IDEA Campus Energy 2016

Sufficient metering - Best practice for thermal energy metering

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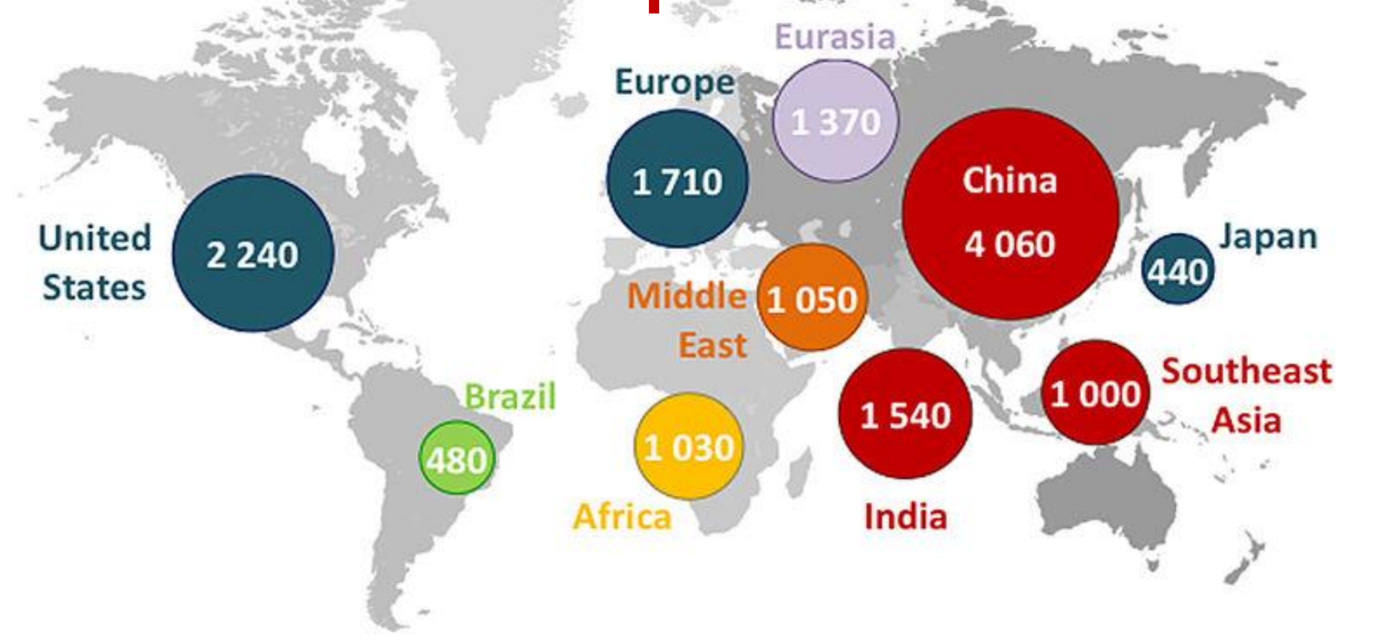
Overview

- Motivation
- Standards and measurement technologies
- Practical problems
- Total cost of ownership

Year 2035…

Energy consumption:
In Europe 50% of energy is used for private households.
Private household is using 50% of energy for heating.

USD 200’000’000 per unit…



Values Mt OU, Expectation from IEA

Need for energy savings

Energy consumption must be reduced – out of question!

But how?

Increase efficiency !

Efficiency is a popular key word in general and the most used word from managers for target descriptions.

- **Measure and compare - with a reliable base!**

BUT

Energy metering in practice has many insufficiencies

- **Acc. to European metrological institutes tests almost 50% of the meters are giving more than 10% deviation within the first 5 years.**
- **From wrong installation or miss planning 30% of the measurements are not able to give right readings.**

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Thermal power calculation

Each component is important as it is a direct factor to the calculation formula of the thermal power

T. Power | **Flow** | **Temperature difference** | **Spec. heat factor**

$$P = Q * (T_1 - T_2) * k$$

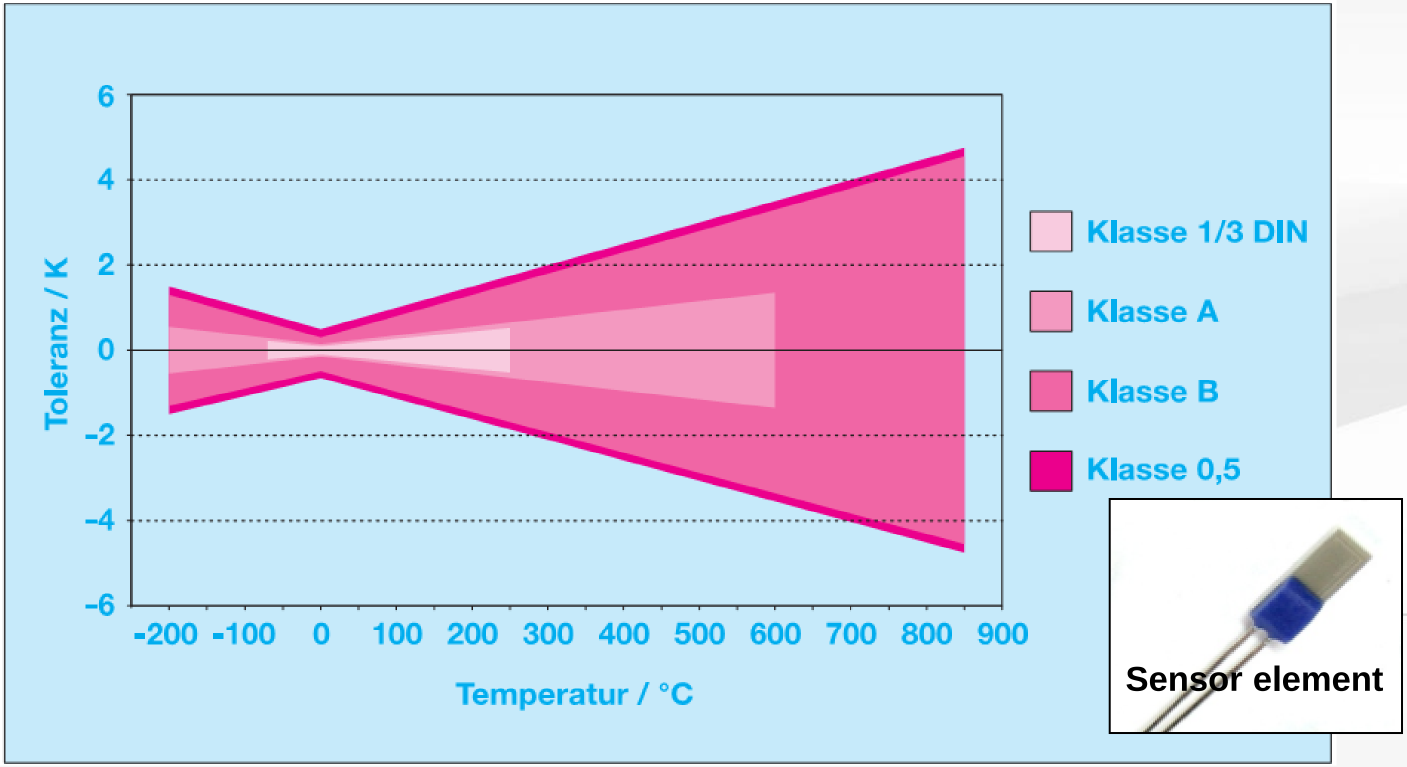
Standard for accuracy of meters – EN1334

But it allows a deviation up to ± 5 %

Temperature sensors

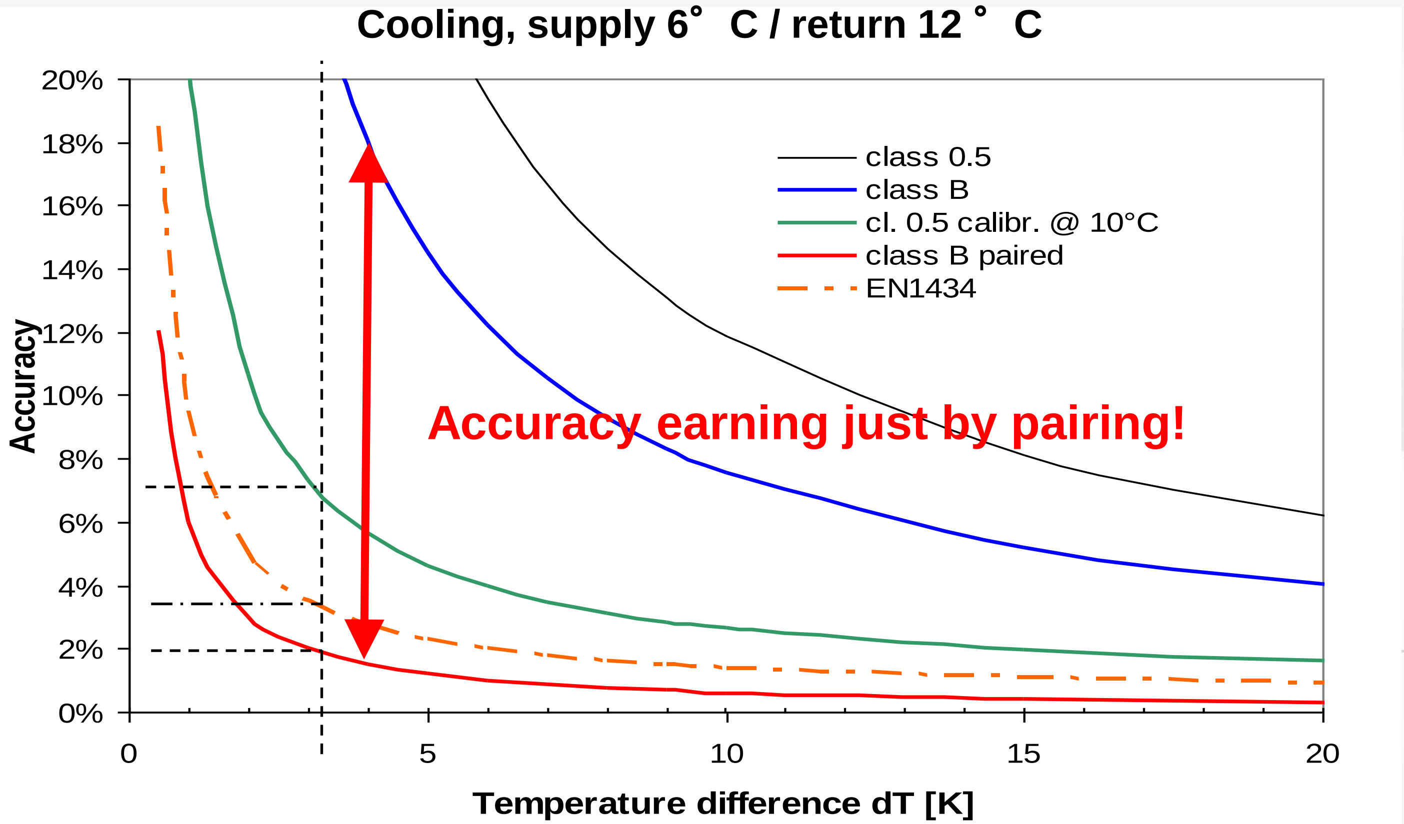
Standard Sensor types: Pt100/Pt500

EN 60751 Class 1/3 B, A, B, 0.5



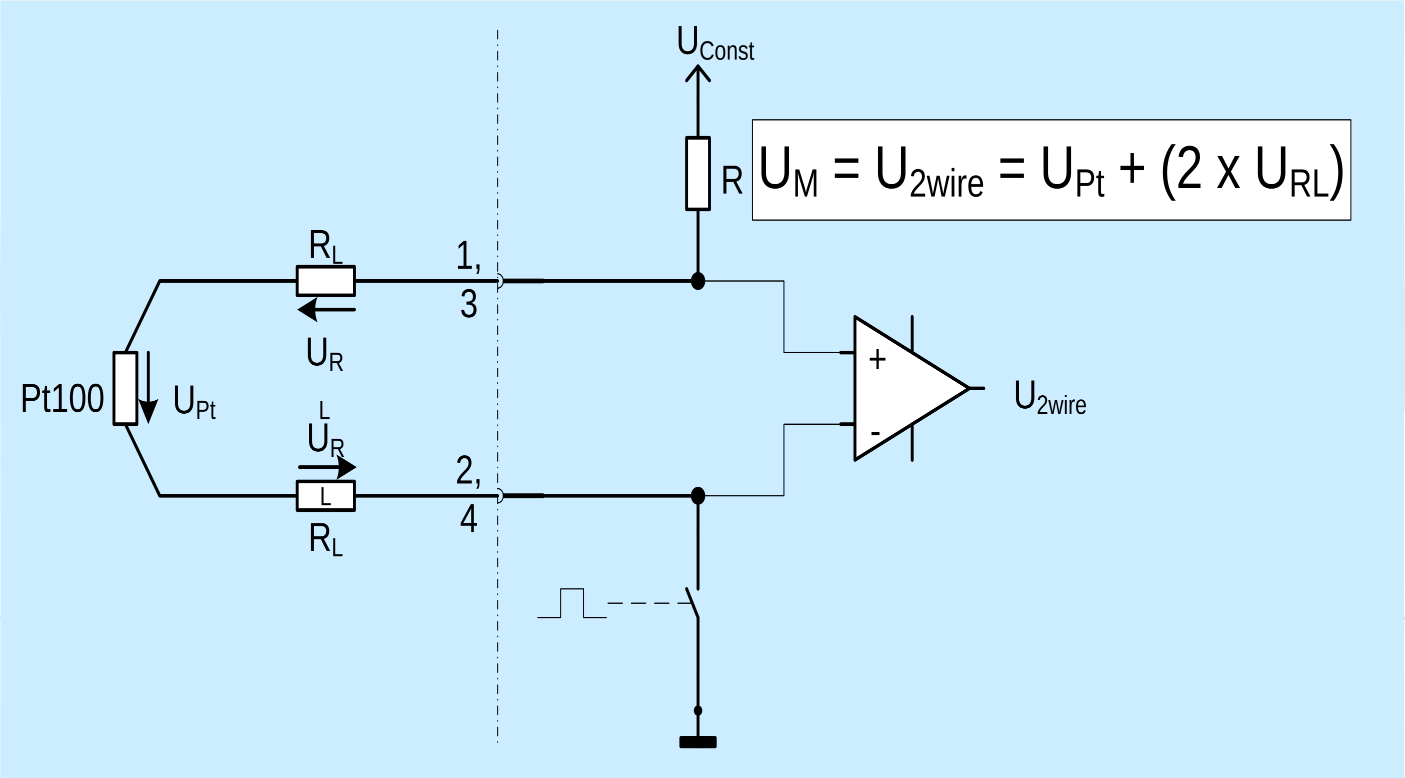
Temperature sensors

Pairing and accuracy of sensor types



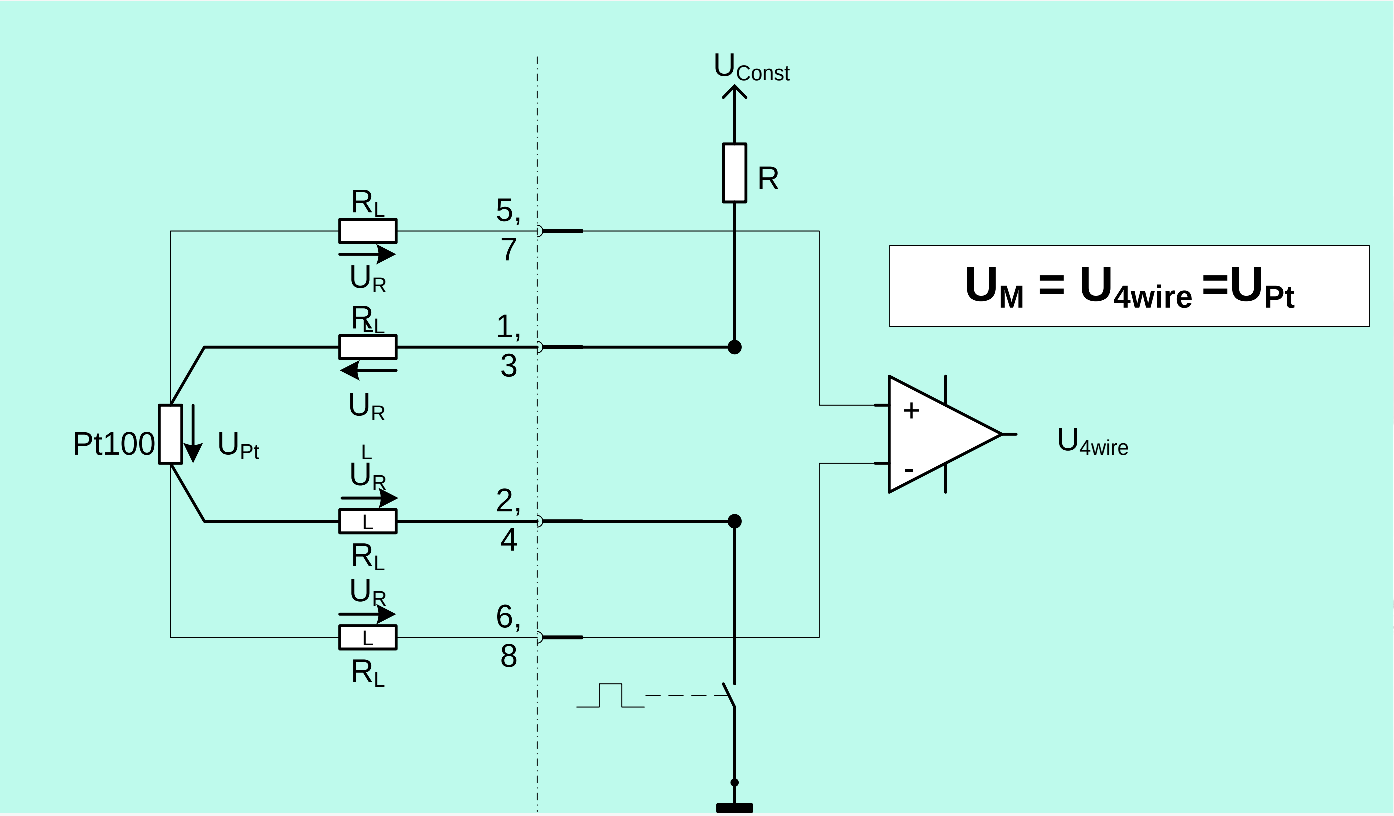
Temperature sensors

Connection with 2-wire technology



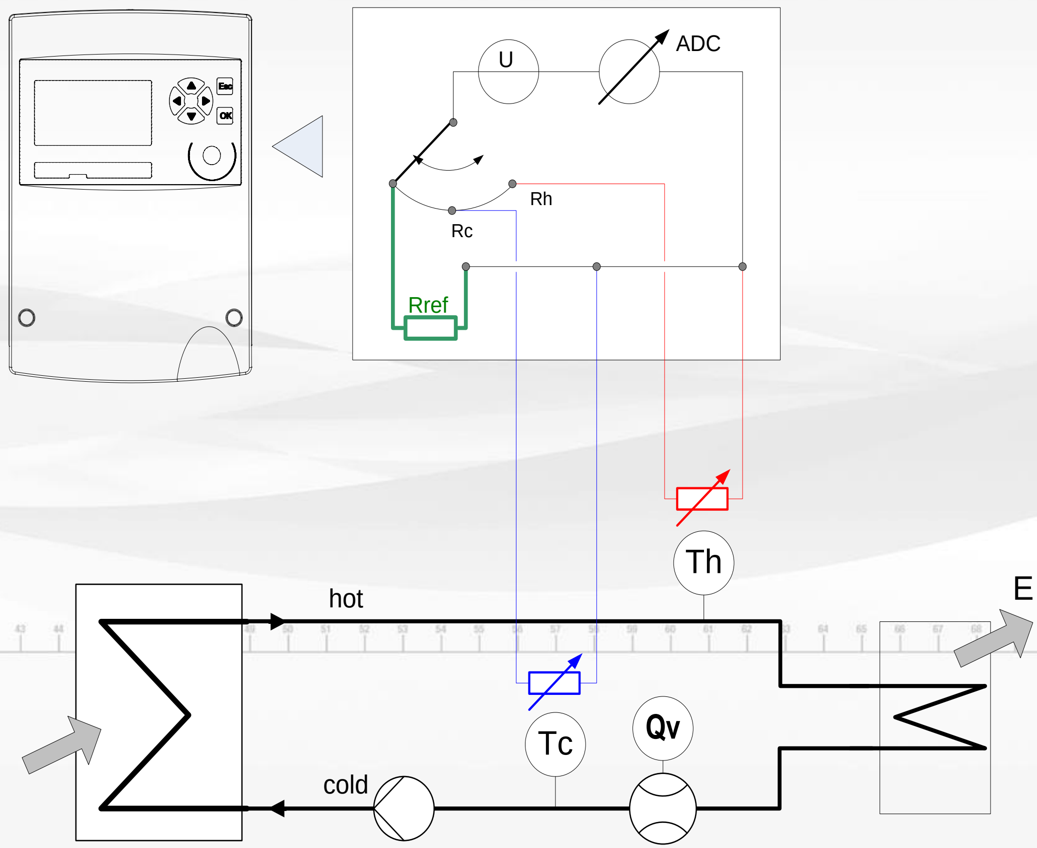
Temperature sensors

Connection with 4-wire technology



BTU calculator

With direct input resp. the A/D converter the BTU calculator is measuring the temperature resistance of the sensor



Ultrasonic flow measurement

Time of Flight principle:

Ultrasonic pulses are sent in direction of flow and against. The time difference between the sending and receiving ultrasonic pulses is proportional to velocity of the fluid.

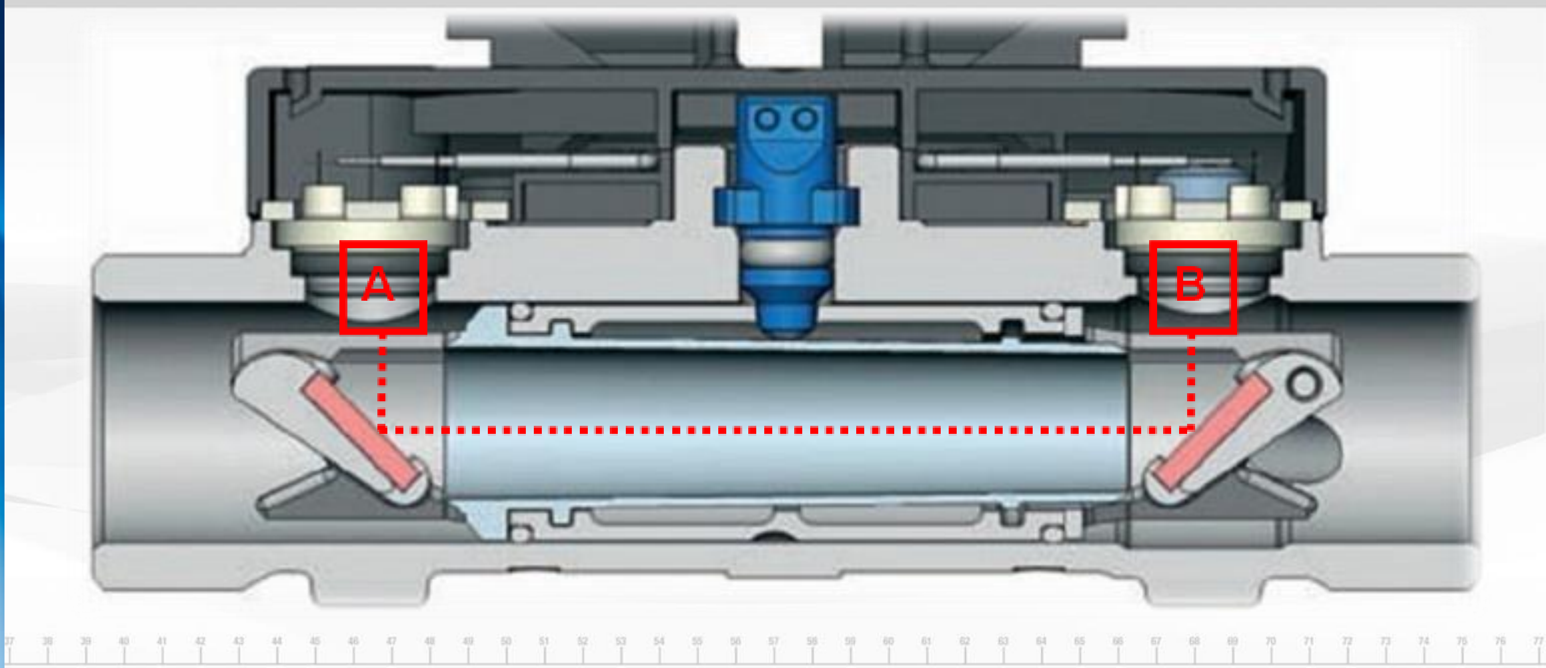
- **$\Delta T \sim V$**
- **$\Delta T \sim Q$**

Different ultrasonic meter types:

- **Inline with reflectors**
- **Inline with one or more beams**

Ultrasonic flow measurement

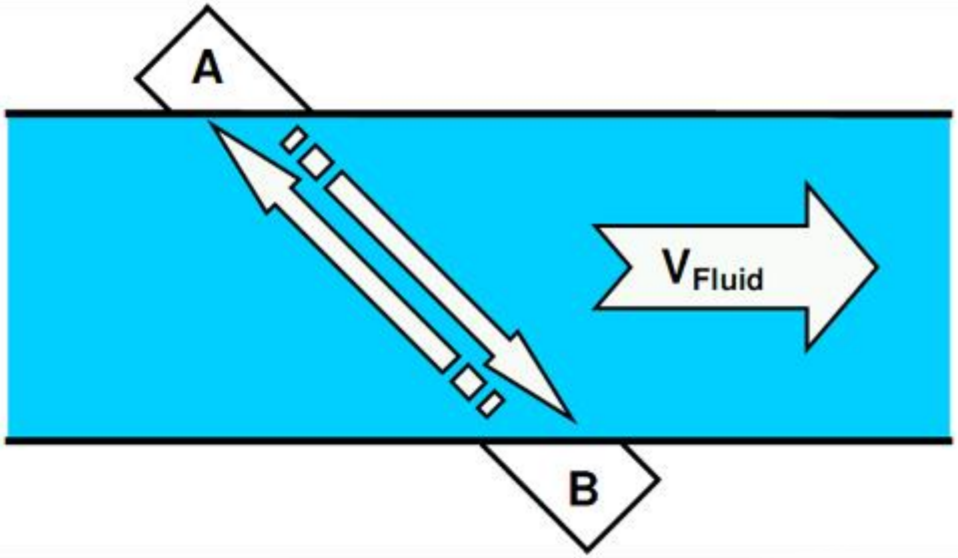
Ultrasonic meter with reflectors:
Ultrasonic pulses are deflected by the reflectors inside the measuring tube.



➢ **Dependent on flow velocity between reflectors**

Ultrasonic flow measurement

Ultrasonic meter with beams:
Ultrasonic pulses are sent diagonal through the pipe, no reflectors inside the pipe diameter.

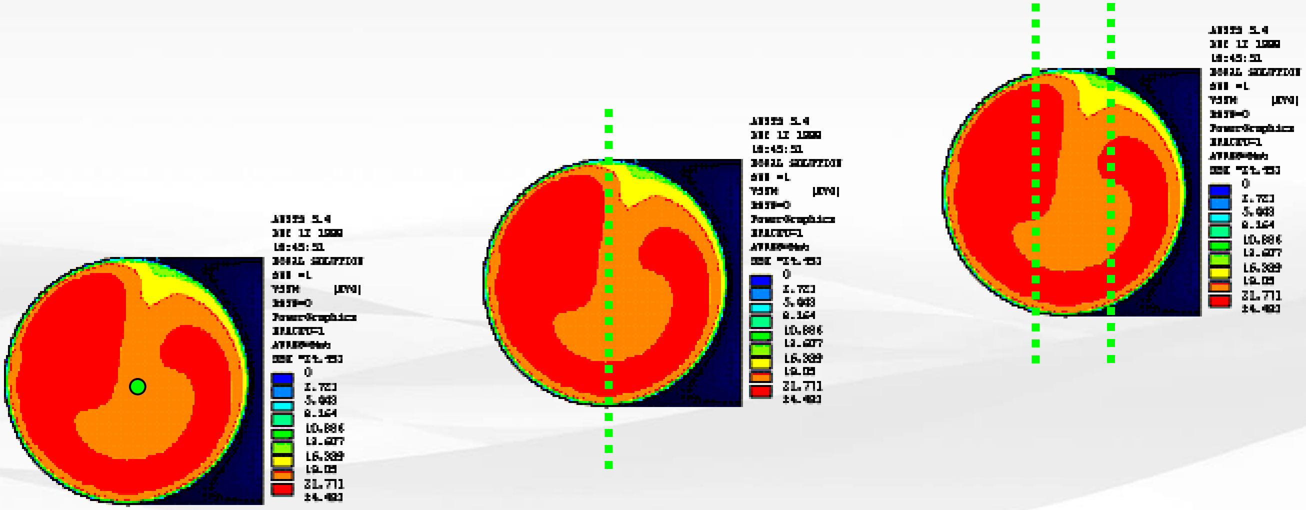


- **Proportionally dependent on flow velocity (angle)**

Ultrasonic flow measurement

Accuracy and reliability:

Flow is always disturbed and not equal over the hole diameter. Point of interest is the correct average.

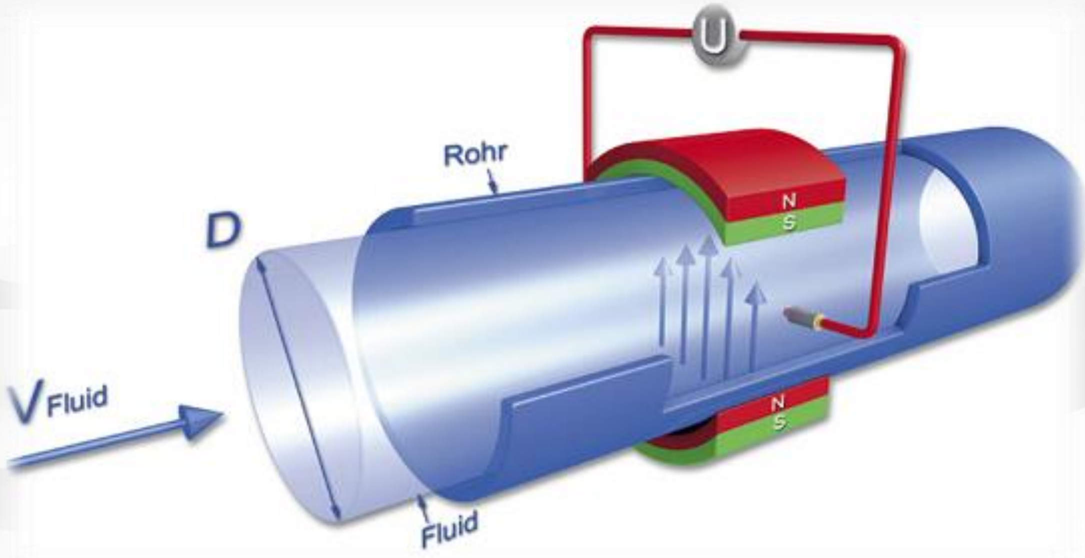


- Massive improvement from reflector types to multi-beam measurement

Electromagnetic flow measurement

The induced voltage is proportional to the diameter (D), the magnetic field (B) and the fluid velocity (V).

D = const.
B = const.
U ~ V
U ~ Q

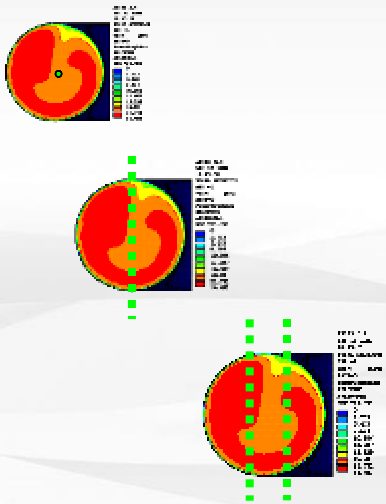


- **The voltage integration over the whole diameter assures high accuracy and repeatability!**

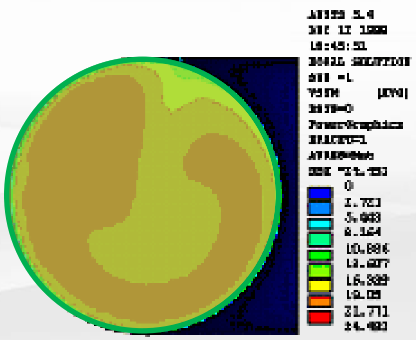
Electromagnetic flow measurement

Accuracy and reliability:

Flow is always disturbed and not equal over the whole diameter. Point of interest is the correct average.



Electromagnetic:



- **Electromagnetic takes measurement as integration of the whole diameter**

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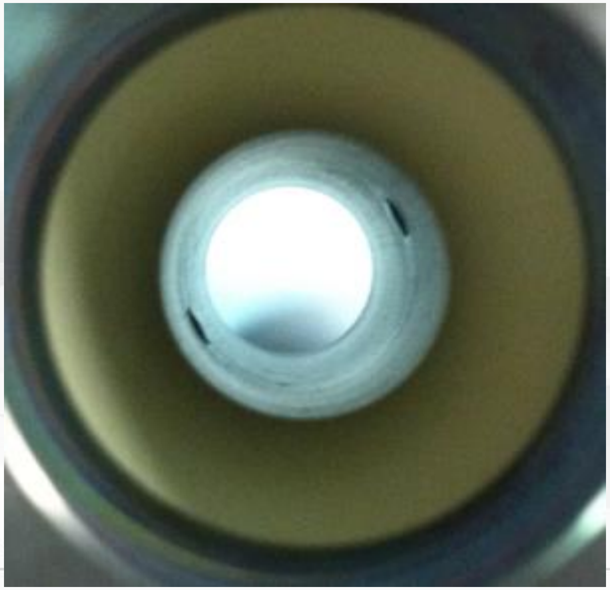
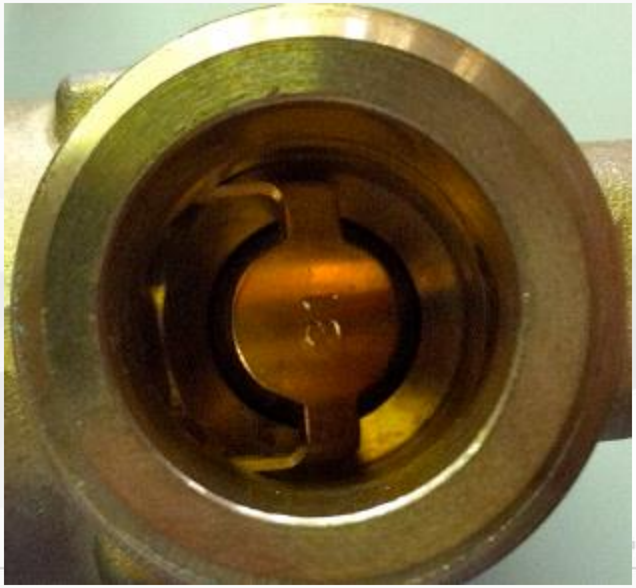
Practical problems

Pressure loss and blocked meters…



Electromagnetic

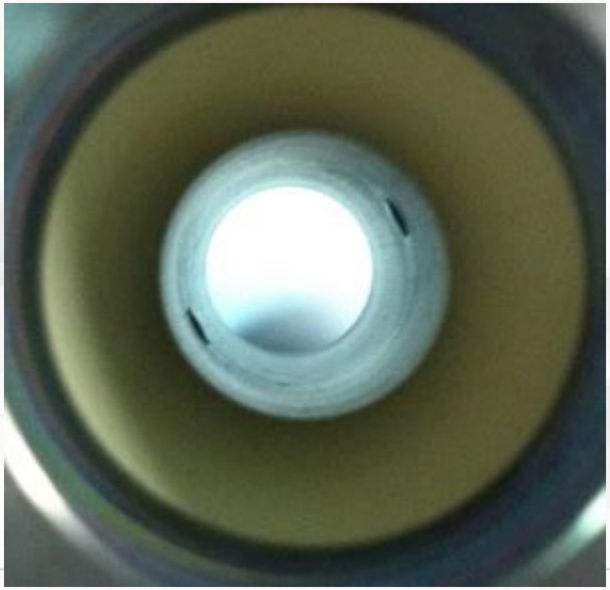


Ultrasonic

Practical problems

Pressure loss and blocked meters…

… after a while



Electromagnetic

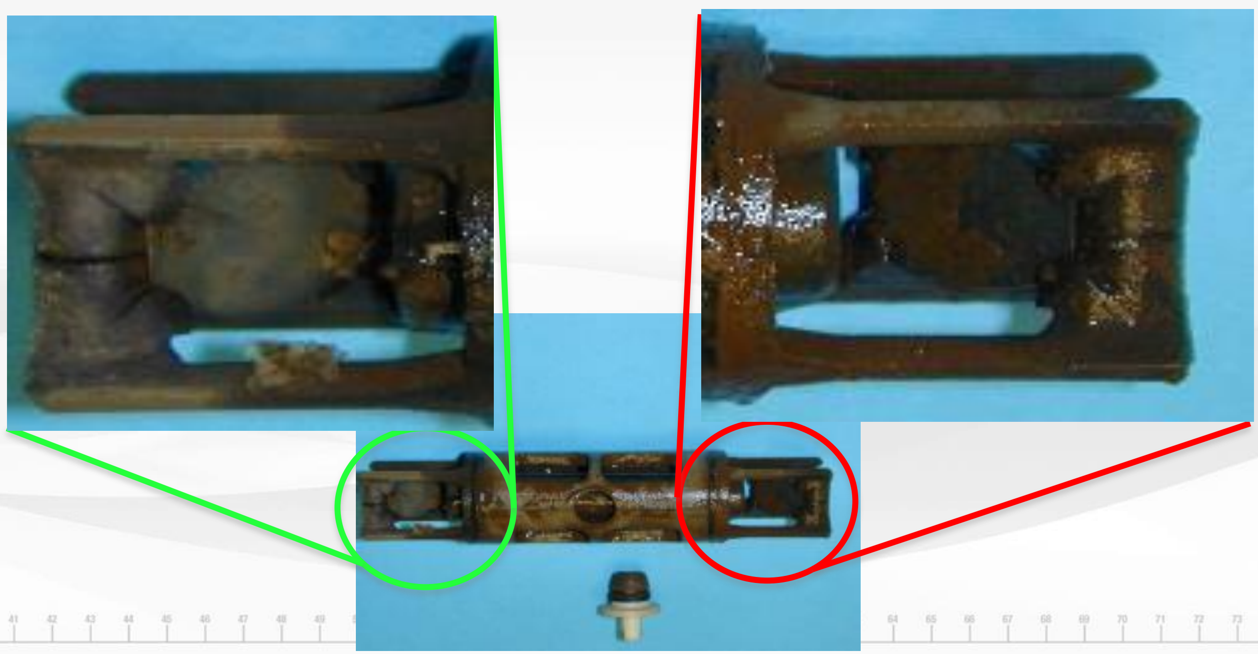
Ultrasonic

Practical problems

Example of electricity cost calculation for pressure loss and pump power		
Higher pressure loss for Ultrasonic flow meter compared to Electromagnetic	150	mbar
Pipe diameter DN	25	mm
Flow rate	3	m3/h
Calculated hydraulic dissipation loss	0.3	kW
Electricity costs	32	Cent/kWh
Usage period	270	days
Electricity costs through pressure loss per year and per meter	**62.20**	**USD**

Practical problems

Dirt sensitivity of ultrasonic reflectors after permanent running tests (5000 h)



- Cleaning and recalibration every 5 years necessary!

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Total cost of ownership

Example caluclation for usage of 10 years

100 pcs. meters	**Electromagnetic**	**Ultrasonic**
Initial cost (purchasing)	50.000	30.000
Cost for pressure loss	10.400 (30 mbar over 10 years)	52.000 (150 mbar over 10 years)
Possible lost from inaccuracy	12.800 (2% of 100x 2000kWh with 32/kWh)	32.000 (5% of 100x 2000kWh with 32/kWh)
Cleaning (every 5 year for ultrasonic)	0	10.000 (10/pcs, more?)
Recalibration (every 5 years for ultrasonic)	0	10.000
Total over 10 years	**73.200 USD**	**134.000 USD**

Thank you for your attention