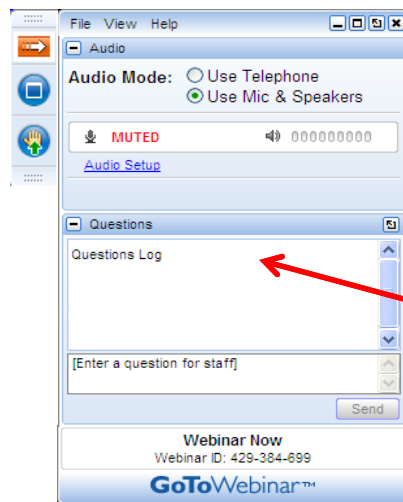


Water Balancing for District Metering

Tuesday, February 26, 2019

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 Presenter



John Van Nostrand
Southeast Regional and
Municipal Manager

3

Technology is changing water management



4

4

Purpose



- Inform water users of Metering concerns for water conservation plans.
- Expect to solve metering problems and improve water balance, collections and treatment.

5

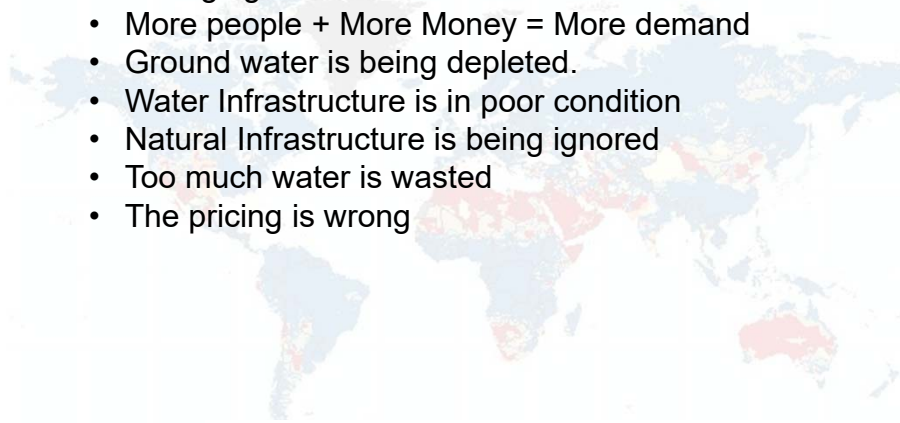
Learning Objectives



- Attendees will learn about Global water concerns
- How the AWWA Lead and Copper Rule can affect flow measurement
- Developments in Ultrasonic Technology
- How Turn down affects accuracy
- Overcome metering concerns
- Reduce Costs and Improve Revenue

6

- Changing Climate
- More people + More Money = More demand
- Ground water is being depleted.
- Water Infrastructure is in poor condition
- Natural Infrastructure is being ignored
- Too much water is wasted
- The pricing is wrong



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7

Water Risk Atlas of the Aqueduct



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Coca-Cola

8

Water Resource Institute

FLEXIM

AQUEDUCT Water Risk Atlas

WORLD RESOURCES INSTITUTE

<https://www.wri.org/applications/maps/aqueduct-atlas>

9

Reducing Water Loss

FLEXIM

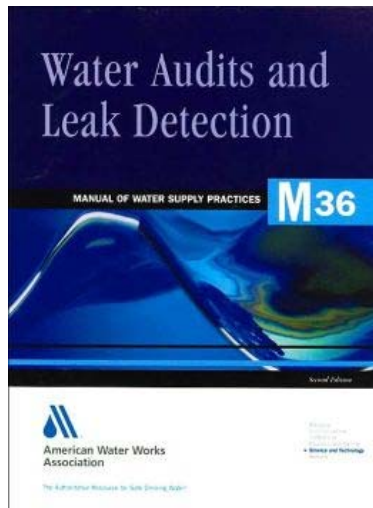
Growing political pressure to reduce water loss

- Local Political pressure
- Competition amongst municipalities for low water loss rates and increase revenue
- Municipalities with high loss rates are regarded as badly managed,
- Regulation pressure on municipalities to reduce water loss by pushing them to feel the revenue loss.
- Utilities must monitor their networks more precisely

Warner

10

- **Stop thinking in terms of Percent of water loss!**
- **Every drop of water that is pumped out of the ground comes at a cost and is a potential for revenue.**
- **Regulators want us to think of water as a commodity**
 - To effectively manage water loss, a utility should be able to answer several questions:
 - Where did we lose the water?
 - How much water was lost, expressed as a volume?
 - How much did the loss cost the utility?
 - Why did we lose the water?
- **Some have already implemented water loss regulations based on the need and the future legislation from the EPA**
 - Texas, Georgia, Washington, California, Delaware River users including NJ, NY, PA, & DE, and Tennessee



This is the Manual for water resource management.

One of the key activities is metering the water.

It helps to change the mind set of water abundance to water as a revenue stream.

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
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

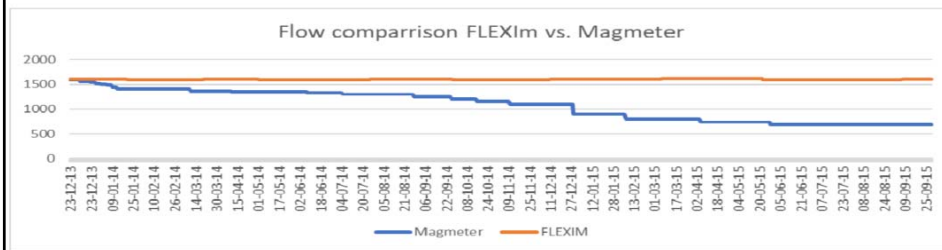
13

Why has my Magmeter become useless?



Injecting chemicals have unintended consequences on magnetic flowmeters.

The coating fouls the electrodes and renders the Magmeter useless.



14

How do you know if you have an inflow and infiltration issue?



- Your lift station pumps run for a long time after a rain event, or there are more pump starts and stops after it rains.
- Pipes back-up. Residential or business basements flood during a rain event. SSO's occur.
- You see significant spikes in flow at your wastewater treatment plant corresponding to precipitation events or high groundwater conditions.
- Identify the leaks with Flow Monitoring.
- Manhole inspections
- Smoke testing
- Dye testing
- TV Inspections.

15

Flow Measurement in Water and wastewater applications

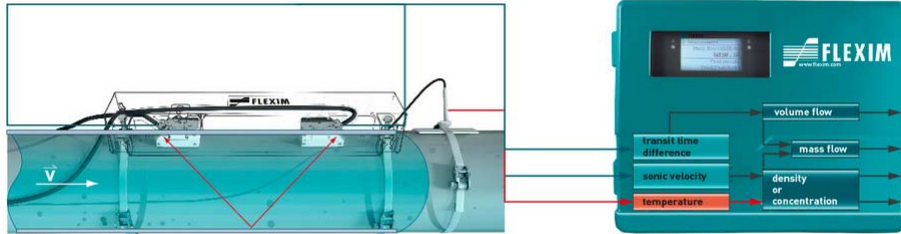


The Water and Wastewater industry requires continuous process measurement systems.

FLEXIM offers the most reliable measurement system for water production, distribution, collections, treatment and reuse



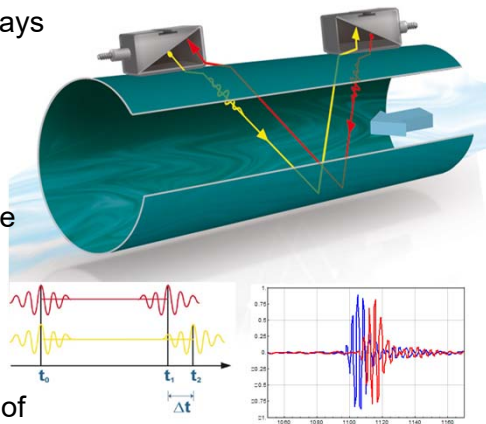
16



Improved Monitoring of District Metered Areas (DMAs)

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

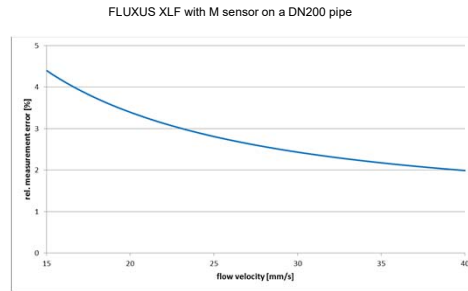


Improved Monitoring of District Metered Areas (DMAs)



FLUXUS XLF: Detection of weep leaks

- The FLEXIM ultrasonic flowmeter can measure flow velocities of 0.03 ft/sec with XLF to 0.003 ft/sec
- Leaks below 2 gpm are classified as very small “weep leaks”*
- Using the unique XLF ultrasound sound technology water suppliers can detect even very small leaks



* Hamilton and Charalambous (2013): “Leak Detection – Technology and Implementation”

Our solution

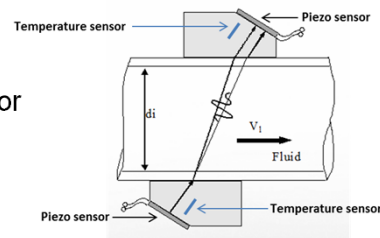
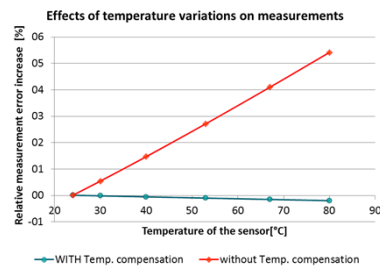
19

Improved Monitoring of District Metered Areas (DMAs)



FLUXUS XLF: Technical advantages

- Ambient temperature variations can have a strong influence on ultrasound measurements if they are not compensated
- FLEXIM is the only manufacturer of clamp-on ultrasonic flow meters that installs temperature probes in every sensor
- By continuously monitoring the sensor temperature and compensating temperature variations the measurements of FLEXIM have an unrivaled repeatability



Value proposition

20

FLUXUS XLF: Technical advantages

- Maintenance-free due to permanent coupling pads
- No connections on the sensor heads for protection against water ingress
- Robust design and high quality material (SS 316)



Competitors using coupling gel



Competitor



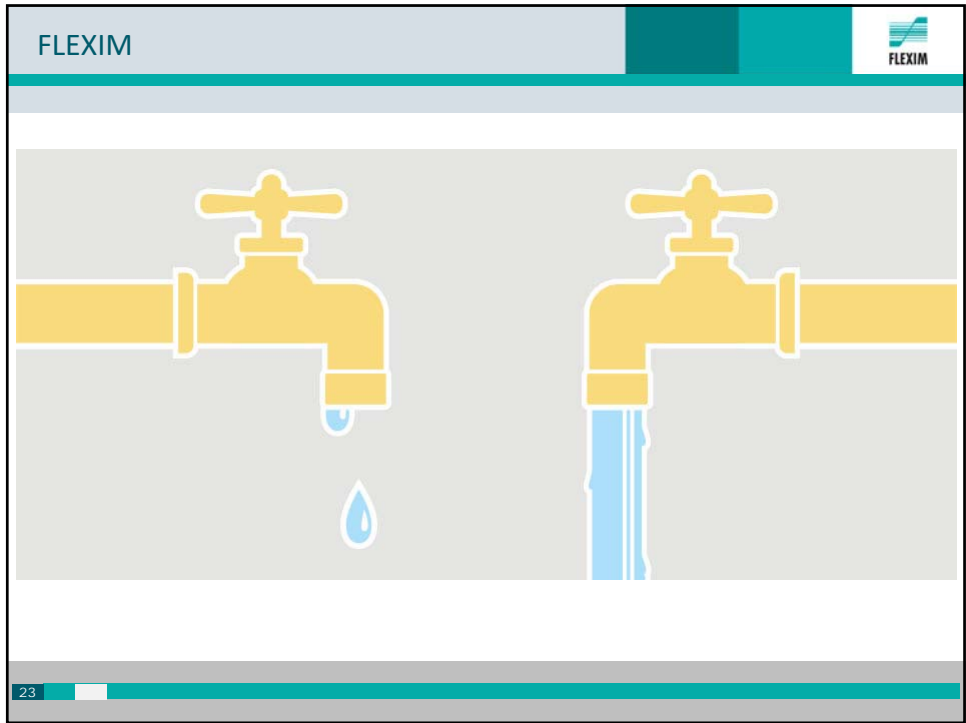
product video



FLUXUS XLF: Technical advantages

- Extremely robust and fully closed mounting system
- Sensors cannot be seen and installation therefore does not attract attention
- Mounting system can only be opened with a tool, to reduce the danger of tampering





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Improved Monitoring of District Metered Areas (DMAs)

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

Reframe

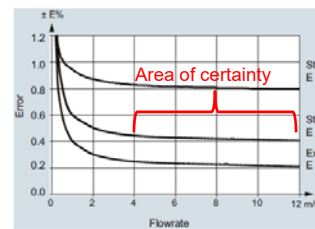
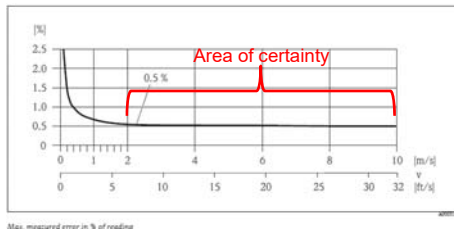
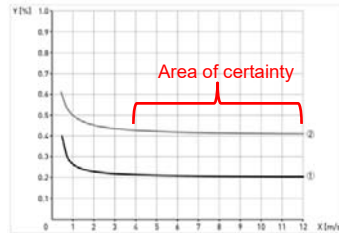
24

Improved Monitoring of District Metered Areas (DMAs)



Who cares about 0.6 – 3 ft/s?

- Most flow meters used including magmeters, ensure relatively stable accuracies for flow velocities of 0.6 – 3 ft/s
- These flow velocities are totally irrelevant for DMA monitoring as they are never reached



Max. measured error in % of reading

Rational drowning

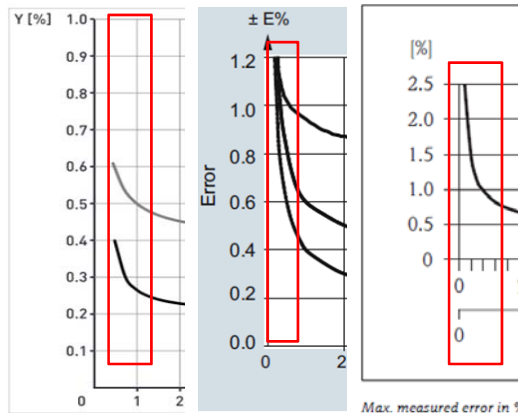
25

Improved Monitoring of District Metered Areas (DMAs)



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

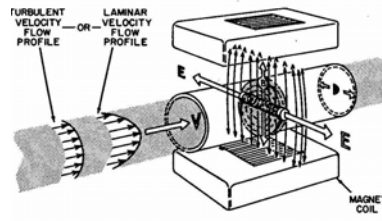


Max. measured error in %

Rational drowning

26

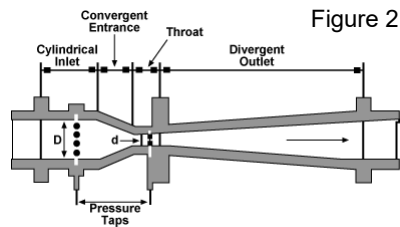
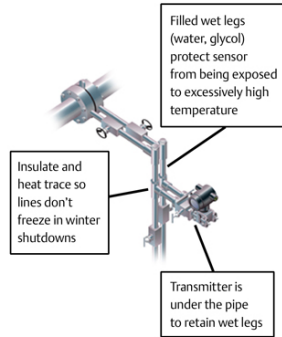
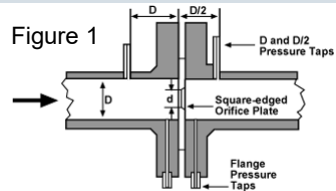
How do you measure?



27

27

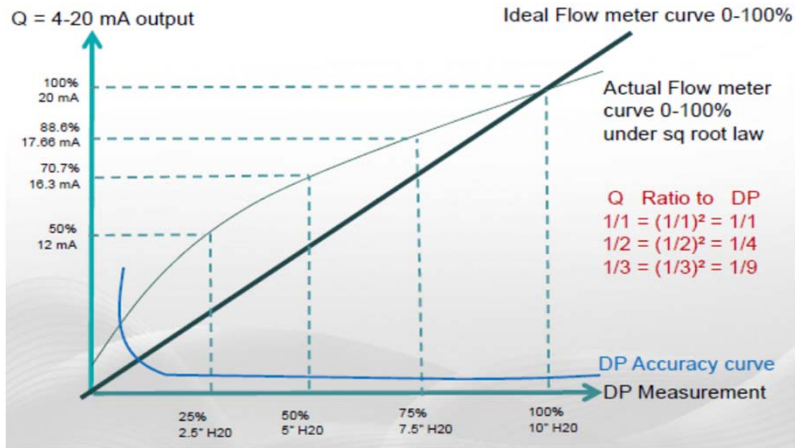
The use of Primary elements



28

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Square root law



Calibration curve of a typical dp transmitter

29

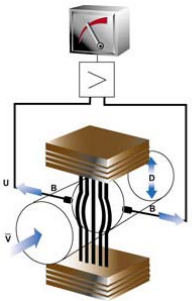
29

Improved Monitoring of District Metered Areas (DMAs)



Why such high inaccuracies below 3 ft/sec?

- Magmeters measure induced voltage
- If flow velocities become too low, then the induced voltage is no longer measurable



U Induced voltage
 k Instrument constant
 B Magnetic field strength
 ∇ Velocity of the conductor
 D Conductor width

Rational drowning

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Does increasing flow velocity improve accuracy?

- Yes, increasing flow velocity would improve the accuracy of the magmeter measurement
- One way of increasing the flow velocity for DMA monitoring is by using magmeters with reduced bore
- But reducing the bore is often not acceptable as it will result in a pressure drop in the DMA that is monitored



Rational drowning

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FLUXUS XLF: Technical advantages

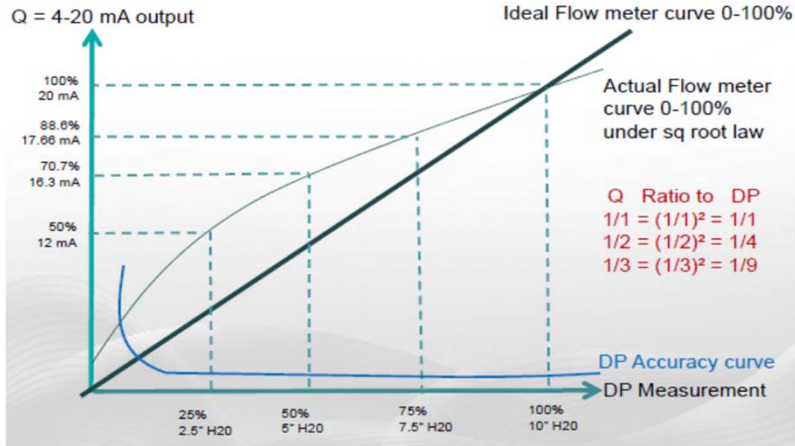
- Installed without cutting or damaging the pipe
- Simple and fast installation process
- No pipe flushing required, as no contact to the water is made
- No water supply interruption
- No field zero calibration needed
- Large overall time and cost savings



Value proposition

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Square root law

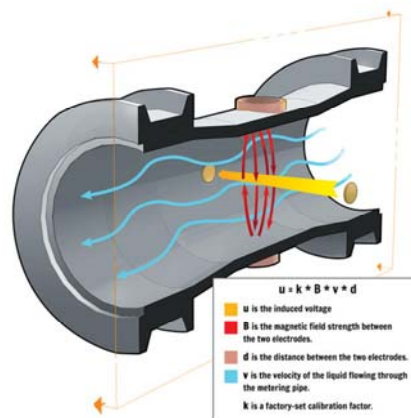


Calibration curve of a typical dp transmitter

33

33

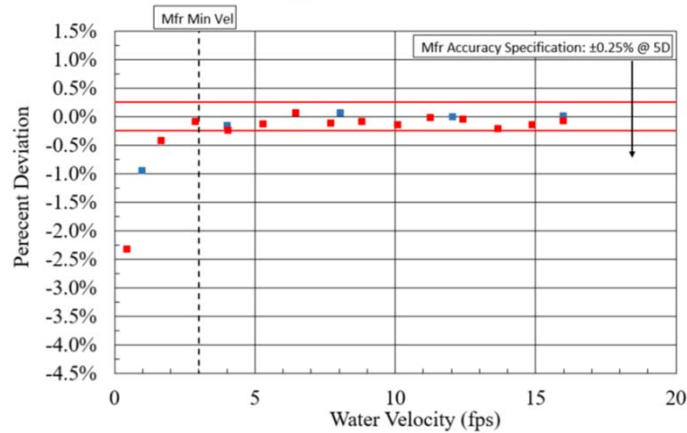
Magneters



34

34

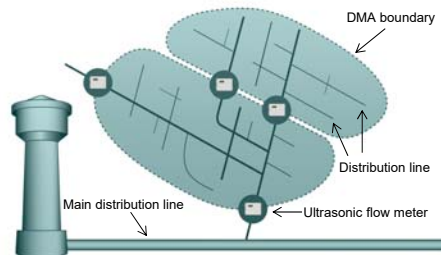
Mfr B Magnetic Flow Meter Data



Improved Monitoring of District Metered Areas (DMAs)

An increase in the establishment of DMAs

- In order to do this drinking water suppliers are further dividing their networks into DMAs that are separately monitored for flow
- This enables them to calculate water balances and determine the consumption in each individual DMA
- Precise flow monitoring also helps to identify DMAs with high leakage rates and detect new leaks at an early stage

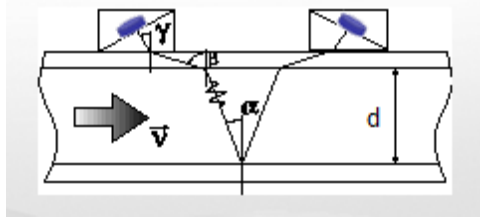
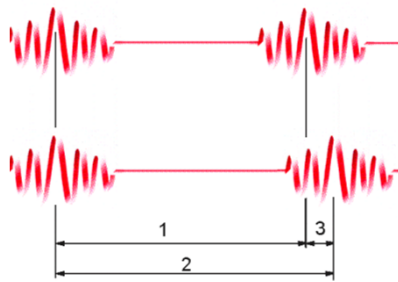


Measurement Principle: Transit Time

(or time-of-flight principle)

Theory:

*Signal in the direction of flow travels faster compared to signal against the flow direction
The difference in transit time is a measure for the flow velocity*



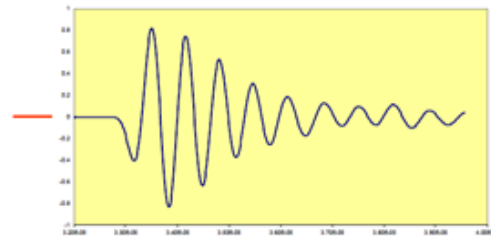
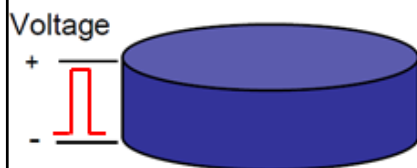
*A swimmer swims faster with the flow as compared to against the flow
The sonic signal does the same*

... external measurement of internal flow

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Creating Ultrasonic Sound

Piezoelectric Phenomenon



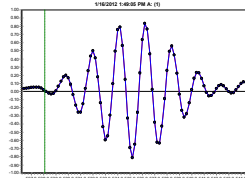
Crystal Rings to Produce Ultrasound – 0.5 to 2 MHz

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Flexim Advantages

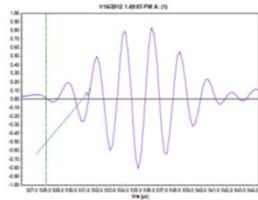


Flexim utilizes smart digital processing where the signal is digitized many times over the entire sinusoidal wave, leaving no margin for error.



Flexim

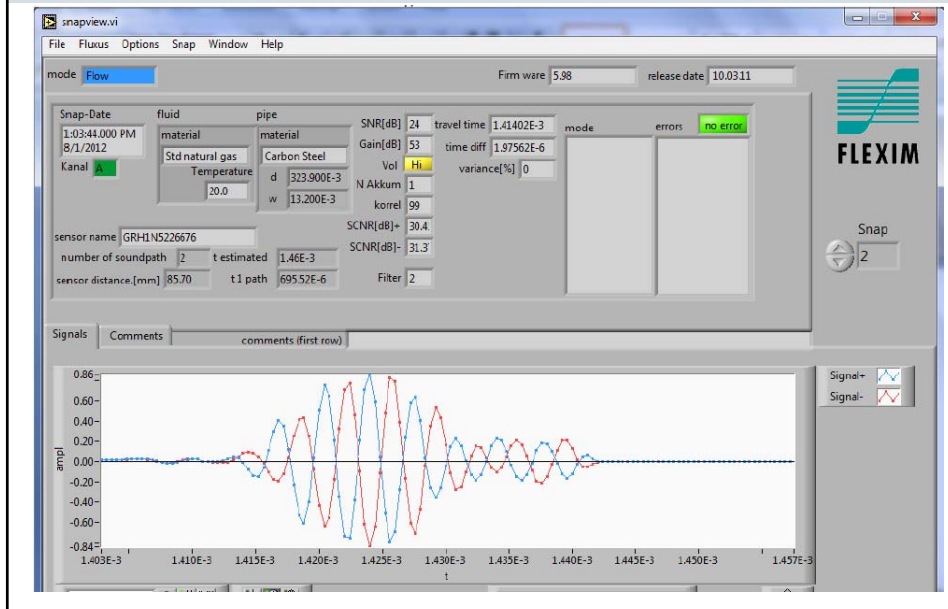
Flexim utilizes a fully digitized signal of 50 to 200 points depending on transducer frequency range, ensuring a high quality signal.



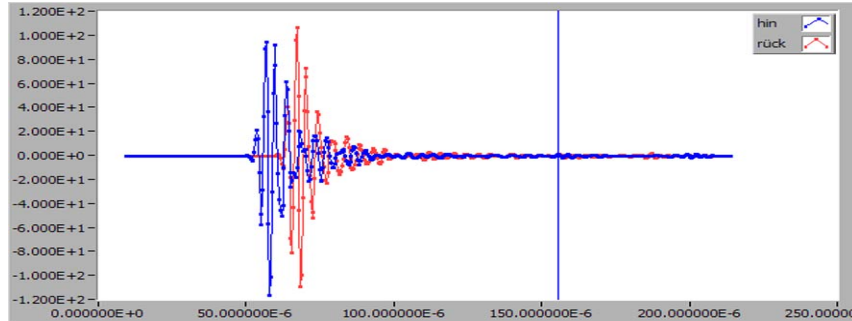
Others

Other manufacturers use a single digital mark in the average of the signal. The digital mark moves based on changing temperature and process conditions, creating meter drift and often falling outside of the meters detection limits, which leads to loss of signal.

Signal Waveforms



Better Signal Processing



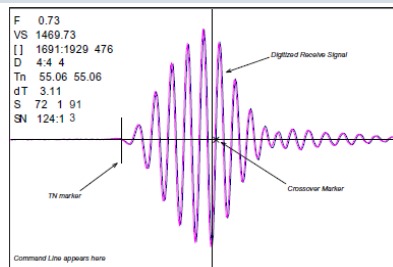
- Up to 1000 signals per second
- Fast signal processing using a digital signal

- High noise suppression
 - For high accuracy
 - For short inlet and outlet straight lengths
 - For high moisture or solid contents
 - For small diameters (<DN25)

- Stable zero flow (no zeroing necessary)
- No drift
- No offset

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Competitors Signal Processing



Zero Crossover Adjustment: (Hot Key 4)

Observe the small "X" mark located on the zero crossing line near the middle of the receive signal in the Graph Screen above. This "X" indicates the central crossover which the FUG1010GN is using to measure the transit-time delta. This crossover will generally be close to the peak of the receive signal with at least

4-59

- Only 1 single point on the signal is processed
- Manual adjustment of crossover point

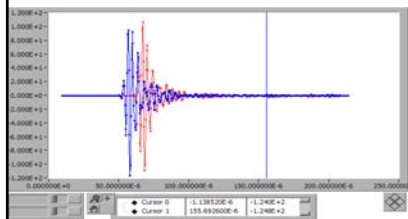
Section 4

FUG1010GNFM-3B

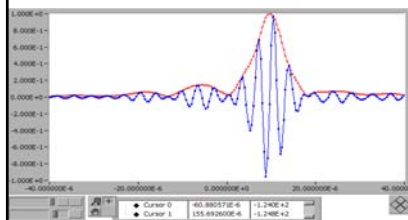
one well formed (non-aberrated) receive cycle on each side of the crossover. If it appears that the placement of this crossover is unsatisfactory then it can be adjusted by pressing the <4> key on the keypad, which will invoke the [ZCOSet] command. The crossover point can then be moved in either direction on the waveform using the <+> or <-> keys. The change from the default value (in receive cycles) will appear in the number to the right of the command. To exit this mode, press the <0> key.

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Cross Check Signal Processing



Cross Correlation



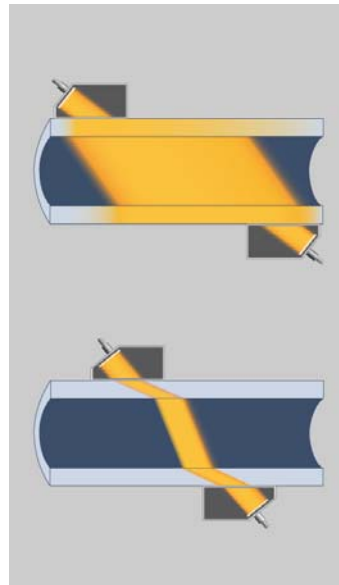
- Up to 1000 signals per second are generated
- Fast signal evaluation with DSP (digital signal processor)
- Time difference calculated by cross correlation
 - excellent noise suppression
 - whole signal is employed
- Resolution and Zero Stability:
 - 1/4000 of a Signal period
 - 0.75mm/s for a 16" / DN400 Natural Gas Line

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Transducer Technologies



- FLEXIM offers two different complementary transducer technologies
- Maximum flexibility depending on application specification.
- Shear wave transducer:
 - **All pipe wall materials**
 - **All pipe wall thicknesses**
- Lamb wave transducers:
 - **Multi Product Pipelines**
 - **Changing Liquids (e.g. concentration)**
 - **Viscous liquids**

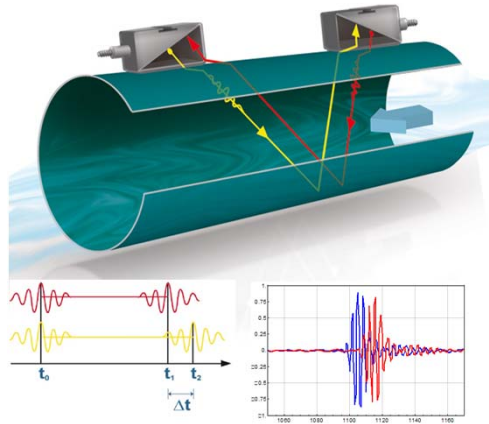


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District Metered Areas (DMAs)



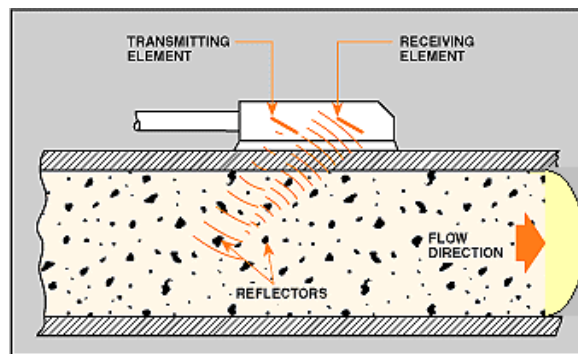
- Extreme low flow measurements with ultrasound
- Measuring low flows with ultrasound technology has always been a strength of FLEXIM
- Even the slowest flow velocity of the media measured leads to transit time differences of the ultrasound signals
- FLEXIM has now developed a flow meter with even greater



Value proposition

45

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

46

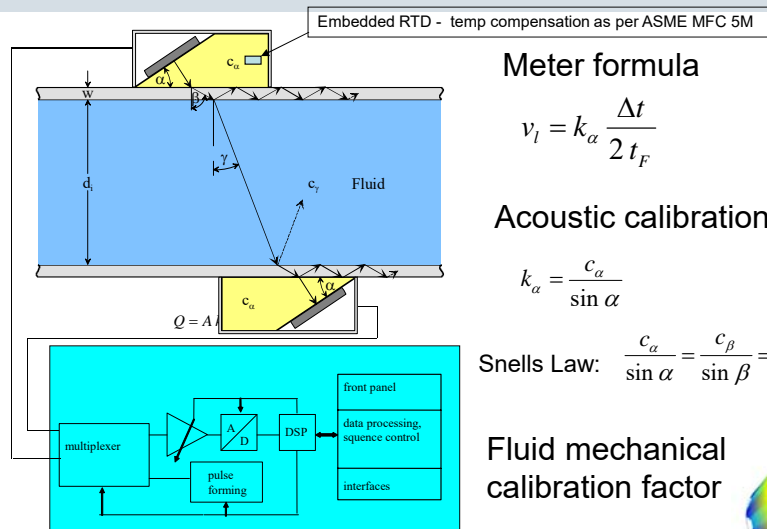
Dual Mode "Transit Time – Doppler"

The Flexim meter can be set up to automatically switch from Transit Time to Doppler (Noisetrek)
Both measurements made from the same transducer

... external measurement of internal flow

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Transit Time - Clamp on



Meter formula

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

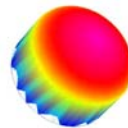
Acoustic calibration factor

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

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

Fluid mechanical calibration factor

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



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Temperature Compensation



Flexim is the only Ultrasonic Flowmeter on the market that meets ASME requirements for temperature compensation.

ASME MFC- 5M: Measurement of Liquid Flow in Closed Conduits Using Transit-Time Ultrasonic Flowmeters

Flexim has NO Temperature drift!



RTD in transducer to compensate for temperature changes.

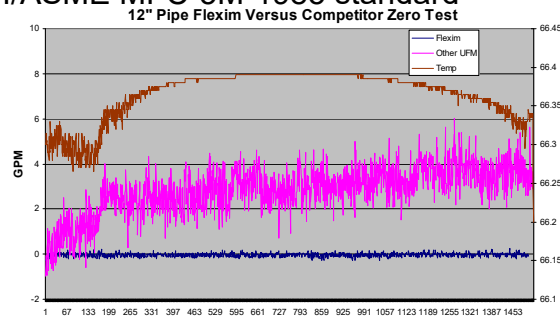
No other manufacturer does this!

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Zero Stability



- real zero stability due to matching of transducers in production and temperature compensation
- long-term drift free measurement
- meets ANSI/ASME MFC-5M-1985 standard



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Temperature Stability test Flexim – Siemens – GE



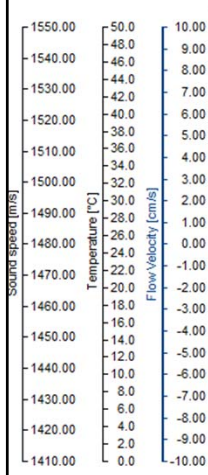
51

Clamp-on metering Drift test

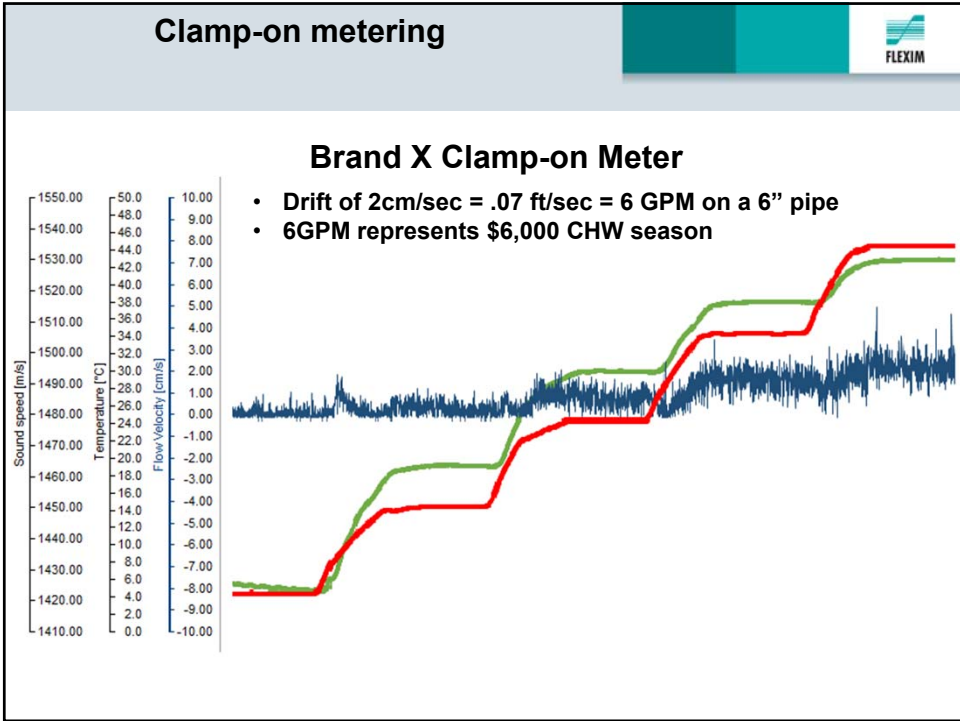


Temperature change is 70°F to 115°F

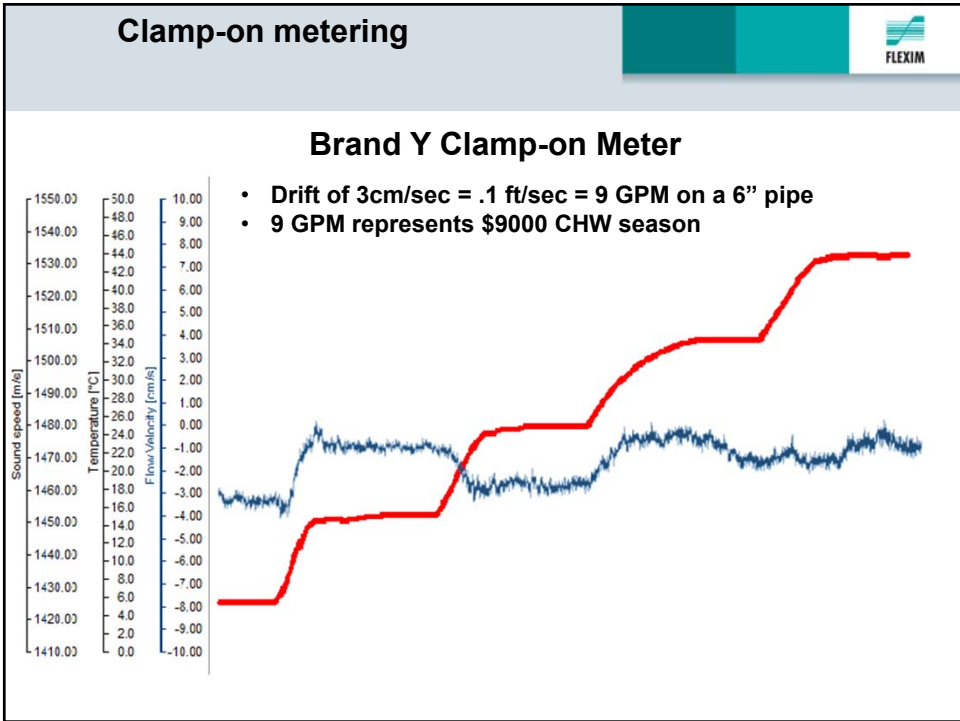
Flexim Clamp-on Meter
No zero drift



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Calibration Facility – Flexim NY



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Typical Calibration Certificate

Calibration Certificate

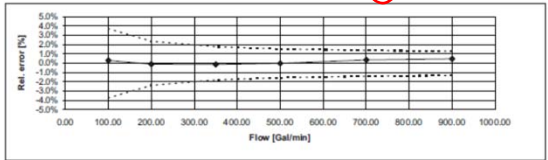


Device under test (DUT) Certificate No.: 20091202-003
 Work Order No.: WO-09-0342
 Purchase Order No.: O 09-0761

Type: Transmitter: F601 Ser. No.: 0667
 Transducer: CDK1NZ7 Ser. No.: 14076
 Pipe ID [inch]: 6.11 Field: Water Temperature: 68.0 °F
 155.1 Offset Allowance: 20.0 °C
 Range[Gal/min]: 900 Spec. Accuracy: 1.0% of rate

Test results

Meas. Point	Meas. Time	Standard Flowrate	DUT Flowrate		Error	Limit	Velocity v [ft/s]	Pass/Fail
			Qn Gal/min	Qp Gal/min				
1	120	-0.01	0.20	0.20gpm	2.70gpm	0.0	p	
2	120	99.99	100.29	0.3%	3.7%	1.1	p	
3	120	199.95	199.77	-0.1%	-2.4%	-2.2	p	
4	120	350.00	349.57	-0.1%	-1.8%	-3.8	p	
5	120	499.96	499.98	0.0%	1.5%	5.5	p	
6	120	700.07	702.65	0.4%	1.4%	7.7	p	
7	120	899.93	904.16	0.5%	1.3%	9.9	p	



Environmental conditions: Temperature[°F]: 68 ± 3 Atmosph. press.: 1013 ± 25 mBar Humidity: 50 ± 15 %RH

The indicated instrument meets the accuracy data published in the specification (passed / failed). P

The calibration of the instrument specified above was carried out against standards with accuracies are traceable to the National Institute of Standards and Technology (NIST).

Standard YOKOGAWA Ser. No. AAXFCS03 Rig PS 101
 AXP160C
 Calibration due 07.17.2010 Certificate No. N66475

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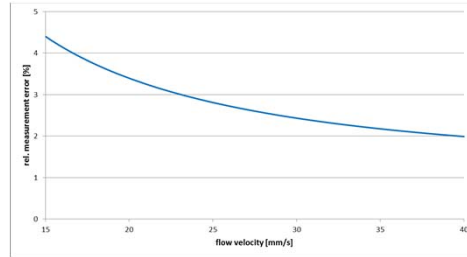
District Metered Areas (DMAs)



FLUXUS XLF: Detection of weep leaks

- The FLUXUS XLF can measure flow velocities of about 0.03 ft/sec
- Leaks below 2 gpm are classified as very small “weep leaks”*
- Using the unique XLF ultrasound sound technology water suppliers can monitor DMAs and detect even very small leaks

FLUXUS XLF with M sensor on a DN200 pipe



* Hamilton and Charalambous (2013): “Leak Detection – Technology and Implementation”

Our solution

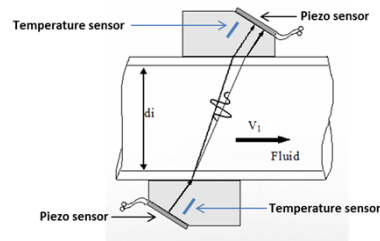
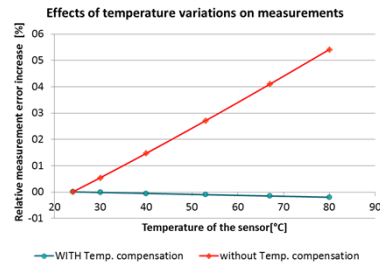
57

District Metered Areas (DMAs)



FLUXUS XLF: Technical advantages

- Ambient temperature variations can have a strong influence on ultrasound measurements if they are not compensated
- FLEXIM is the only manufacturer of clamp-on ultrasonic flow meters that installs temperature probes in every sensor
- By continuously monitoring the sensor temperature and compensating temperature



Value proposition

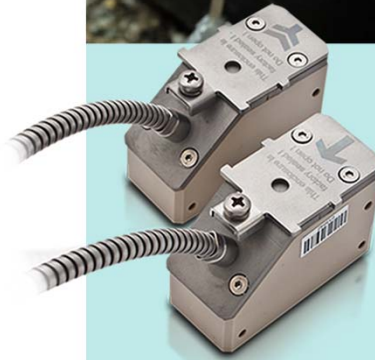
58

District Metered Areas (DMAs)



FLUXUS XLF: Technical advantages

- Maintenance-free due to permanent coupling pads
- No connections on the sensor heads for protection against water ingress
- Robust design and high quality material (SS 316)



Value proposition

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District Metered Areas (DMAs)



FLUXUS XLF: Technical advantages

- Extremely robust and fully closed mounting system
- Sensors cannot be seen and installation therefore does not attract attention
- Mounting system can only be opened with a tool, to reduce the danger of tampering



Value proposition

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District Metered Areas (DMAs)



FLUXUS XLF: Technical advantages

- Installed without cutting or damaging the pipe
- Simple and fast installation process
- No pipe flushing required, as no contact to the water is made
- No water supply interruption
- No field zero calibration needed
- Large overall time and cost savings



Value proposition

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Solution



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FLEXIM








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FLEXIM
May 21, 2012
John Van Nostrand

Case Study: The 5th largest utility in the nation has issues with meters coating with magnetite.

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Customer and Case



- The City of Jacksonville Florida has extremely hard water and magnetite coats the inside of magnetic flow meters causing a short and meter reads low and lower over time.
- JEA is the 5th largest utility in the Nation.



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Application - Customer Motivation



- Potable water wells are monitored for depth, conductivity for salt water intrusion and flow.
- A World Class Magnetic flow meter company thought they had a solution with their electrode cleaning circuit.
- The magnetic flow meters came calibrated from the factory and worked perfectly measuring water production wells for the first six months.
- The flow meters began to drift downward after six months until they read 50% of the actual flow after a period of one year.
- When the 12 inch meters were removed from service, and the electrodes cleaned with Vinegar, the meters once again read accurately.
- JEA has hundreds of meters and can not remove them and clean them every six months.

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Application - Measurement Point



- A meter test was performed between all ultrasonic meters against their meter test standard.
 - A newly calibrated electromagnetic flowmeter
 - A newly calibrated turbine flowmeter
 - A graduated tank over time.
- The utility tested the meter over various flow rates
- The accuracy of the Flexim meter was $\pm 0.9\%$



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Application - Technical Details



- Potable water
- Re-Use water
- Raw Sewage
- 8" – 36" Ductile Iron pipe with cement liner
- 60° to 80° F operating temperature.
- 26° to 100° F ambient temperature.
- 5 to 70 PSIG pressure.



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Solution - Installation



- Flexim single channel 5107 and 7404 meters
- M transducers strapped directly to the ductile iron pipe.
- Permalok is used to protect the transducers from the elements
- 4-20mA output for volumetric flow



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Solution - Results



- Based on previous testing, customer recently placed order for (36) complete dedicated meters, and 2 portable meters.



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Customer Benefits



- Improved system reliability.
- Installation is easy.
 - No special equipment and no down time.
- The utility no longer has to remove the magnetic flowmeters and clean them.
- The utility managers can trust the readings.
- Calibration of the meters satisfies the governing authority.
- The cost does not increase with the size of the meter.

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Applications in the water and wastewater industry



1603 mm – 45 years old: Reflex mode on a very corroded pipe



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Asbestos cement pipe: IP68 sensors suitable for buried installations



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Versatile installation options: High placement tolerance of sensors



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Sensors for mobile and fixed transmitters

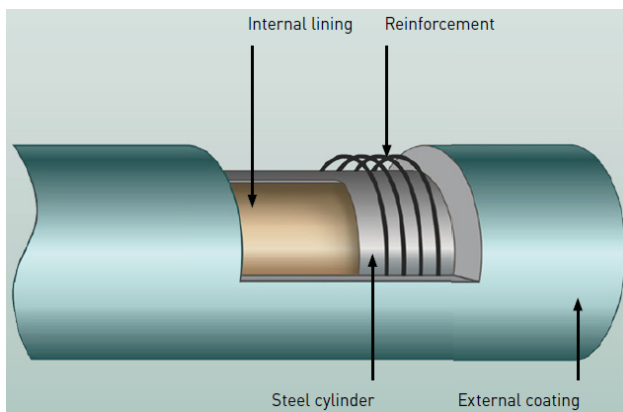


FLEXIM Water and Wastewater, February 2017

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Prestressed Concrete Cylinder Pipes (PCCP)

- Very large wall thickness
- Several layers of different material
- High amount of interfering signals (reflections)



FLEXIM Water and Wastewater, February 2017

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FLEXIM's key to success on PCCP

- Very powerful low-frequency sensors
- Advanced signal evaluation and noise suppression software
- Extensive installation experience



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77

A competitor was failing on this 2880 mm pipe, so the customer called FLEXIM to try



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Our ultra low-frequency G sensors made it easy ...



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...although the pipe material looked like this



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Penstock monitoring with FLEXIM flow meters

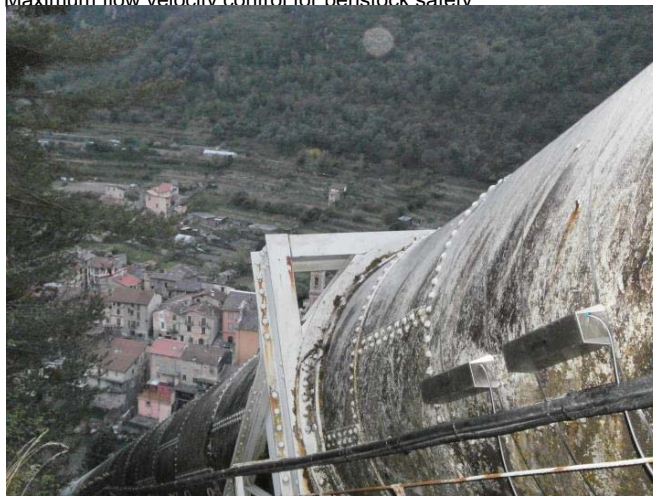


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Électricité de France (EDF): 2880 mm pipe with lamb wave transducers for high flow velocities.

Application: Maximum flow velocity control for penstock safety



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Applications in the water and wastewater industry



ENEA Poland: 4800 mm steel pipe with flow volume of up to 60 m³/s.
Application: Monitoring turbine efficiency



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Applications in the water and wastewater industry



Mighty River Power, New Zealand: 5500 mm pipe.
Application: Monitoring turbine efficiency and run-off amounts for environmental reasons.



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Applications in the water and wastewater industry



Municipality of Munich (Leitzach), Germany: 4045 mm carbon steel with cement lining of a pumped-storage hydro power plant. Application: Leakage detection



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Applications in the water and wastewater industry



Municipality of Munich (Leitzach), Germany: 4045 mm carbon steel with cement lining of a pumped-storage hydro power plant. Application: Leakage detection



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Installation in Japan



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Hydroelectric power generation water line



F704+G transducer(2 path)

Condition: Over 30 years (Old pipe)

Pipe material: Carbon Steel

Pipe size: 1.8m

Pipe thickness: 11mm

Water(15°C, 1467m/s)

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Competitors trial test



GE sensing

Configuration: 1 Pass, 1 Channel

Result: Failure due to poor field service engineer experience

Installation: it took 1 day by 2 persons.

Tokyo Keiki(Ex-Tokimec)

Configuration: 1 Pass, 2 Channel

Result: Measurement, but, many times re-installation

Installation: it took 1 day by 3 persons.

FLEXIM

Configuration: **2 pass**, 1 Channel, magnet type mounting fixture for test

Result: Good stable measurement

Installation: it took **30 minutes** by **1 person**

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Installation 2



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Is there something specific you would like to know about?



Thank you for participating.

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