Ultrasonic Flow Innovations in Water and Wastewater Applications

WEF Webinar July 20, 2021

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Southeast RSM

FAC Water Market Manager

Agenda

- Where we are today
- Outside influences
- About FLEXIM
- 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.

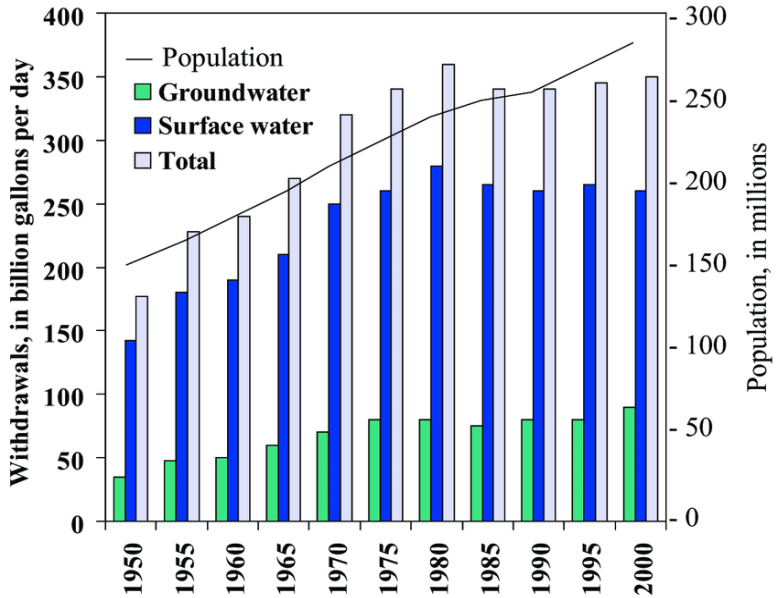
Market trend is Regulation and more Regulation

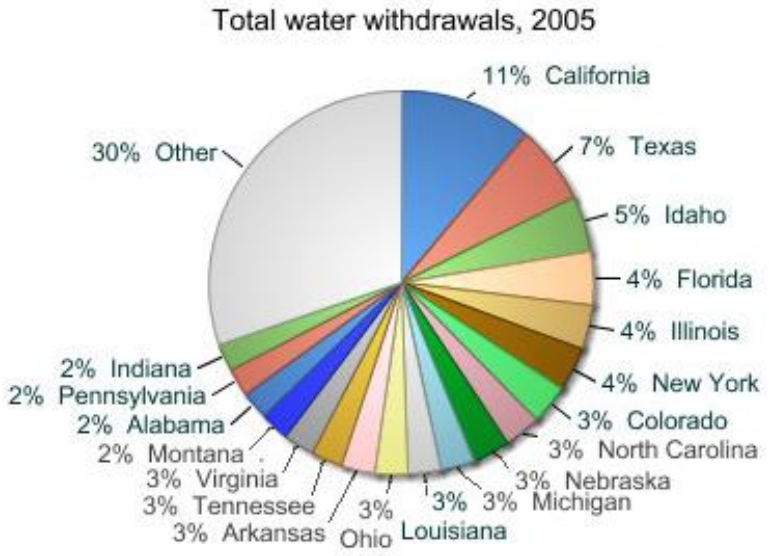
FLEXIM
when measuring matters

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





Overview

All at a glance

Founded in 1990 by

4

graduates of Berlin‘s Humboldt University and of the University of Rostock

Revenue

$100

Million in sales worldwide

450

employees worldwide

Headquarters in Berlin &

16

subsidiaries around the globe

More than

70,000

Flowmeters in use

Number

1

in the field of non-invasive flow measurement with clamp-on ultrasonic technology

Product Overview
Flow Measurement
FLUXUS® Transmitters

4 series

Portable
flowmeter for
water and waste water
applications

5 series

Permanent
flowmeters for
water and waste water
applications, BTU /
Energy

6 series

Portable
flowmeters for
liquids, gases & steam

7 series

Permanent flowmeters
for liquids, gases and
steam

8 series

Permanent flowmeters for
liquids and gases in
explosion-hazardous areas

Product Overview Analytics

PIOX® & FLUXUS® H721

PIOX® S

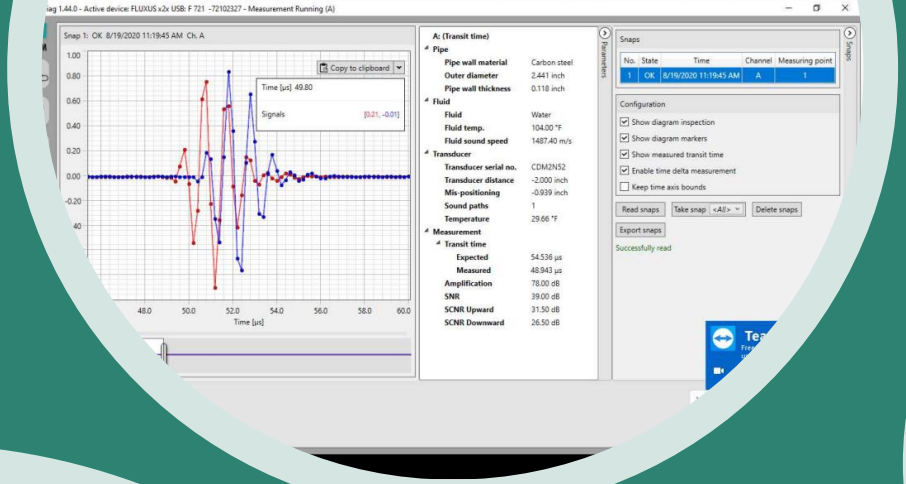
Non-invasive determination of concentration, density and mass flow with clamp-on ultrasonic technology

PIOX ® R

Process Refractometer
Concentration measurement through inline-refractometry with laboratory accuracy

FLUXUS ® H721

Available as a product variant of the FLUXUS® series.
Non-invasive measurement of media-specific data of hydrocarbons as well as media identification



Service by FLEXIM: technicians on site and remote support with *Virtual Technician*

Typical Measurement Technologies

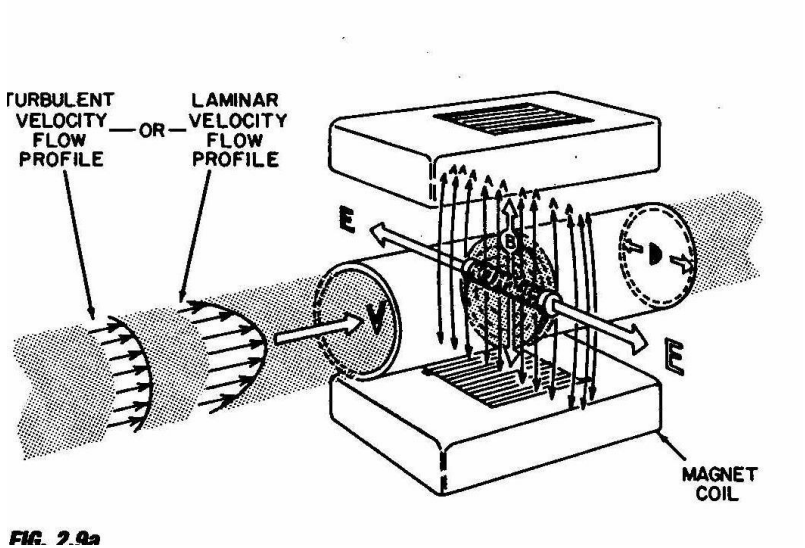


FIG. 2.9a

The Use of Primary Elements

Figure 1

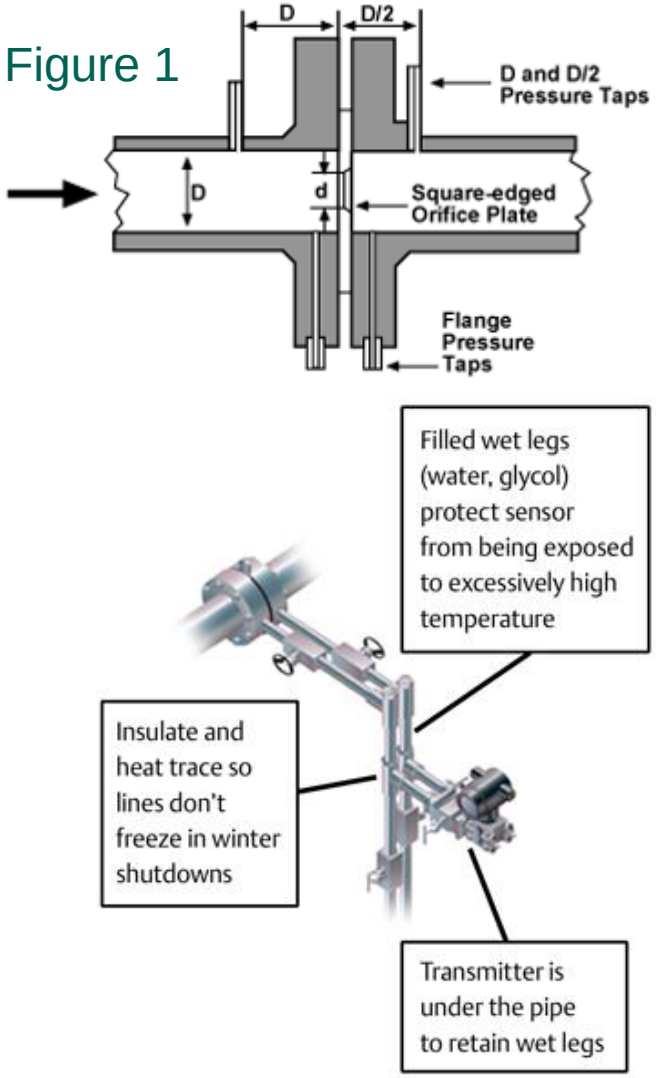
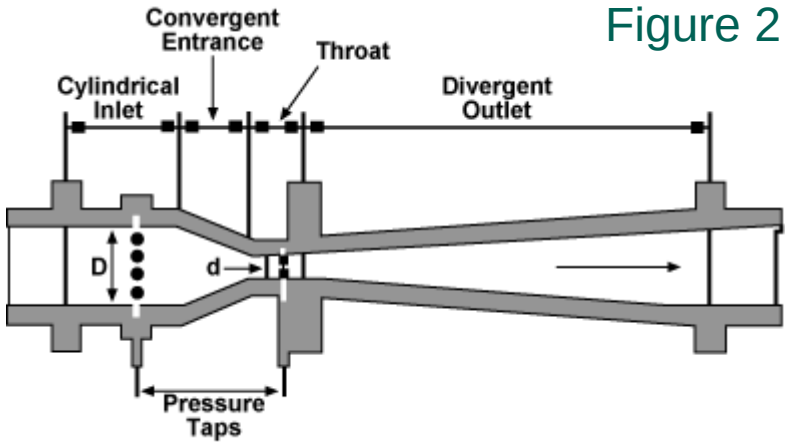
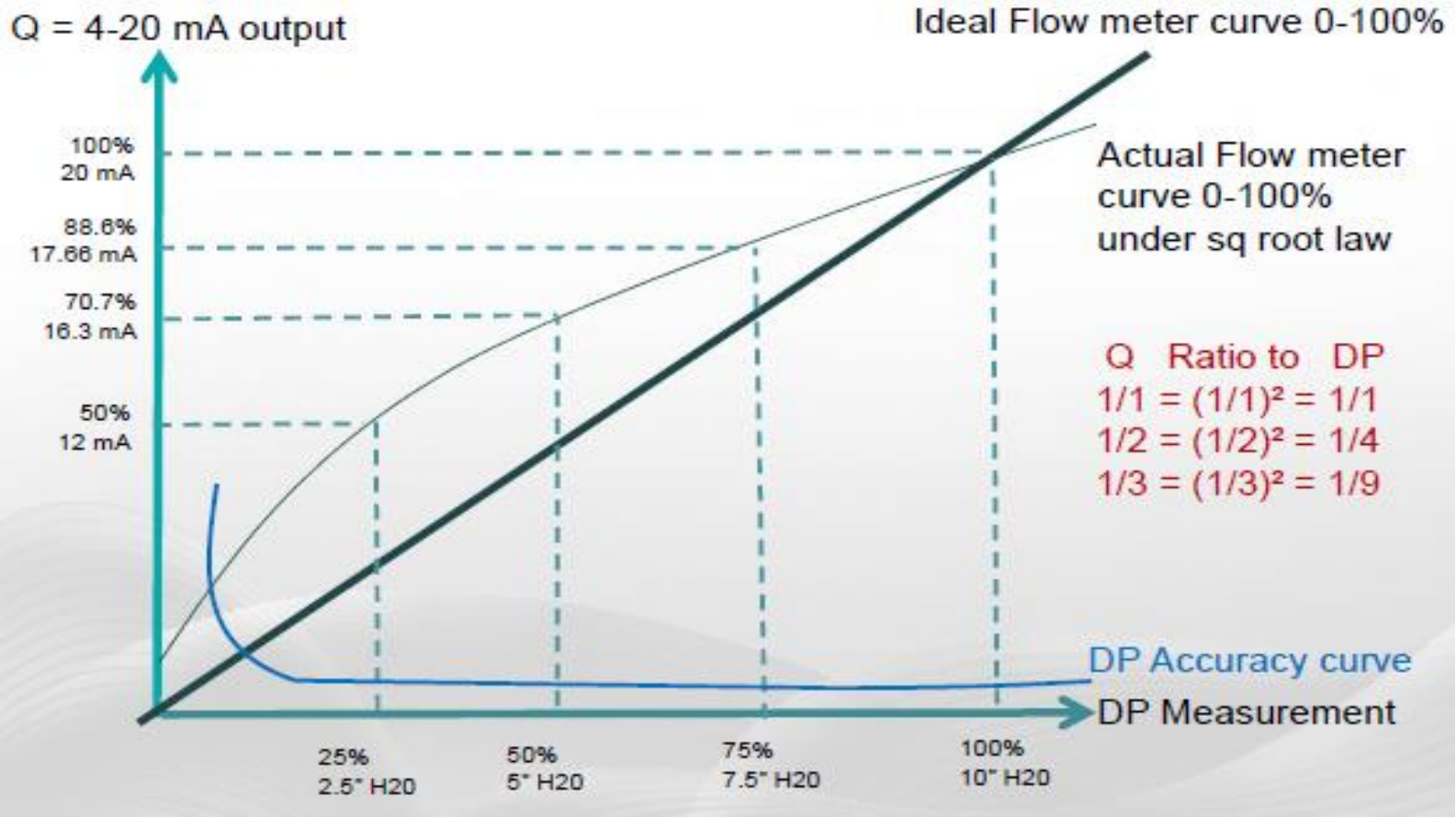


Figure 2

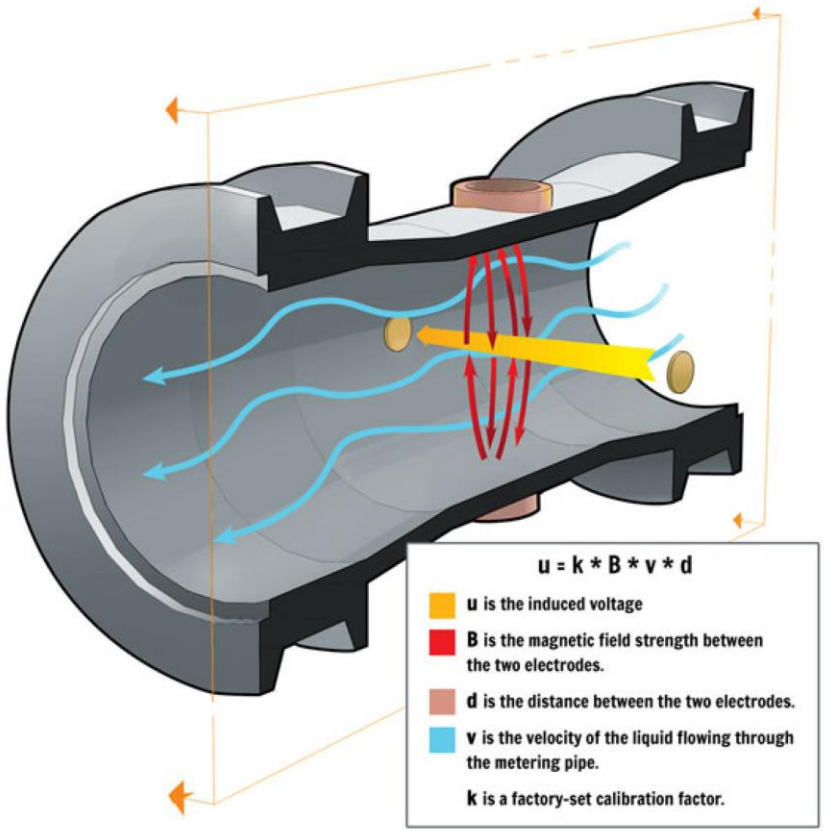


Square Root Law

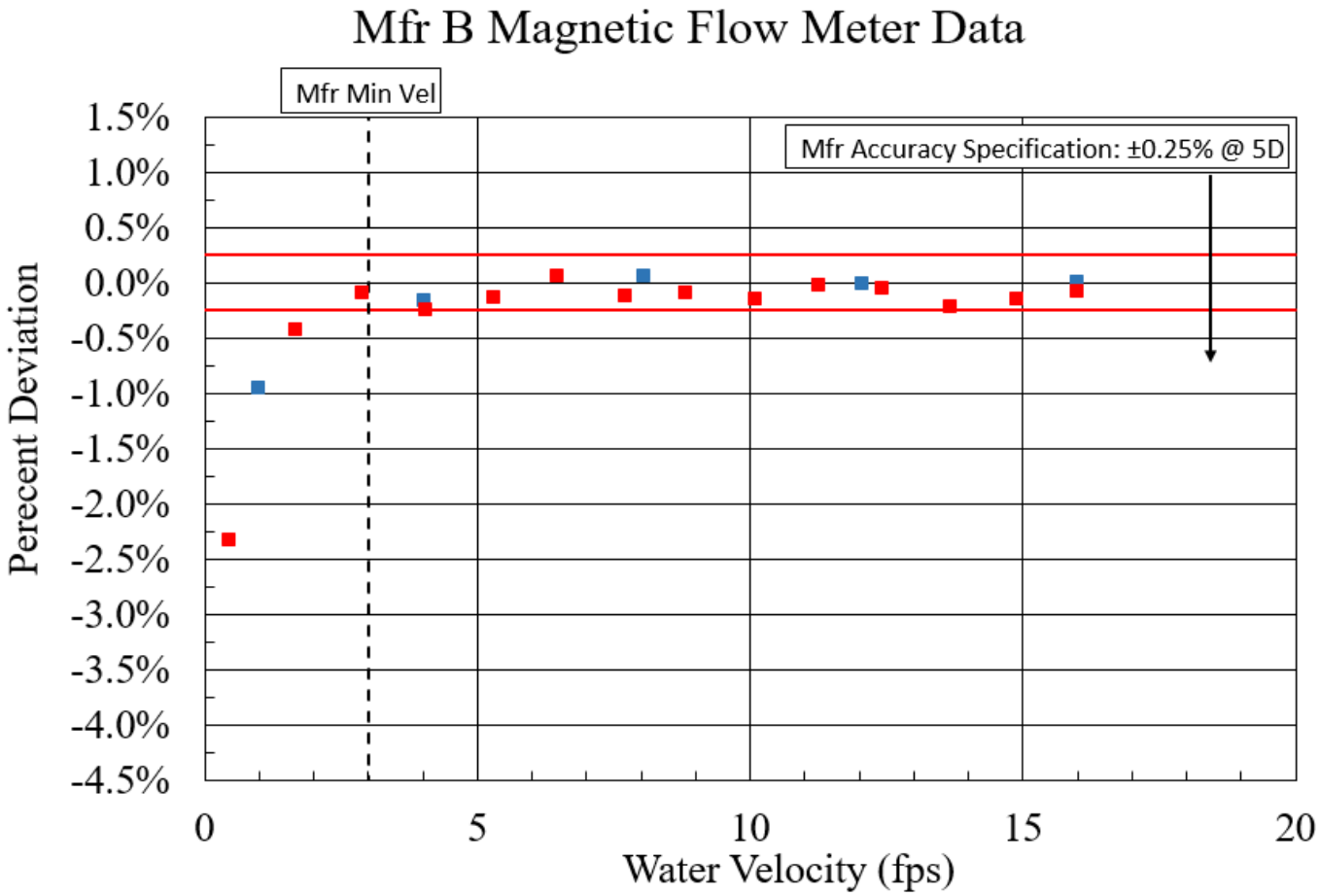


Calibration curve of a typical dp transmitter

Magmeters

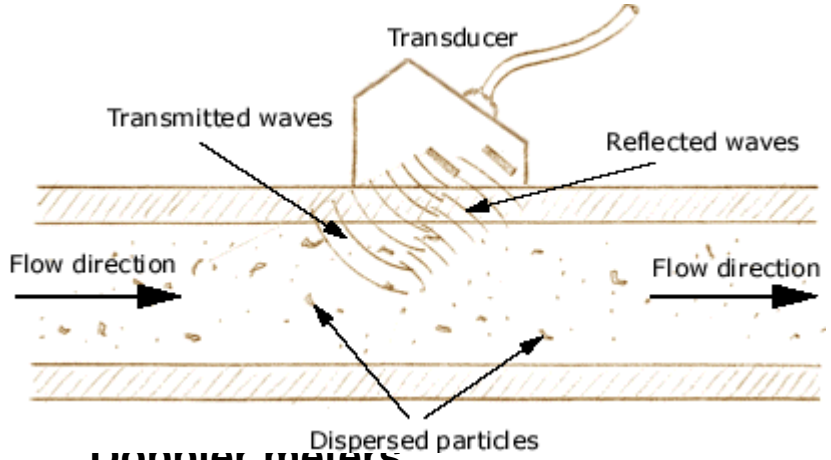

u = k * B * v * d
u is the induced voltage
B is the magnetic field strength between the two electrodes.
d is the distance between the two electrodes.
v is the velocity of the liquid flowing through the metering pipe.
k is a factory-set calibration factor.

Magmeter low flow



Ultrasonic Introduction

The Old Days

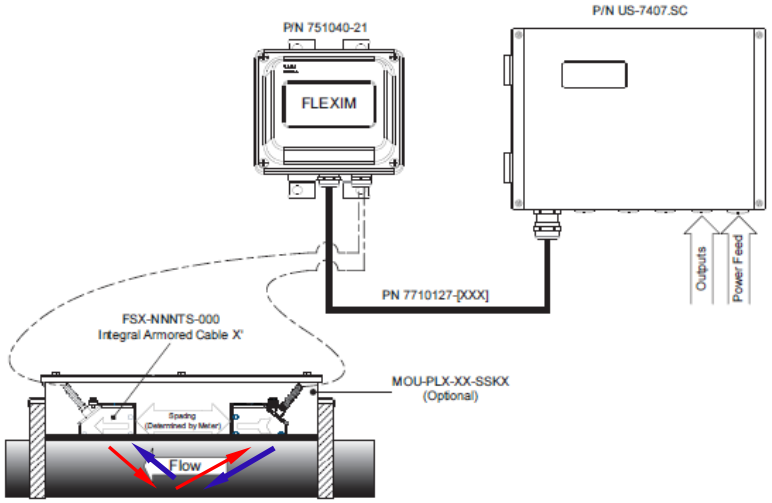


Doppler meters

had

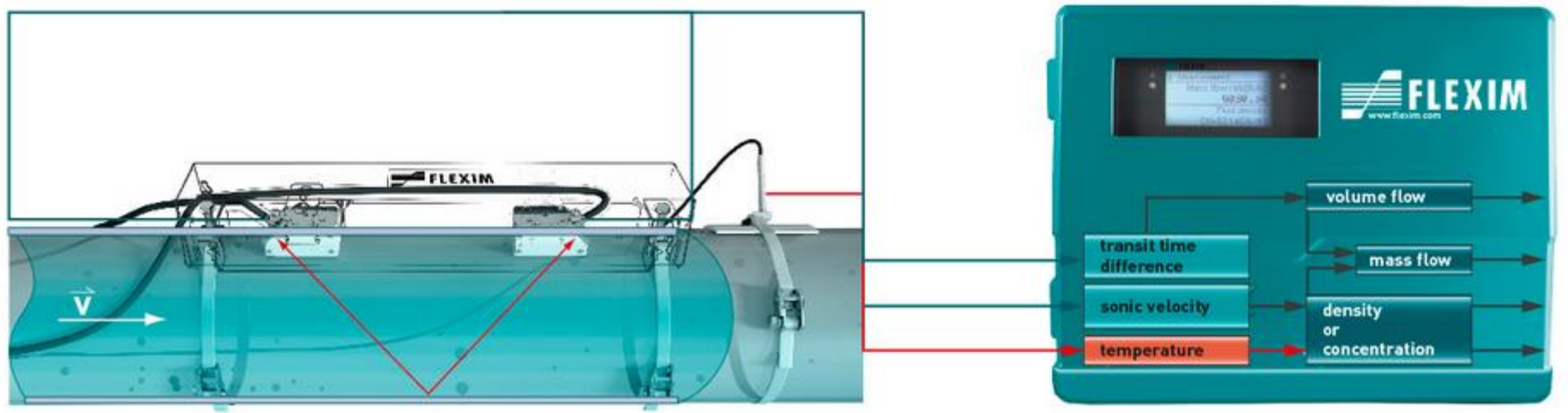
Varying levels of success.

Today



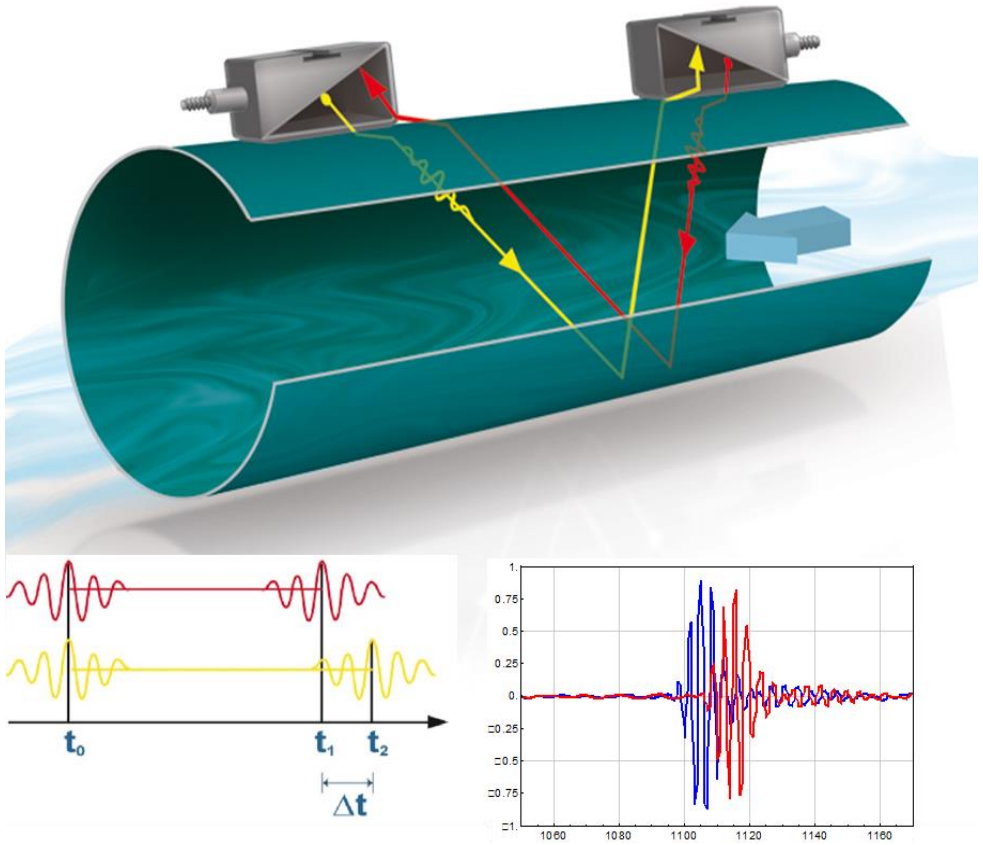
No other meter on the Planet works as well as a FLEXIM meter in Water and Wastewater applications.

Technology is changing in water and wastewater



Improved Monitoring

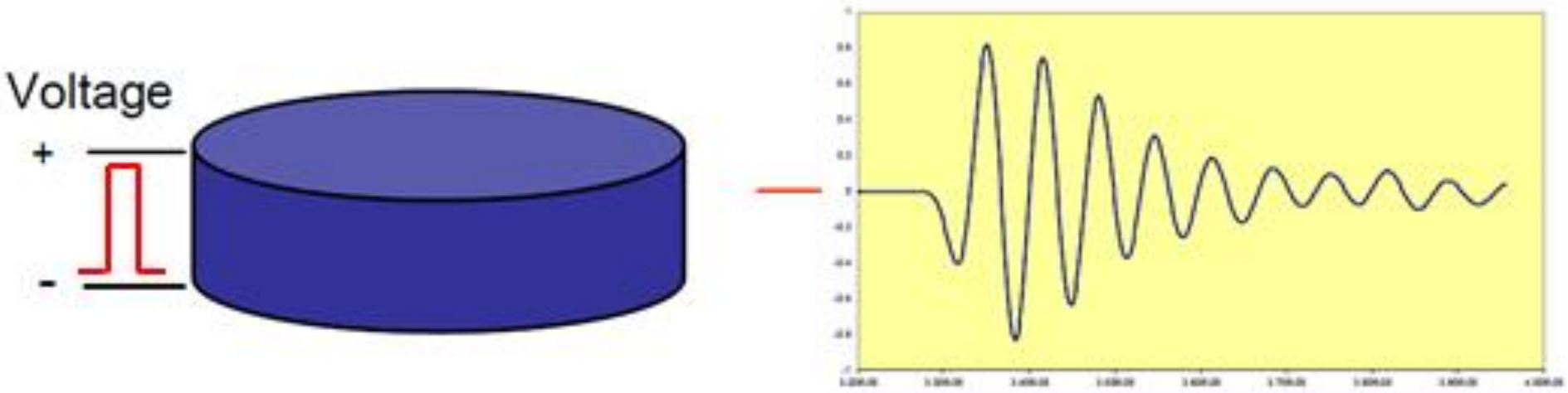
- Extreme low flow measurements with ultrasound
- Measuring low flows with ultrasound technology has always been a strength of FLEXIM
- Even the slowest flow velocity of the media measured leads to transit time differences of the ultrasound signals
- FLEXIM has now developed a flow meter with even greater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



Piezoelectric Crystal

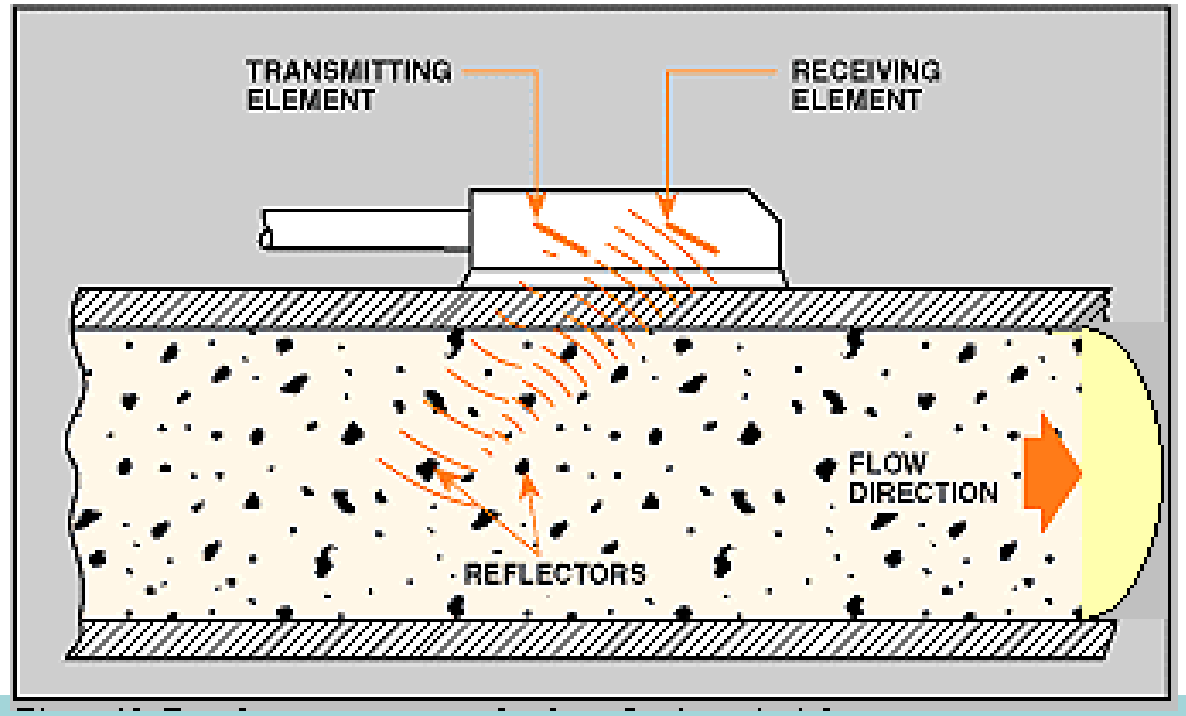
Creating Ultrasonic Sound

Piezoelectric Phenomenon



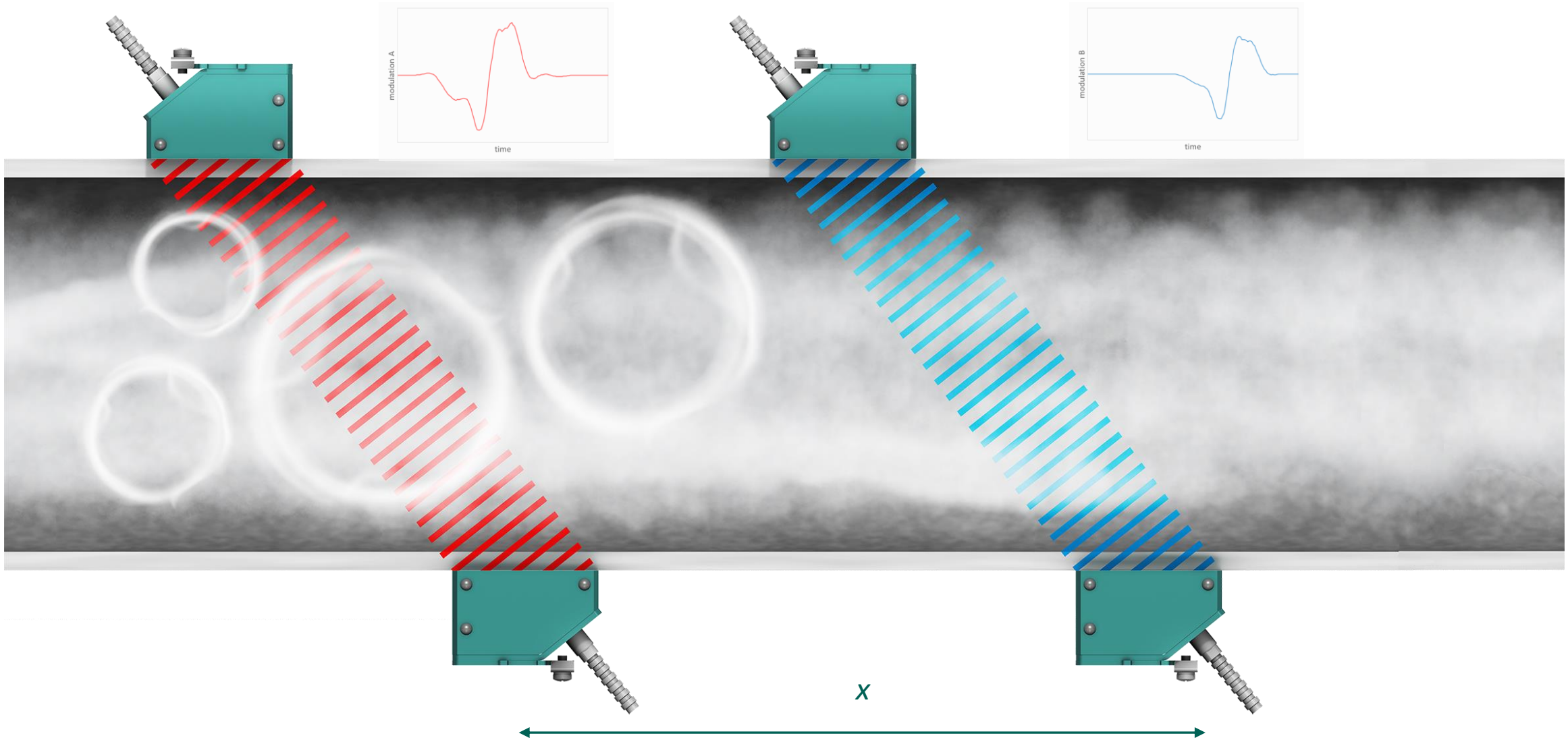
Crystal Rings to Produce Ultrasound – 0.5 to 2 MHz

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

Measurement Principle: Correlation Flow Measurement



Six factors for success

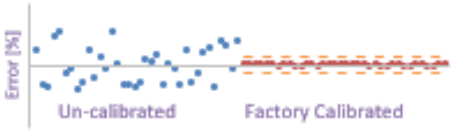
FLEXIM
when measuring matters

1 Zero Maintenance

No gels, greases or coupling compounds - 10 year "fit and forget" convenience and reliability

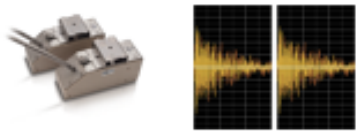
2 Factory calibration

All transmitters and transducers are ISO17025 factory calibrated. Traceable to National Standards



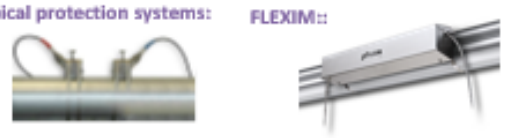
3 Matched pairs

Matched, paired transducers = best in class low flow



4 Robust cables and mounting rail

Robust Mounting system & cable protection



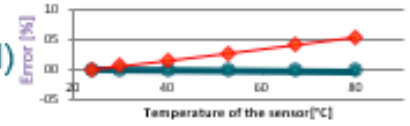
5 Shear Wave & Lamb Wave

Transducers – two available propagation techniques:

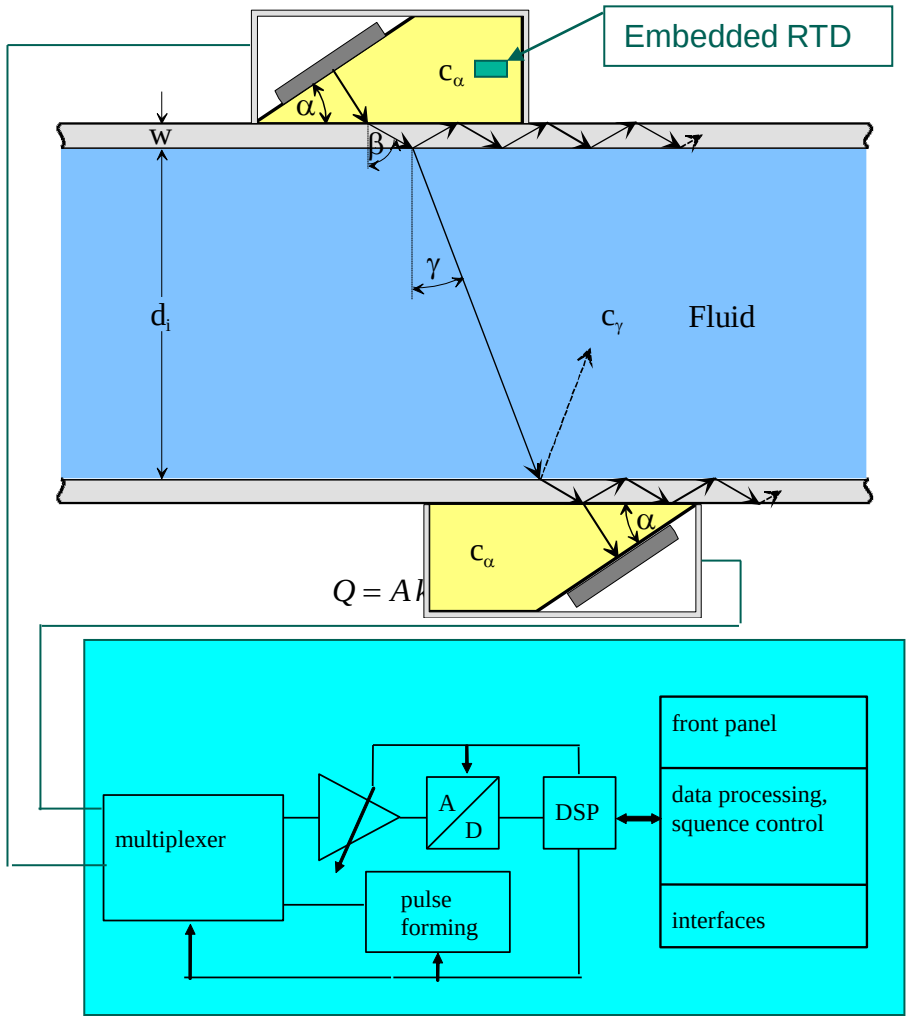
- Shear Wave for standard liquids
- Lamb Wave for Gas and heavily aerated or sedimented liquids

6 Temperature compensation

Temperature compensated transducers (Meets the ASME MFC-5M-1985 Standard)



Operation Principle



Meter formula

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

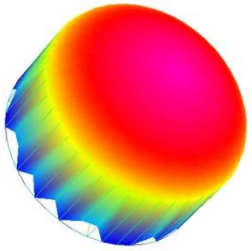
Acoustic calibration factor

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

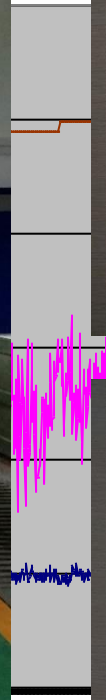
Snells Law: $$\frac{c_\alpha}{\sin \alpha} = \frac{c_\beta}{\sin \beta} = \frac{c_\gamma}{\sin \gamma}$$

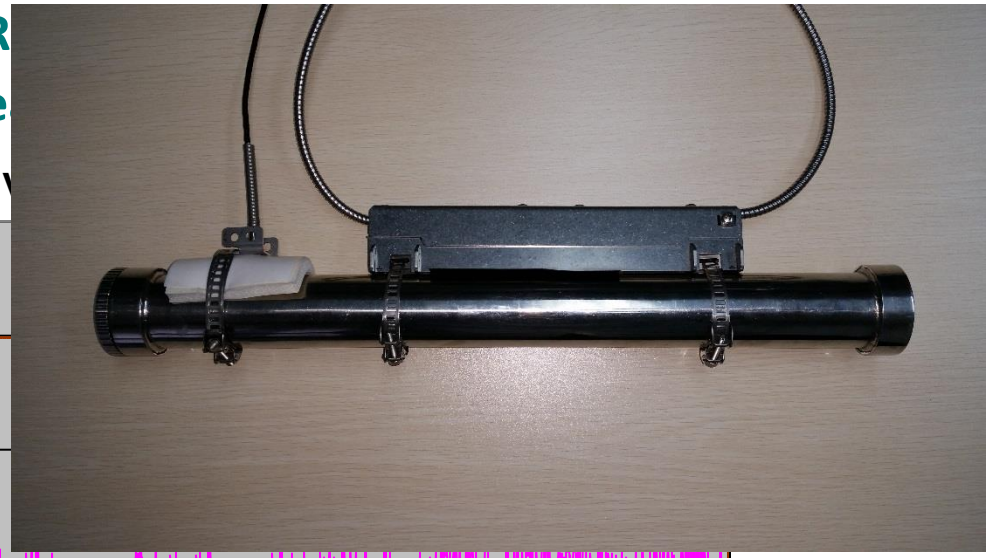
Fluid mechanical calibration factor

$$Q = A\, k_{\mathrm{Re}}\, v_l$$



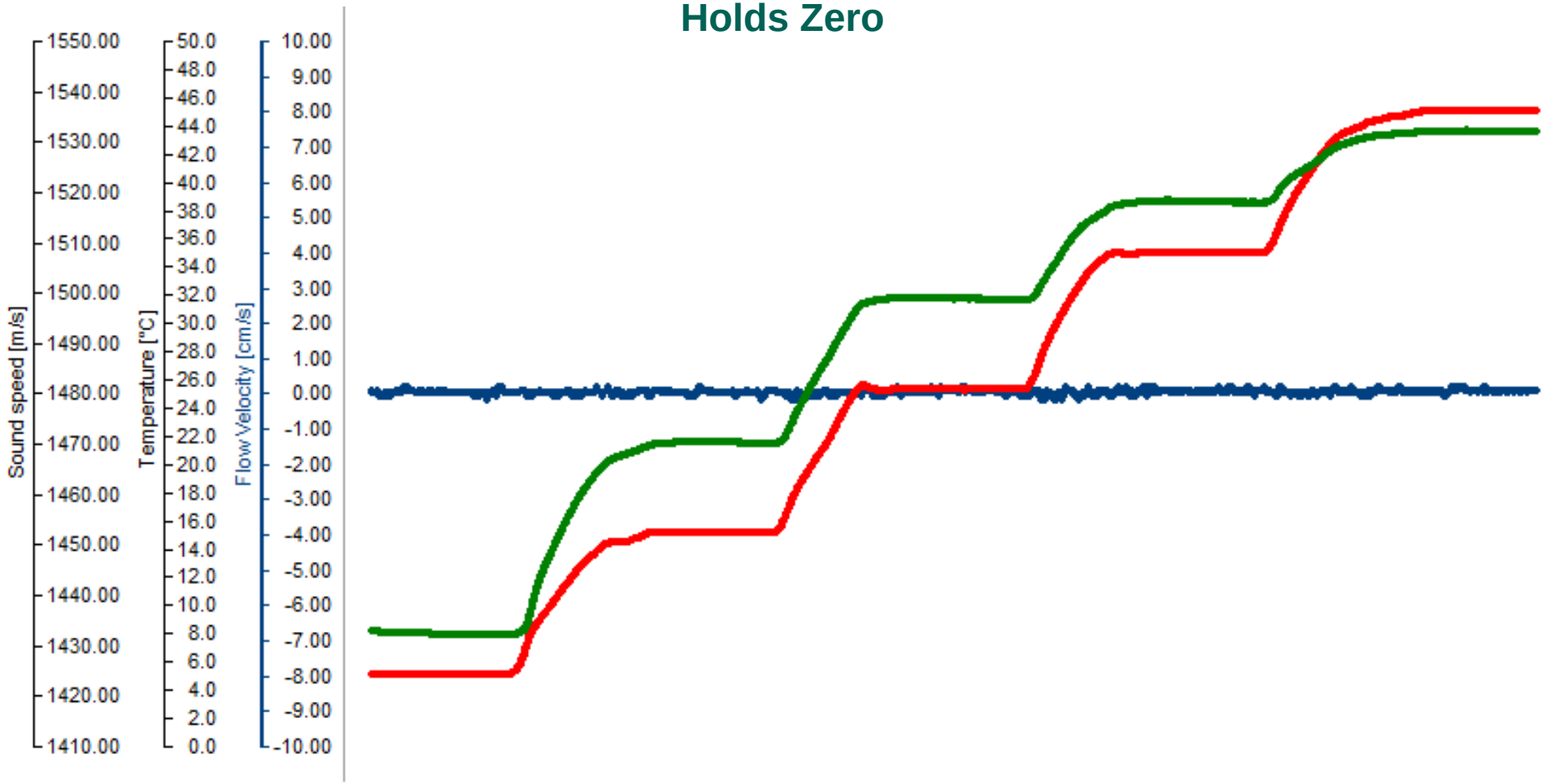
No Zero Drift



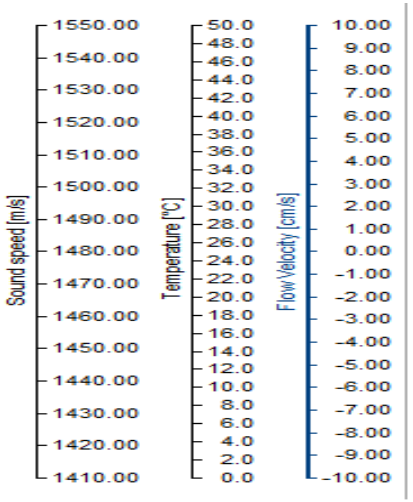


FLEXIM Meter

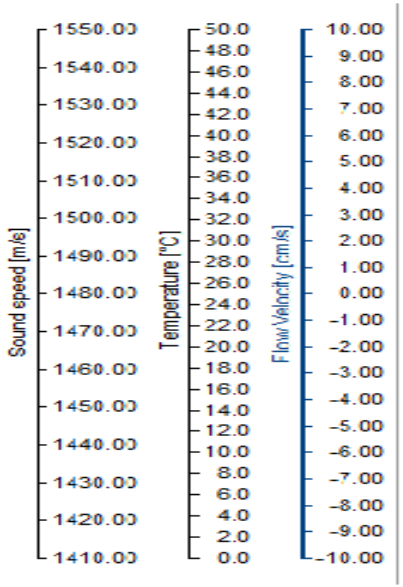
Temperature change is 70ºF to 115ºF
Holds Zero



Leading Brands



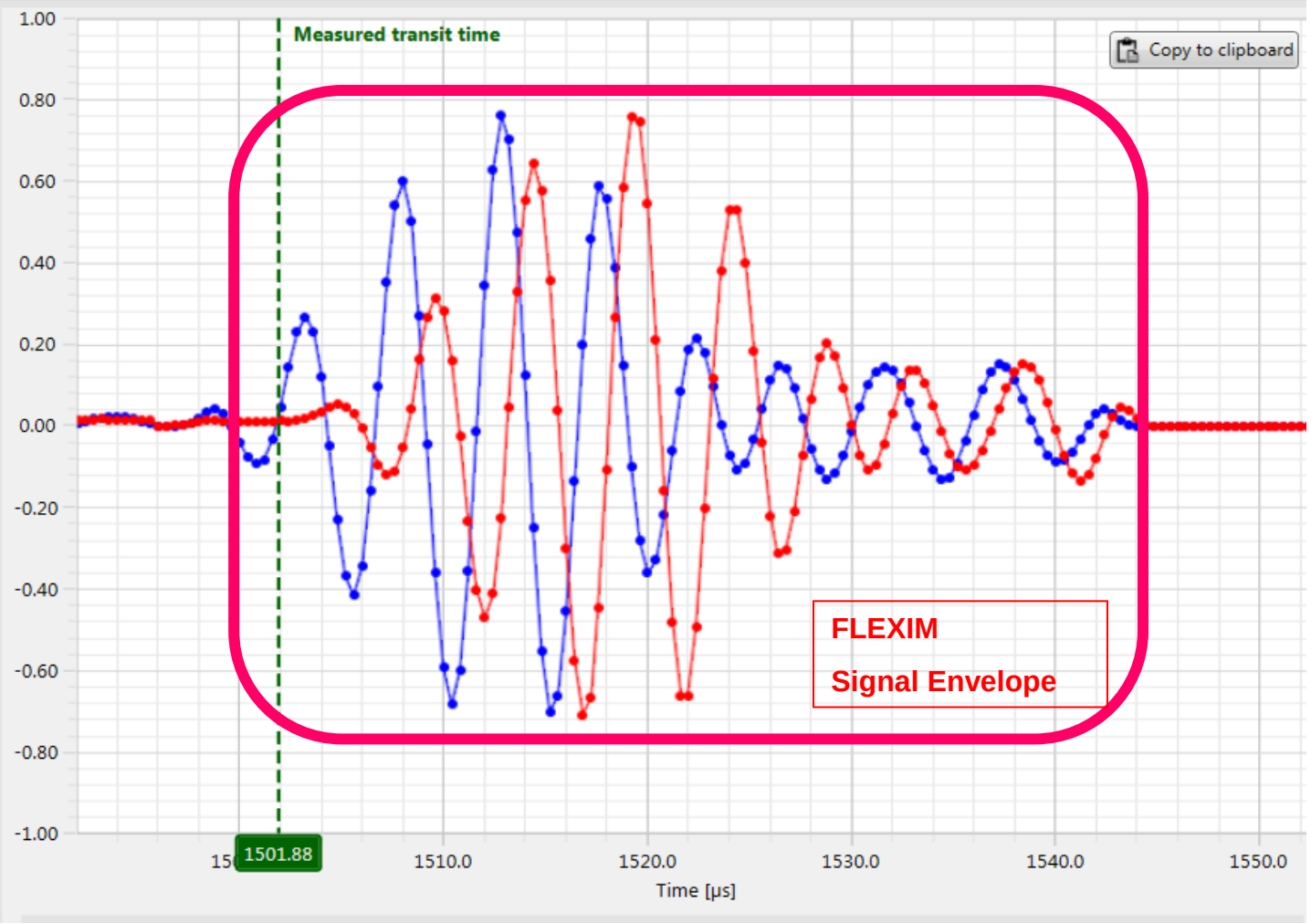
Drift of 2cm/sec = .07 ft/sec = 6 GPM on a 6” pipe



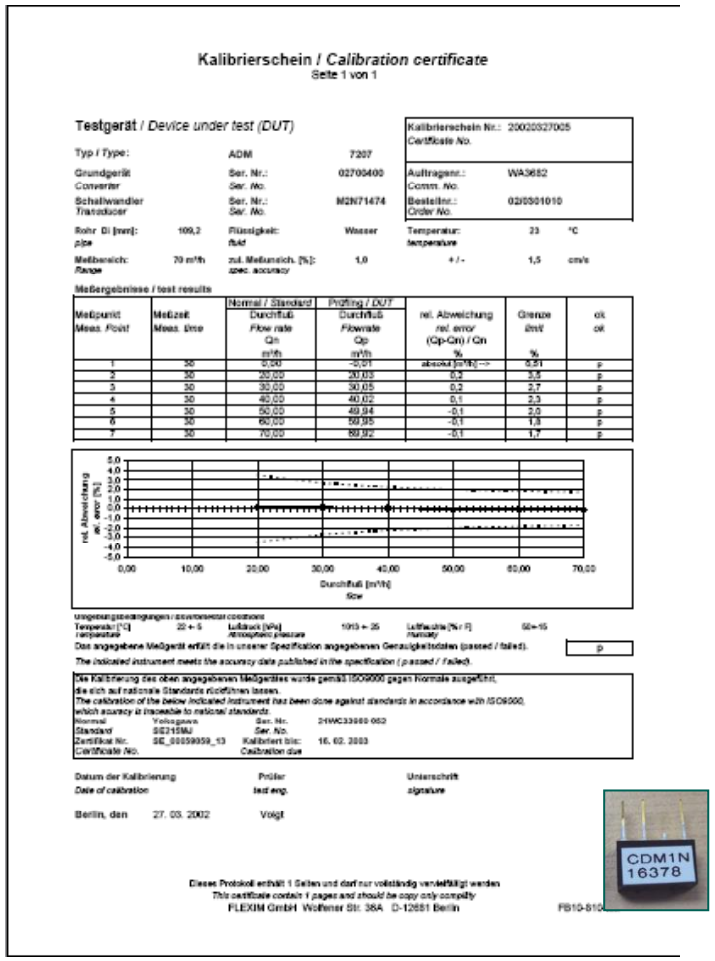
Drift of 3cm/sec = .1 ft/sec = 9 GPM on a 6” pipe

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 Tracible Calibration



Kalibrierschein / *Calibration certificate*
Seite 1 von 1

Testgerät / *Device under test (DUT)*

Typ / Type:		ADM	7207	Kalibrierschein Nr.: Certificate No.	20020327005
Grundgerät Converter		Ser. Nr.: Ser. No.	02700400	Auftragsnr.: Comm. No.	WA3682
Schallwandler Transducer		Ser. Nr.: Ser. No.	M2N71474	Bestellnr.: Order No.	0205501010
Rohr Di [mm]: pipe	109,2	Flüssigkeit: fluid	Wasser	Temperatur: temperature	23 °C
Meßbereich: Range	70 m³/h	zul. Meßunsich. [%]: spec. accuracy	1,0	+/-	1,5 cm/s

Meßergebnisse / test results

Meßpunkt Meas. Point	Meßzeit Meas. time	Normal / Standard Durchfluß Flow rate Qn m³/h	Prüfling / DUT Durchfluß Flowrate Qp m³/h	rel. Abweichung rel. error (Qp-Qn) / Qn %	Grenze limit %	ok ok
1	30	9,00	-9,01	absolut [m³/h] -->	5,51	p
2	30	20,00	20,03	0,2	3,5	p
3	30	30,00	30,05	0,2	2,7	p
4	30	40,00	40,02	0,1	2,3	p
5	30	50,00	49,94	-0,1	2,0	p
6	30	60,00	59,95	-0,1	1,8	p
7	30	70,00	69,92	-0,1	1,7	p

Umgebungsbedingungen / environmental conditions

Temperatur [°C] temperature 22 +- 5 | Luftdruck [hPa] Atmospheric pressure 1013 +- 25 | Luftfeuchte [% r.F.] Humidity 55+-15

Das angegebene Meßgerät erfüllt die in unserer Spezifikation angegebenen Genauigkeitsdaten (passed / failed). p

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

Die Kalibrierung des oben angegebenen Meßgerätes wurde gemäß ISO9000 gegen Normale ausgeführt, die sich auf nationale Standards rückführen lassen.
The calibration of the below indicated instrument has been done against standards in accordance with ISO9000, which acuracy is traceable to national standards.

Normal Standard	Volumgefäß SE215MU	Ser. Nr. Ser. No.	21WC33980 002
Zertifikat Nr. Certificate No.	SE_00059059_13	Kalibriert bis: Calibration due	16. 02. 2003

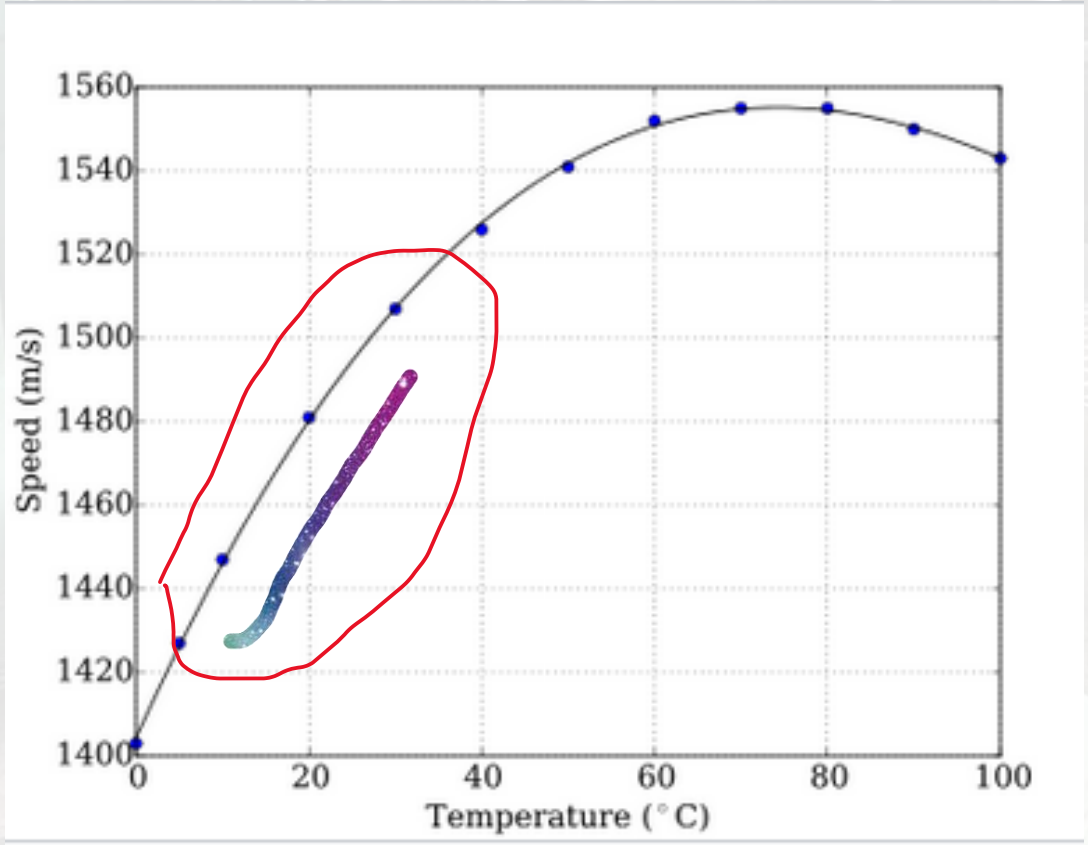
Datum der Kalibrierung *Date of calibration*	Prüfer *test eng.*	Unterschrift *signature*
Berlin, den 27. 03. 2002	Voigt	

Dieses Protokoll enthält 1 Seiten und darf nur vollständig vervielfältigt werden
This certificate contain 1 pages and should be copy only complety
FLEXIM GmbH Wolfener Str. 36A D-12681 Berlin FB10-810

Calibration Station
traceable to national standards
(DKD, PTB / Alden labs NIST)

all transducers sets are hydraulically calibrated

Technology is changing in water and wastewater



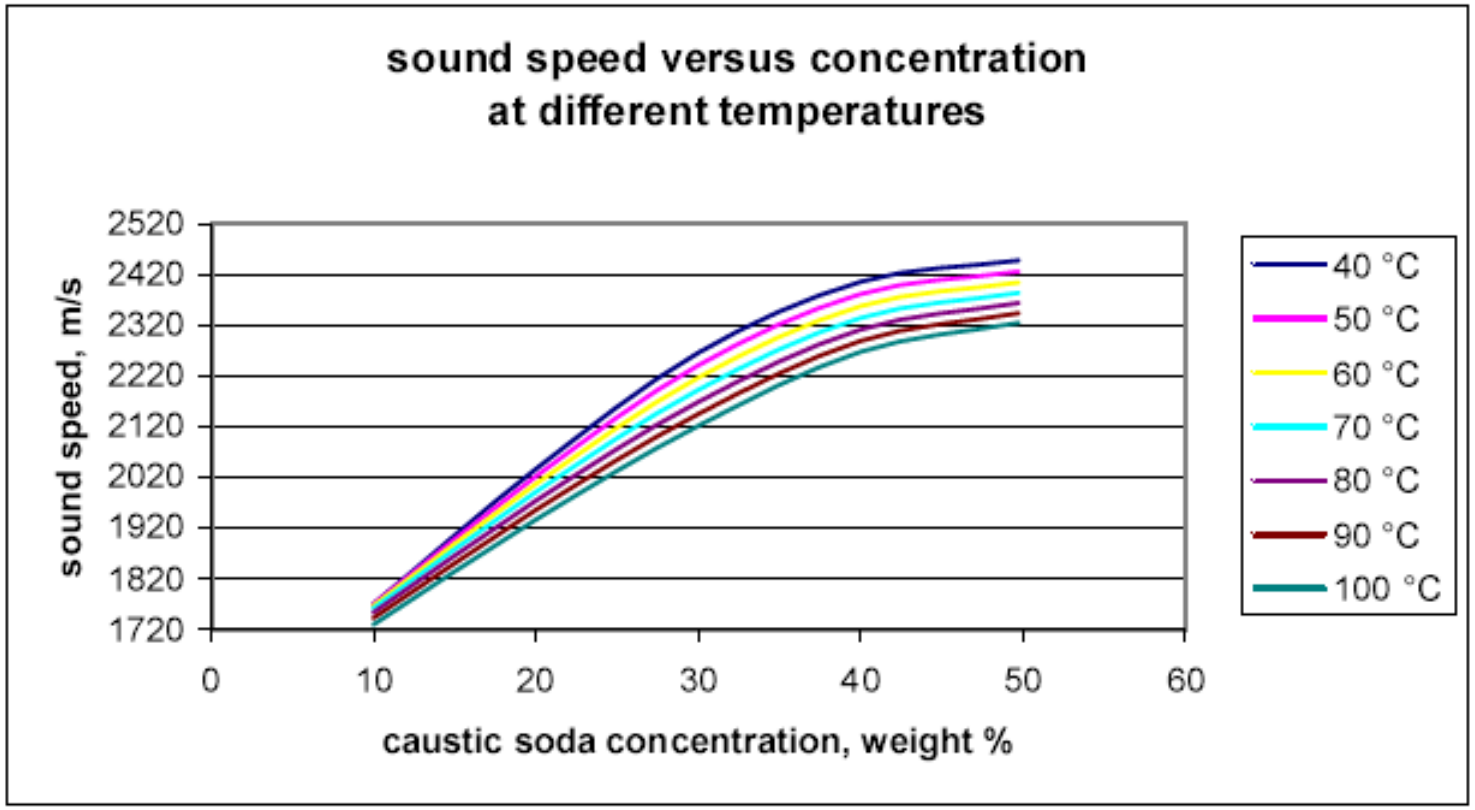
40ºF to 80ºF
1425 to 1485 m/sec

NaOCl

FLEXIM
when measuring matters

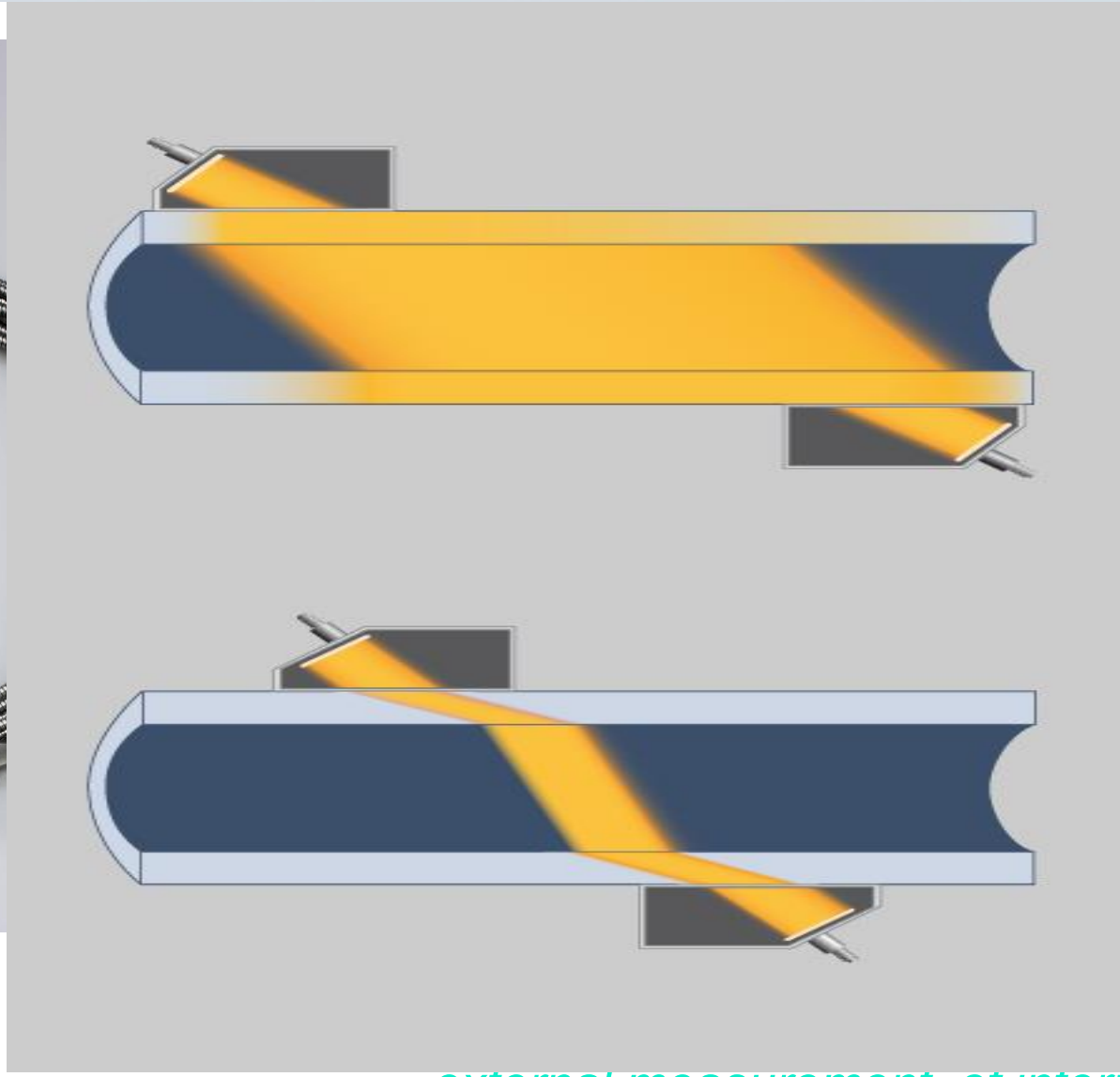
FluxFlow report

Property				
Pipe				
Outer diameter				
Pipe material				
Wall thickness				
Lining				
Inner diameter				
Roughness				
Analytic applic				
Fluid				
Fraction mass				
Temperature				
Measureable r				
Fraction mass				
Density				
Temperature				
Soundspeed				
Measureable r				
Fraction mass				
Density				
Temperature				
Soundspeed	1362		1996.5	m/s
Measureable ranges at MAXIMAL conditions				
Fraction mass	-4.995	U=0.02425 @U_T=±0.2°F U=0.14127 @U_T=±1.8°F	18.174	M%
Density	56.229	U=0.02549 @U_T=±0.2°F U=0.14853 @U_T=±1.8°F	82.047	lb/ft3



Show: Application range

Grid lines



oupling Pad

… external measurement of internal flow

Water and Wastewater Market Approvals

Approvals for water and Wastewater Industry

ISO17025 - Calibration Certification

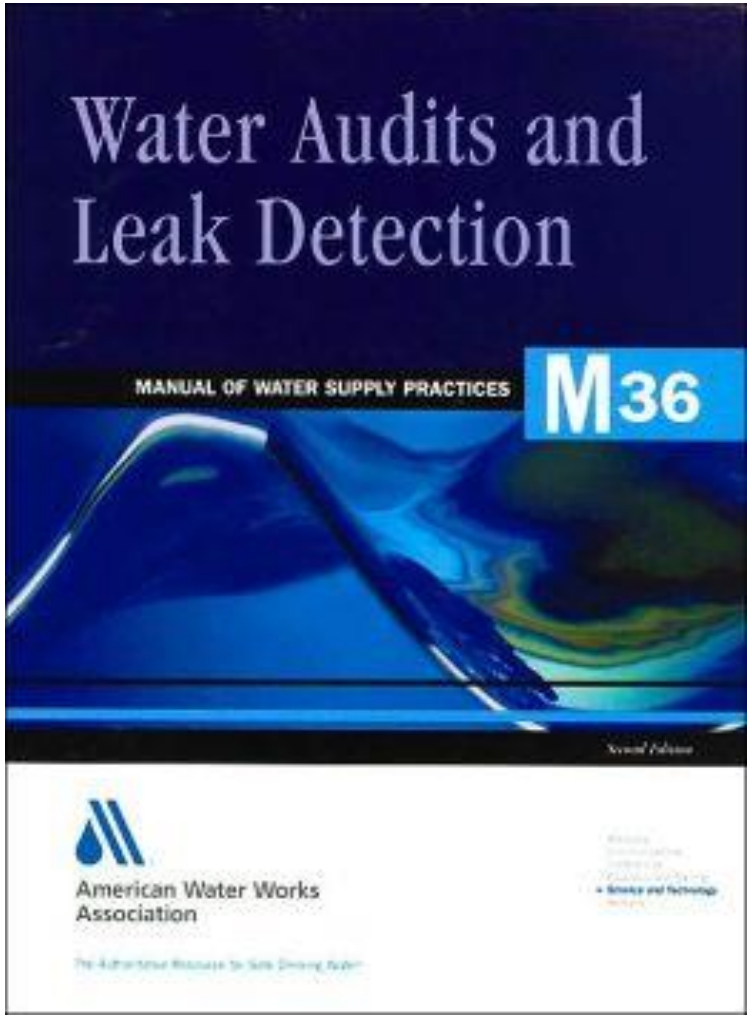
AWWA C50-19 – AWWA Approval
C750 - Transit-Time Flowmeters in Full Closed Conduits

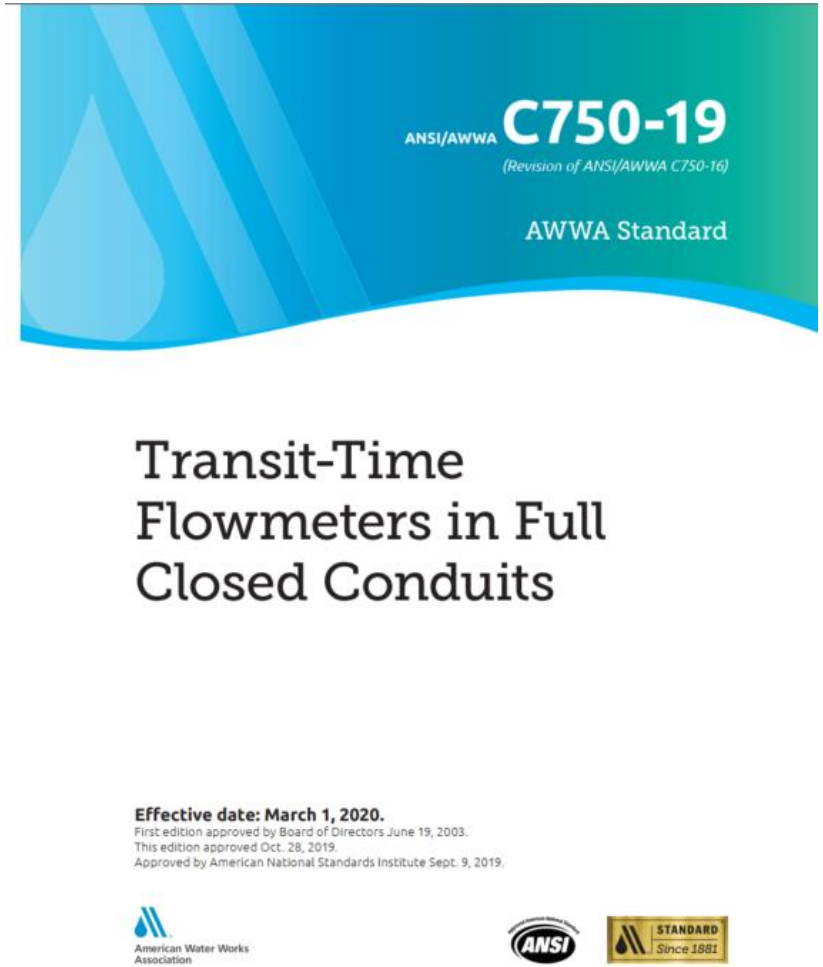
ASME MFC5M

NSF is not a requirement for Clamp-On technology

No meter left behind – Customer Approval

AWWA is there to help

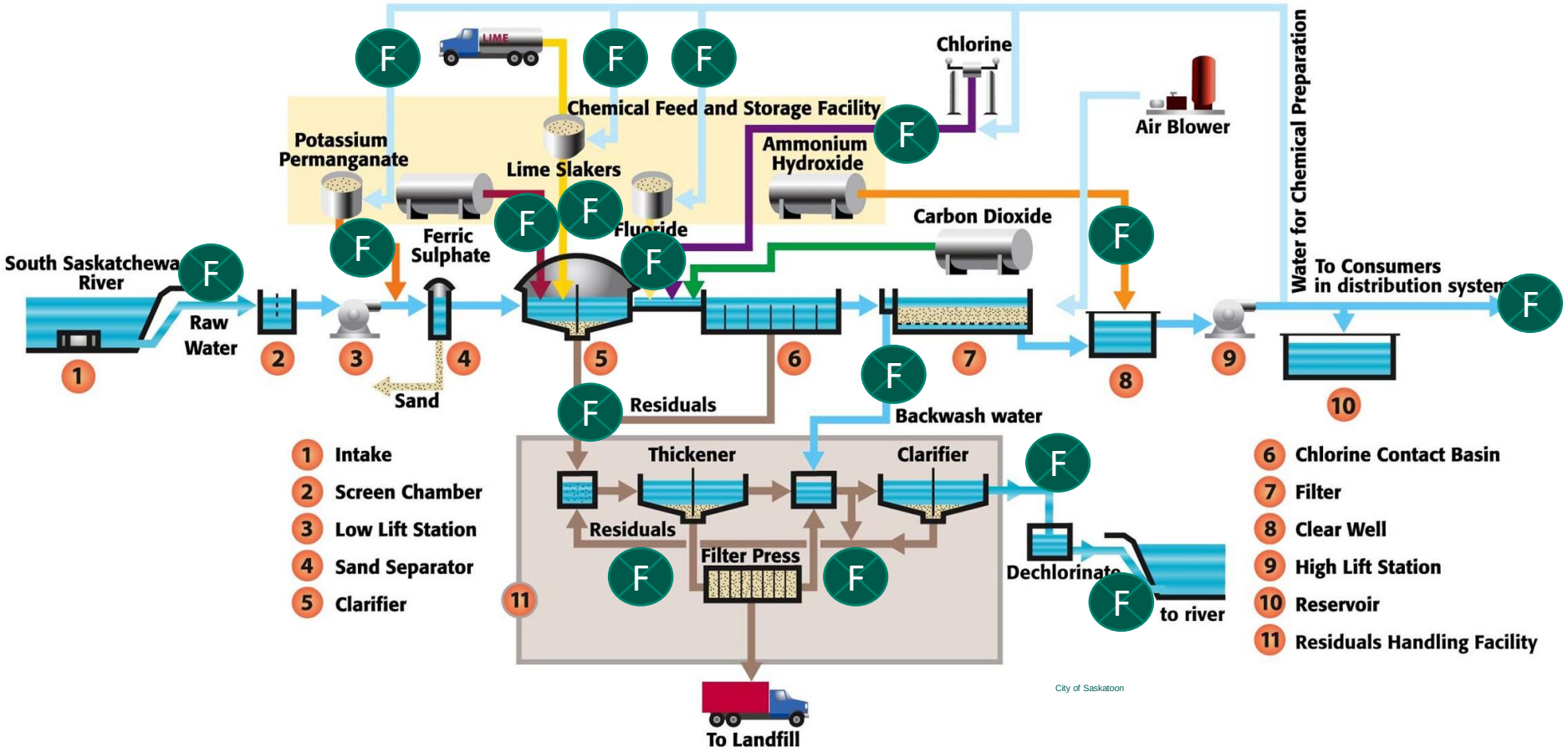




Where FLEXIM Fits

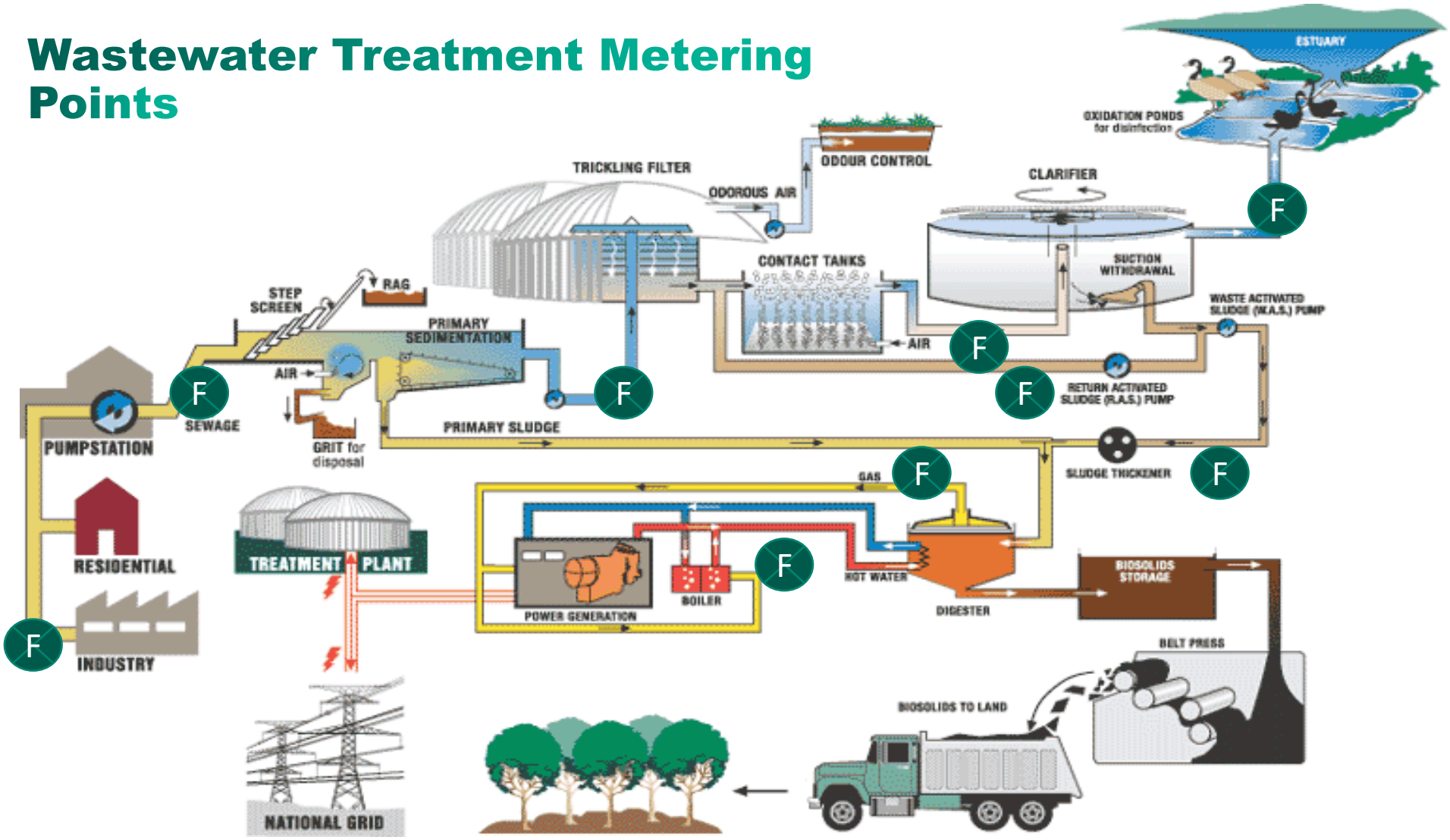
FLEXIM
when measuring matters

Water Plant Flow



FLEXIM
when measuring matters

Wastewater Treatment Metering Points



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.**

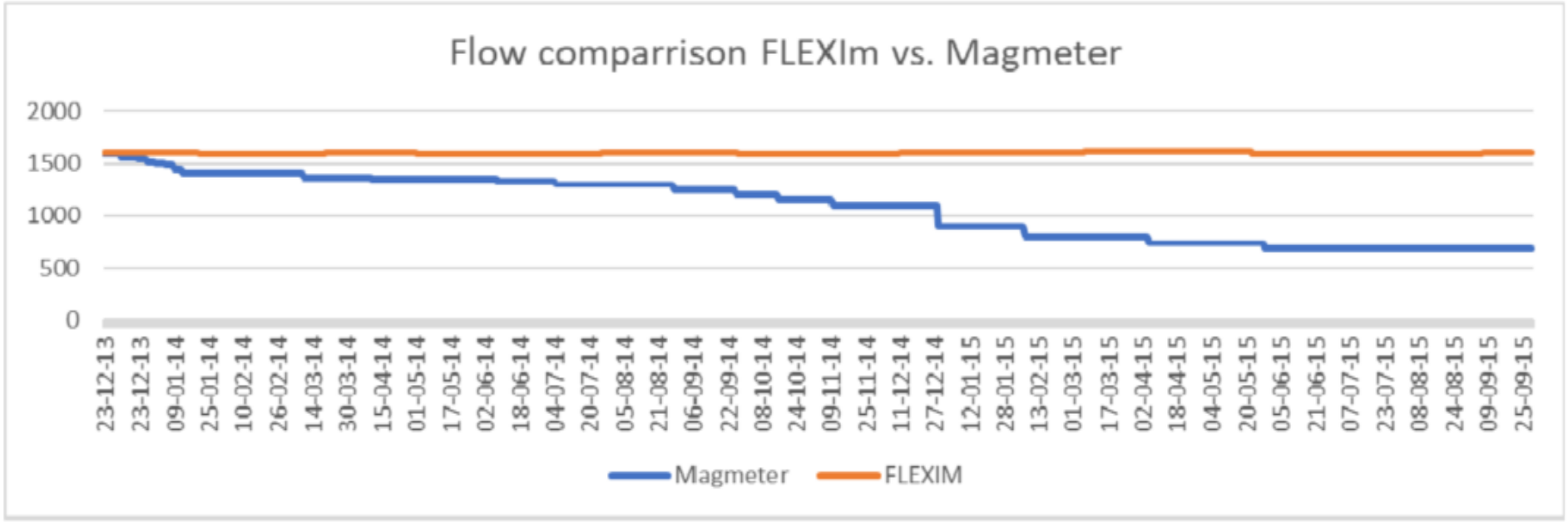
The LCR is evolving to include enforcement of Lead and Copper reduction.

- **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.



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

What about maintenance?

Since electromagnetic flow meters have no moving parts,

maintenance is typically very minimal

Expected service life is 30 years

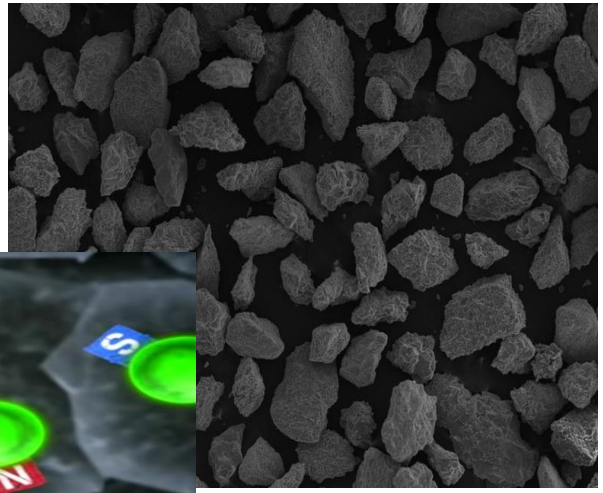
Depending on your fluid media and/or water quality,

The electrodes may need to be periodically cleaned according to the manufacturer's recommendations.

To clean electrodes

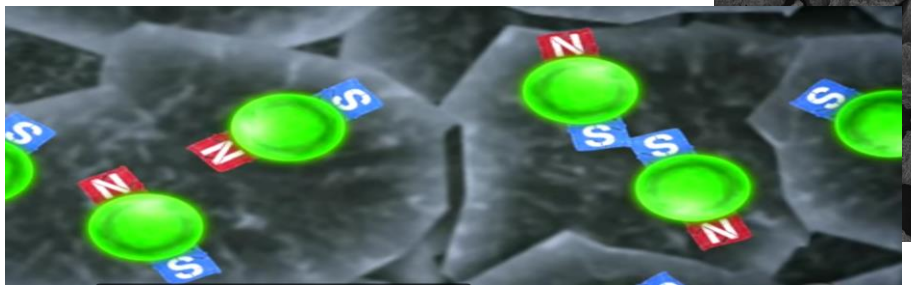
The meter must be removed from the line and the inside of the meter must physically cleaned.

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

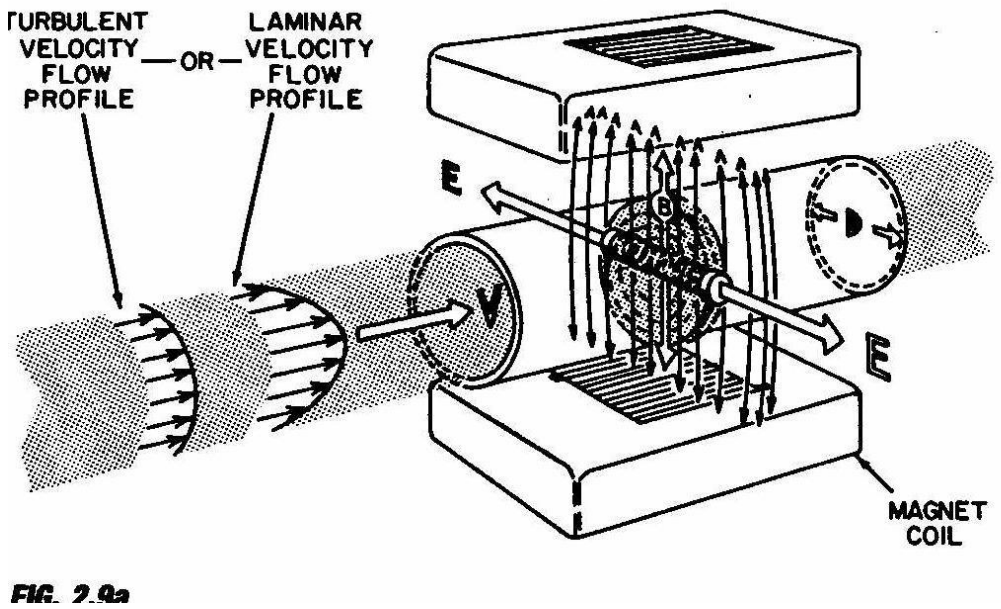


FIG. 2.9a

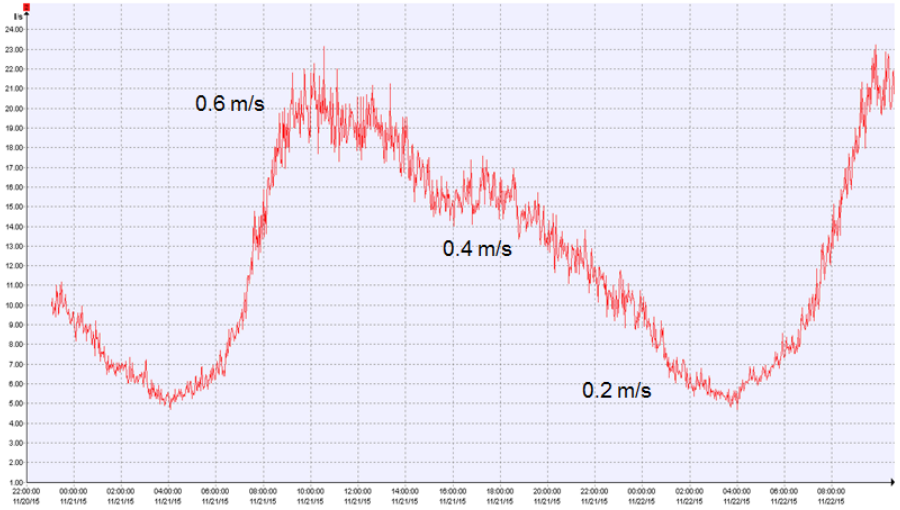
Magnetic flowmeters contribute to water loss when water is wells high in iron and when chemicals like orthophosphate are injected.

Improved Monitoring

FLEXIM
when measuring matters

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

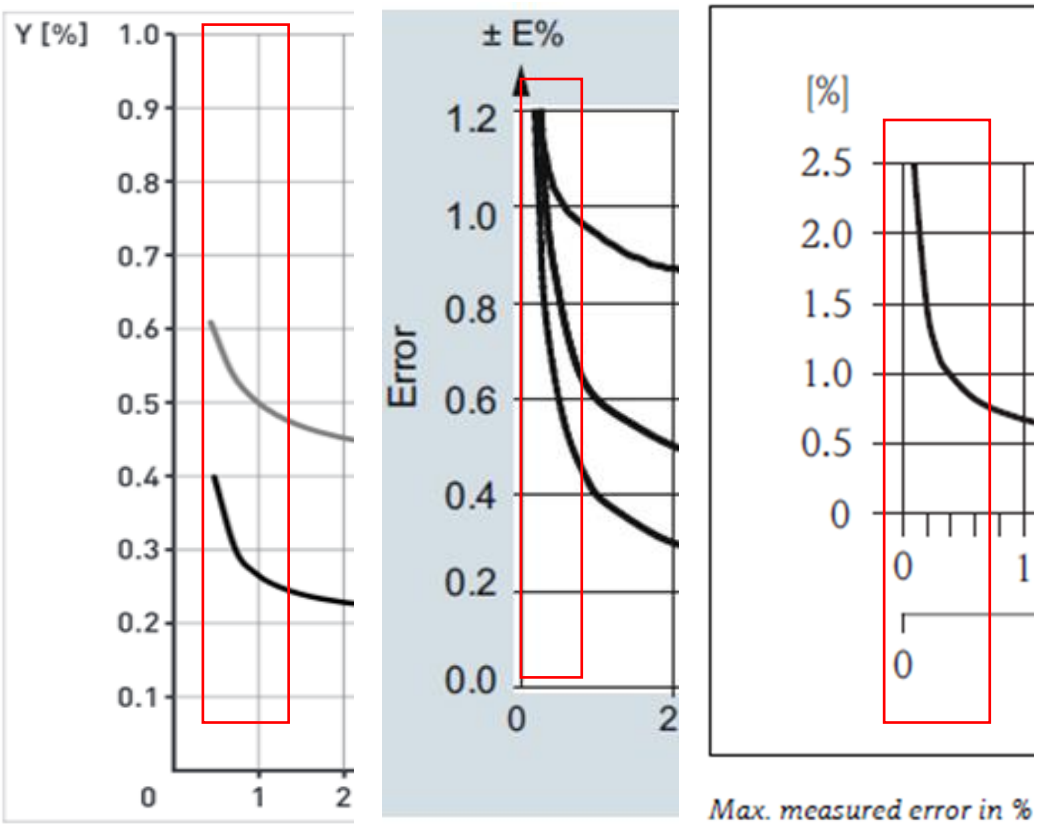


- In a considerable amount of cases it was also discovered, to the great surprise of the operator, that during the times of minimum consumption the flow direction changed

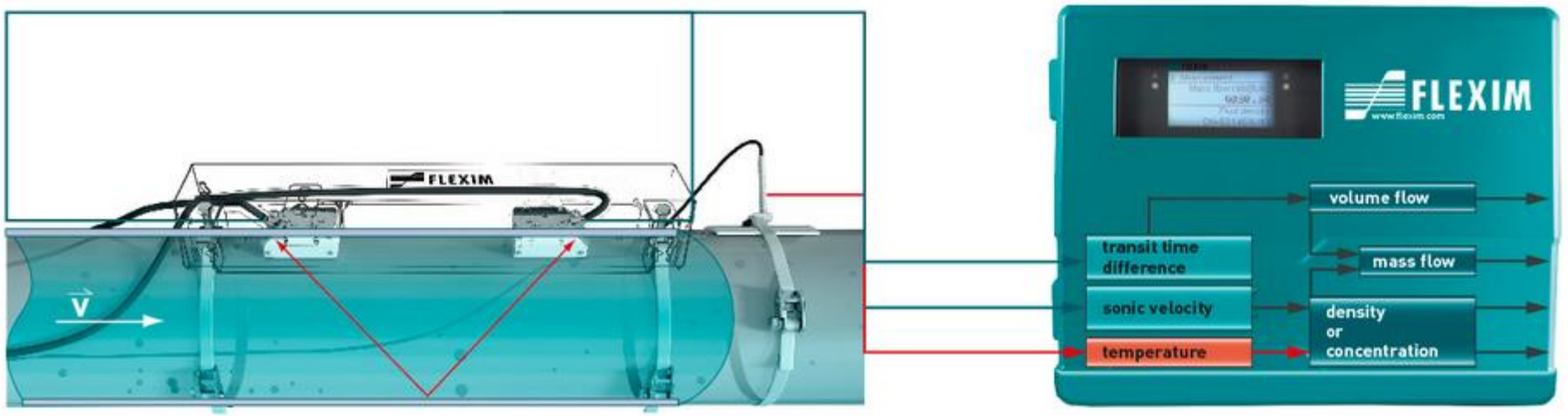
Improved Monitoring

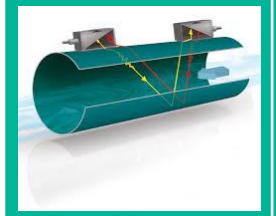
What accuracies for flow velocities < 1 m/s?

- **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


FLEXIM
v
FLEXIM
volume flow
transit time difference
mass flow
sonic velocity
density or concentration
temperature

Differences	721			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, Mod bus, BACnet, Binary Ethernet, Fieldbus,	2 4-20mA Passive/Active 3 Binary	1 4-20mA passive	4-20mA only	4-20mA, HART, Mod bus, BACnet, Binary Ethernet, Fieldbus,
Stainless steel option	✓	NA GP	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	✓	✓	✓	✓	✓

FLEXIM
when measuring matters

Portables


serial data kit
user manual and
Quick Start Guide
measuring tape
power supply, power cable
transducer pipe mounting fixture
coupling compound
wall thickness probe (option)
QuickFix pipe mounting fixture for
flowmeter
temperature probes (option)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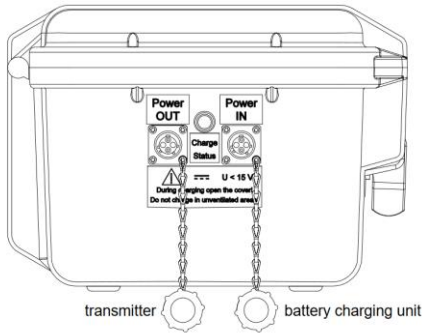
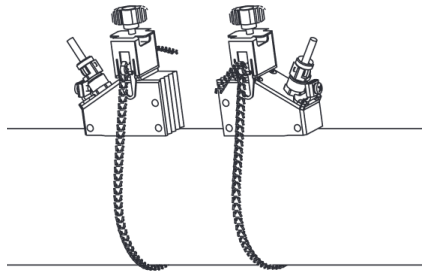
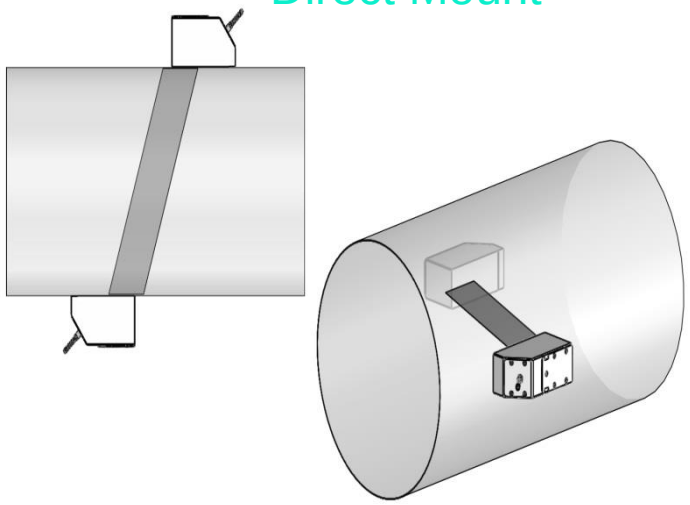
FLUXUS
→PAR←mea opt sf
Parameter


Power
OUT
Power
IN
Charge
Status
transmitter
battery charging unit

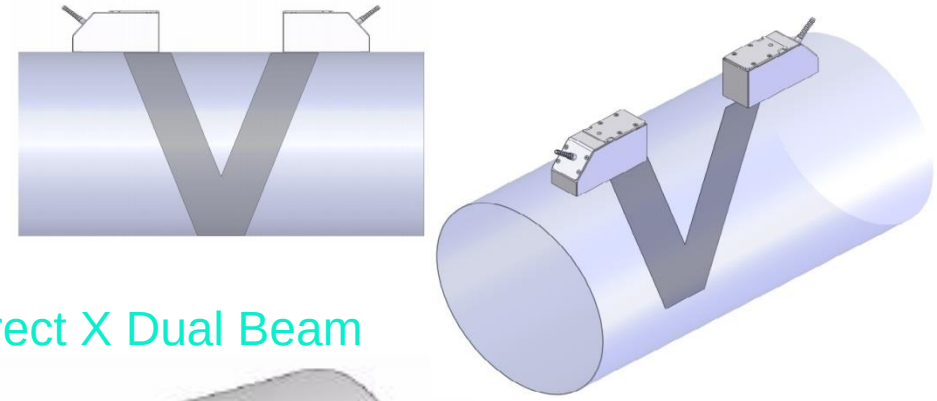


Mounting Configurations

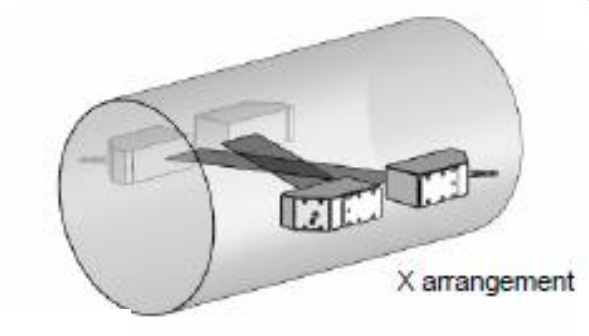
Direct Mount



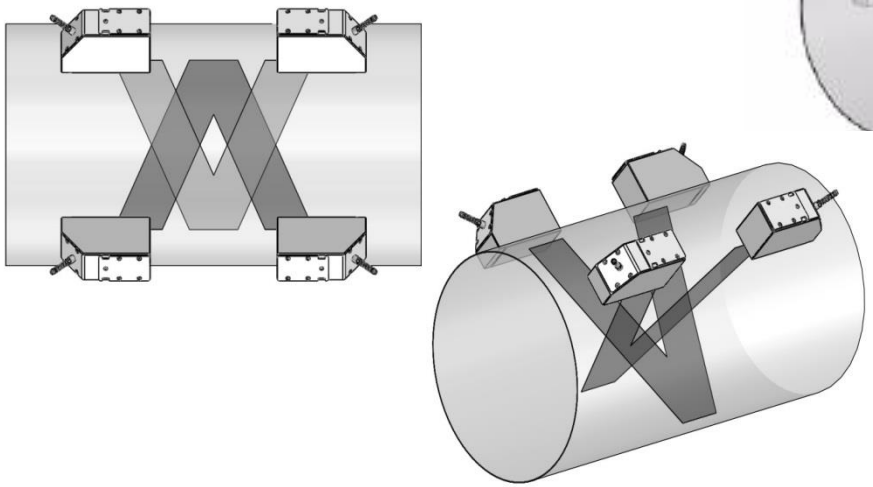
Reflect Mount – 2 beams



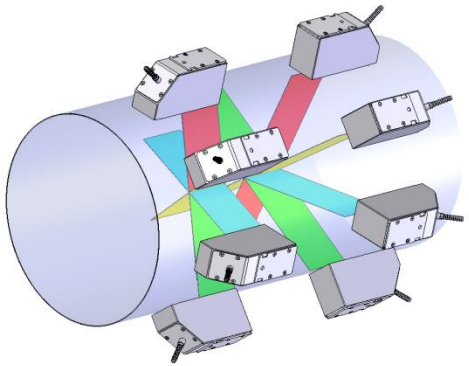
Direct X Dual Beam



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?

Applications

- **Chemical Injection**
- **Cement Lined Pipe**
- **Well Field**
- **Water Distribution**
- **Raw Sewage**
- **Buried in the Ground**
- **Submerged under water**
- **Low Flow**
- **Concrete Pipe - PCCP**
- **Hypochlorite Injection**
- **Hypochlorite Concentration**
- **Polymer Injection**

Wastewater Collections

Water Distribution

Wastewater Influent and Effluent

Wastewater Treatment
Pollution Control

Questions and Discussion

jvannostrand@flexim.com