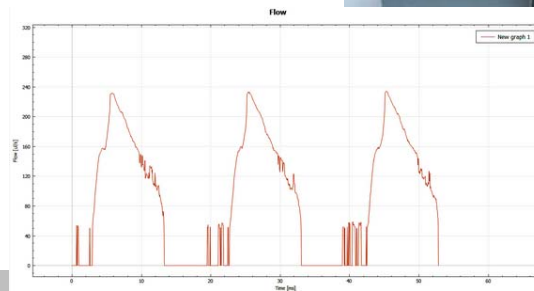
Wastewater Treatment Pollution Control

47

Chemical Injection



Odor Control
Disinfection
Nitrate removal
ALL
Chemical feed
applications
Flexim can
manage pulsating
flow and very low
velocities to 0.03
ft/sec



48

Tough Applications



49

Installed 4-2007



50

The meter are in perfect condition



51

14 Years later – No wear



52

Pump Station – Raw Sewage



... external measurement of internal flow

53

48" Ductile Iron Wastewater



54

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.



55

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



- F
 - No more lost revenue during off peak hours in this station.

56

Subterranean Install



57

57

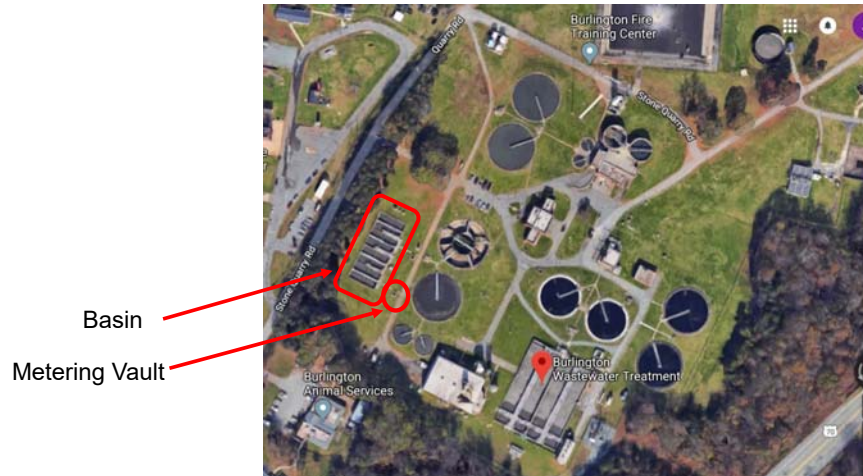
Submerged



58

58

Plant View - Location



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

59

59

Application Site



- This is an 18 inch DIP

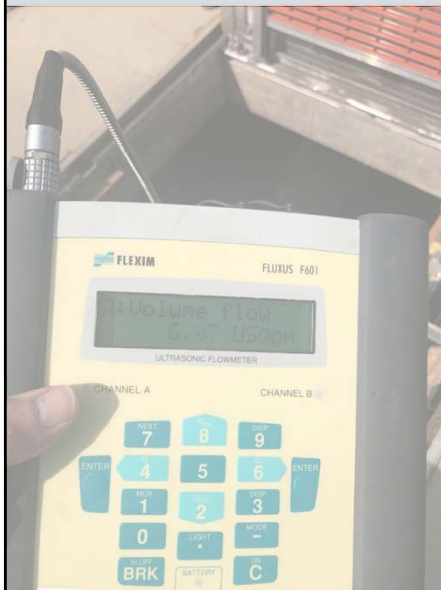
FAST Form - FLEXIM Application Support Tool

Flow		FLEXIM	
<p>Configuration</p> <p>Company: <input type="text"/> Division: <input type="text"/> Project: <input type="text"/> Date: <input type="text"/></p> <p>Flow: <input type="text"/> Unit: <input type="text"/></p> <p>Flow Direction: <input type="text"/></p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Application</p> <p>Process: <input type="text"/> Unit: <input type="text"/></p> <p>Flow: <input type="text"/></p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow</p> <p>Flow: <input type="text"/></p> <p>Flow Unit: <input type="text"/></p> <p>Flow Direction: <input type="text"/></p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Process Parameters</p> <p>Process: <input type="text"/> Unit: <input type="text"/></p> <p>Flow: <input type="text"/></p> <p>Flow Unit: <input type="text"/></p> <p>Flow Direction: <input type="text"/></p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Parameters</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Installation</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Performance</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Maintenance</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Troubleshooting</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Calibration</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			
<p>Flow Meter Documentation</p> <p>Flow Meter: <input type="text"/></p> <p>Flow Meter Model: <input type="text"/></p> <p>Flow Meter Serial: <input type="text"/></p> <p>Flow Meter Part: <input type="text"/></p> <p>Flow Meter Location: <input type="text"/></p> <p>Flow Meter Orientation: <input type="text"/></p> <p>Flow Meter Installation: <input type="text"/></p> <p>Flow Meter Installation Date: <input type="text"/></p> <p>Flow Meter Installation By: <input type="text"/></p> <p>Flow Meter Installation Notes: <input type="text"/></p>			

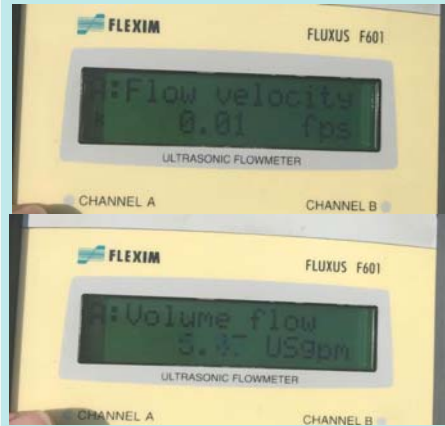
60

60

How can it be?



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



61

61

Existing meter



SITRANS F M MAG 3100

Measuring range	0 to 10 m/s
Measurand	Flow 200 to 500 000 (10" to 18")
Accuracy	± 0.2 % of 1 m/s
Operating pressure	10 bar / 150 psi (max. 1600 psi)
Ambient temperature	From -40 to 130 °C (-40 to 250 °F)
Medium temperature	From -40 to 130 °C (-40 to 250 °F)
Process	Non-corrosive
Line	PTFE, PFA, EPDM, Lined
Electrodes	AgCl 316 L (1.4571), Hastelloy C, Platinum/Iridium, Titanium
Material	Carbon steel (or 304 SS) with corrosion resistant trim component epoxy coating or AgCl 316 L polished flange and housing
Optional approvals	ATEX, FM, CSA, ICT and Drinking Water approvals

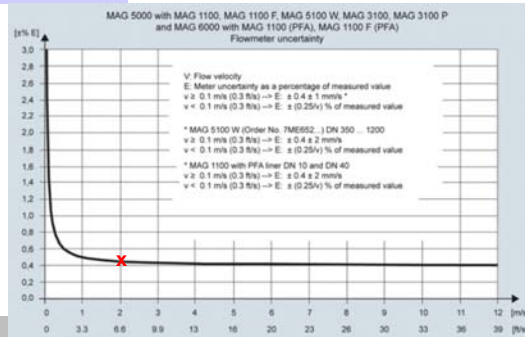
Just like ultrasonic meters

Not all Magmeters are the same

Varying quality means varying results

The sweet spot for a magmeter

3 to 33 ft/sec



62

62

Results

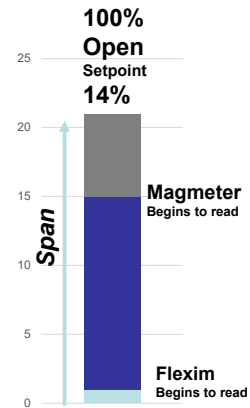


The customer was more than impressed

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 0.5 ft/sec the magmeter began to detect flow.

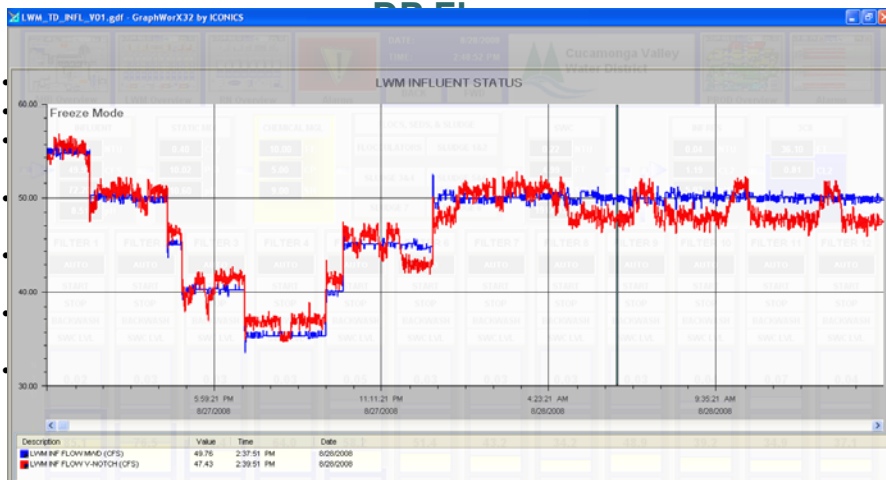
By now the valve is open 14%, and the maximum travel is 20% twenty percent.



63

63

Application

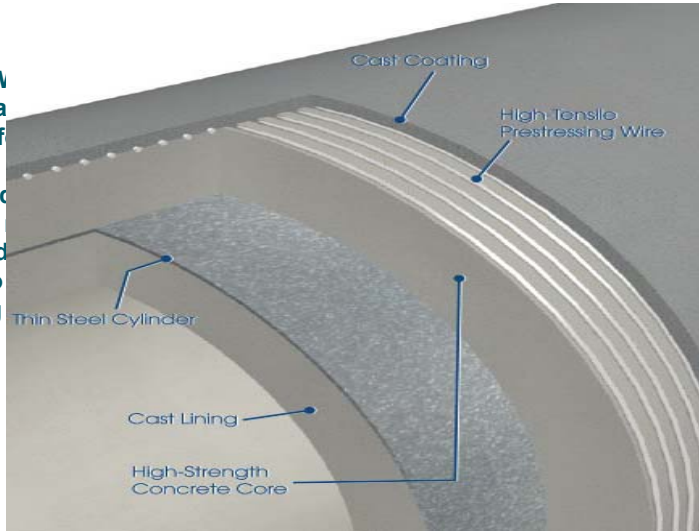


64

Application



The NTMV Pump Station solution for flow. The reinforced concrete structure was previously failed and had to be replaced with a new meter.



65

Application

Meter diagnostics

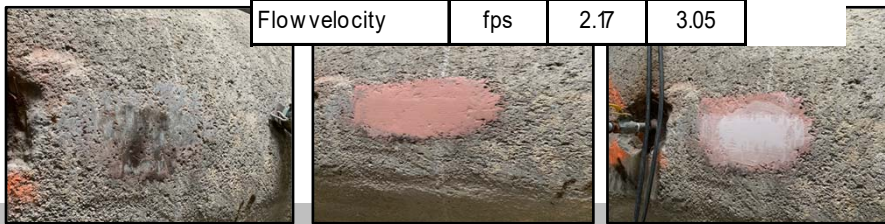


- Measure OD using
 - Wall thickness est previous experien
 - Once a test signal
 - Using a belt s smooth as po
 - Apply a layer many air pock
 - Apply a second
 - Once set, use
- PIPE PREP IS CR

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

and

URE



66

Application



- Readings within 0.15 MGD of calculated expected flow

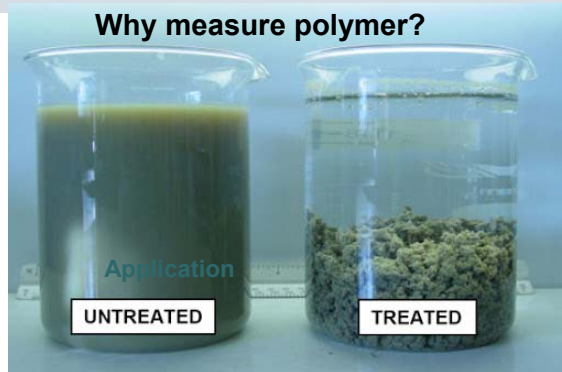


67

Application



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 know volume; typically to a full basin of sewage.

John Van Nostrand

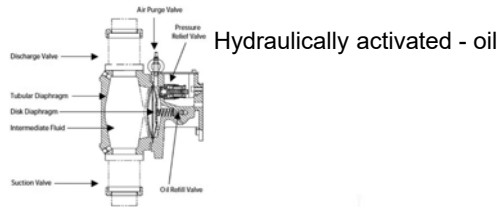
68

Application

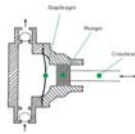
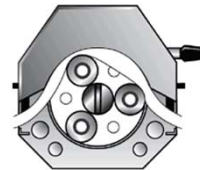


- The dosing pump measures volume by counting the number of strokes or pump cycles and assumes a predetermined volume per stroke. It's really more of an estimate than a known volume.

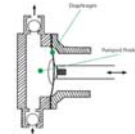
Peristaltic – hose pump



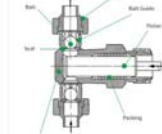
Hydraulically activated - oil



Hydraulic Diaphragm Liquid End



Mechanical Diaphragm Liquid End



Piston Liquid End

69

Application



- 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.



FLEXIM F2200-10



FLEXIM F2200-15



Peristaltic

70

Application



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.

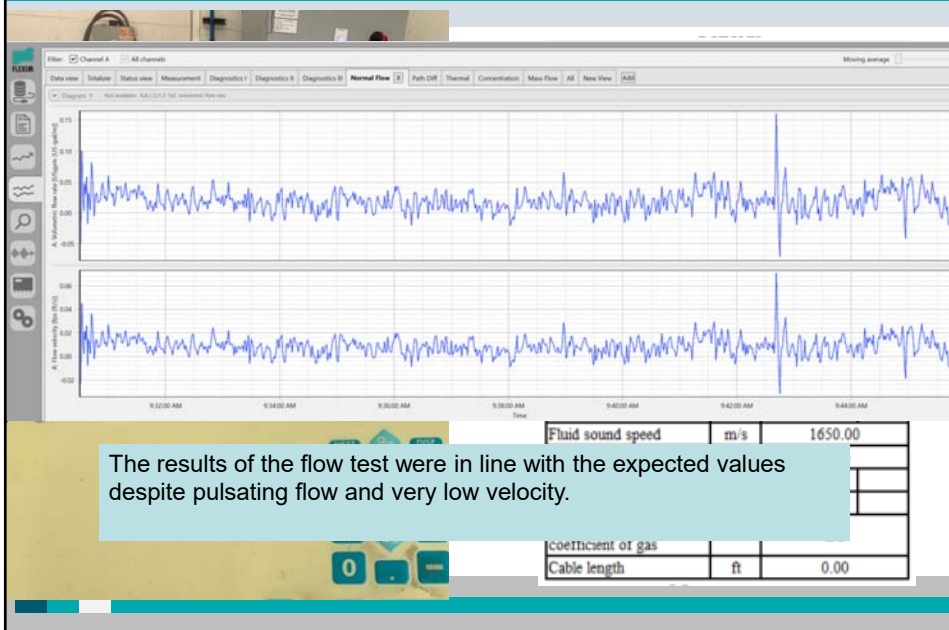
The FLEXIM meter performed well with P transducers.

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



71

Application



The results of the flow test were in line with the expected values despite pulsating flow and very low velocity.

72



Sodium Hypochlorite Meter
for dosing applications

73

73

- A high level Cl₂ Slug found it's 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

74

74

Background



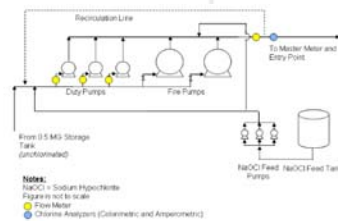
NaOCl must be precisely delivered.

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.



They measure residual Chlorine and control to 1.0 PPM why do they need a flowmeter?

Schematic of Water Treatment and Monitoring at the Ground Water Station (Aurora, CO)

https://www.hach.com/cms-portals/hach_com/cms/documents/pdf/Application-CaseHistory-Whitepaper/ComparisonofOn-lineChlorineAnalysis.pdf

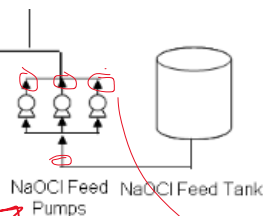
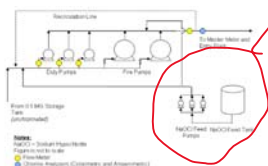
75

Problem Detected



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

Danger!
Epic Failure.

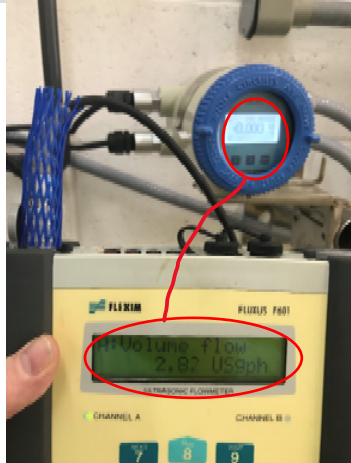


Sediment builds inside the tank which finds its way in to the check valves causing them to stick open.

Schematic of Water Treatment and Monitoring at the Ground Water Station (Aurora, CO)

76

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

77

Wooden Pipe



78

78

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.

79

References



- Agriculture, B., & Walton, B. (2020, April 13). Covid-19 Crisis Could Decimate Water Utility Revenue, Worsen Affordability Problems. Retrieved June 19, 2020, from <https://www.circleofblue.org/2020/world/covid-19-crisis-could-decimate-water-utility-revenue-worsen-affordability-problems/>
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80