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Vgradnja toplotnega števca - Nekaj navodil za izbiranje, vgradnjo in delovanje toplotnih števcev

Heat meter installation - Some guidelines for selecting, installation and operation of heat meters

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Heat meter installation - Some guidelines for selecting, installation and operation of heat meters

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1 Introduction

1.1 General

When EN1434 was being prepared, much useful information and practical advice concerning the choice and installation of heat meters was received. Though unsuitable for inclusion in the standard it is given here to help heat meter users.

1.2 Explanations of terms

For the purposes of this report, in addition to the definitions in EN1434, the following terms and symbols apply

1.2.1 DH (network)
District heating systems

1.2.2 Meter
Heat (energy) meter

1.2.3 Water
Sanitary water

1.2.4 Warm water
Sanitary warm water

1.2.5 Make up liquid
Liquid for refilling leakage of heat conveying liquid

1.2.6 Liquid
Heat conveying liquid in a DH system

2 Selection of meters

2.1 General

A heat meter is composed of three parts, a flow sensor, a temperature sensor pair and a calculator.

The calculator is a unit which calculates volumes and energy consumption using the values from the temperature sensors and the flow sensor.

The most common type of temperature sensor is a resistance thermometer of platinum type Pt 100, Pt 500 or Pt 1000. The sensors measure the temperature difference between the incoming and outgoing liquid .

The flow sensor is probably the most troublesome assembly of the heat meter. Despite an accuracy requirement of only 4-10% it is very easy to fall outside these limits. In order to counter these effects as far as possible, there follows a summary of the various types of flow sensor and their advantages and disadvantages.

The sizing of meters to match their required duty frequently turns out to have been incorrectly estimated when the heating plant commences operation. In most cases heat meters that are too large for their eventual duty are specified and accuracy at low load suffers as a result. Whilst this paper will give some guidance on essentials, it is felt that more information on this topic would be welcomed.

Heat meter accuracies at times of rapidly changing heat demand are unlikely to be high. Whilst at times of low demand the effect of meter inaccuracy in terms of lost revenue is likely to be small, rapid changes involving high demands on the network may possibly have important implications in lost revenue if meter reaction to rapid changes is slow. Research into the subject seems to have been largely neglected so far.

The most commonly used types of flow sensors have been listed in Annex B and the effect on accuracy of different types of disturbances for each of the listed types of flow sensors are considered.

There is little information on the effects of flow and flow disturbances on the service life of the flow sensor, as distinct from its effect on the sensor's accuracy. To be welcomed, therefore, is the long term research project on this topic initiated in Germany which should result in useful data.

2.2 Operational conditions

To get the total power needs of the building you have to calculate the sanitary warm water production and add this power to the power due to heating.

The demand of power for sanitary warm water may be calculated by using the "Guidelines for hot service water preparation" which is the established European method worked out by Euroheat and Power (UNICHAL).

When the maximum power is found the sizing of the meter can start.

Effect on accuracy of changes in heat demand

In times of changing heat demand, factors which have an important effect on measurement results are:

- Level of system temperatures
- Operating strategies of the network
- The quality of the installation
- How the substations are designed
- The changing temperature level in the building
- The maintenance levels of the building

Therefore it is essential to have a routine or checklist for the personnel dealing with meters in the DH-company. The routine should cover consideration of all factors above.

A classic expression is 'to measure is to know', and there is a great deal in this. But several preconditions should be met to enable the measured values to be used and understood in the right way:

- **You must know what you want to measure and use the correct measuring method for that purpose.**
- **You must have data on the object being measured.**
- **That the most suitable meter is used for what is to be measured.**
- **That the limits of the meters are known.**

2.3 Life cycle costs

Once you have established the technical requirements for the meters you have to buy them from somewhere. The tenders from different suppliers should be evaluated. Then you should consider not only the cost price but also the costs for:

- installation
- service and maintenance
- spare parts
- testing and verification
- storage
- replacement meters
- expected service life (in years)
- expected intervals for overhaul (in years)
- trouble shooting
- lost revenues due to poor accuracy
- lost revenues due to faults and standstills

Of course many of the listed costs are difficult to estimate, especially when it comes to new types of meters or new manufacturers, but with the experience from other similar meters, technical knowledge and common sense you should reach a satisfactory estimate.

It is a recommended not to buy too many meters at the same time when you are not familiar with the type of meter or the manufacturer. The meter is perhaps not suitable for the quality of your heat conveying liquid, the procedures for testing the meter are maybe costly or even impossible at your ordinary testing facilities and so on.

2.4 Flow sensors

2.4.1 General

In order to optimise the conditions for a flow sensor, the following recommendations should be followed as far as possible, irrespective of which type of sensor is being used.

Long straight pipes
A straight pipe cannot be too long, which is why it is best to take advantage of all physical opportunities for straight pipes. If the measurement position is planned at the design stage, this usually makes it possible to take advantage of straight pipes.

Avoid rotating flow
Rotating flow is always a bad thing, and should be avoided, for example, by fitting pipes correctly. If the pipe run cannot be altered, a flow conditioner is a possible solution, but be careful of increased pressure drop.

Avoid pulsating flow
This is avoided by correct positioning of the sensor in relation to pumps or other sources of pulses.

Correct sensor size
What is the actual nominal flow, and how often is maximum flow reached?

Calibration in the right environment
Ideally a sensor should be tested under conditions as close to its actual working environment as possible. This means that the sensor should be tested at the correct temperature and with a liquid quality which closely corresponds to the actual liquid in the system.

The correct type of sensor in relation to the liquid quality.
Which type of sensor suits your quality of liquid the best?

2.4.2 Quality of the heat conveying liquid

It is widely recognised that liquid quality has an important effect on the service life and operation of liquid heating systems through the interaction between the liquid and construction materials of the system, but little guidance is available concerning the effect of liquid on the durability etc. of heat meters. Even on what might be thought to be a relatively simple matter on which to have agreement, i.e. the pH of the liquid, there is conflicting advice. In the UK 6.5 to 8.5 pH is recommended whereas in Sweden < 9.5 is specified. As long as a heat meter is considered to be a series of fittings forming part of the heating system, it is unlikely that any special requirements for the heat meter concerning liquid quality will be recognised and incorporated into the heat meter Standards.

Air bubbles in the liquid
All forms of contamination in the liquid cause errors in measurement in some form. Though it seems the most harmless of 'contamination', air causes major problems for most types of sensors. This means that a sensor should not be located at the highest point in a pipe or in any other place where air-bubbles in the liquid could be suspected.

Magnetite
Magnetite, Fe_2O_4, formed from iron oxides, is present as a product of corrosion in the DH network.

Conductivity
Conductivity is measured in µS/cm. If totally desalinated liquid is used in the DH network, conductivity can be as low as 2µS/cm. Otherwise the conductivity of the liquid may exceed 600µS/cm.

Dirt
Dirt in the pipe system usually consists of oil and grease from pumps and valves, but it may also contain solid particles from repairs, etc.

2.4.3 Measuring principles / type of sensors

a) Turbine flow sensor

There are a number of variants within this group, such as single-jet impeller sensors, multi-jet impeller sensors and Woltman sensors.

Single or multi-jet sensors are, as the name suggests, sensors where the liquid-flow meets the flat blades on the impeller at one or more inlet jets.
The Woltman sensor is a sensor where the flow meets a propeller type turbine wheel axially.

The transfer between the rotor and the counter unit can be done in different ways, liquid unit, dry unit or inductive transfer.

Liquid unit means that the counter unit and rotor are directly connected and the whole counter is immersed in the liquid.

In a dry unit the transfer takes place by means of a magnetic coupling and the counter unit parts are fitted outside the liquid part.

In some modern sensors, inductive transfer is used, i.e. there is a digitiser on the impeller shaft which is read by a receiver in the upper dry part of the sensor.

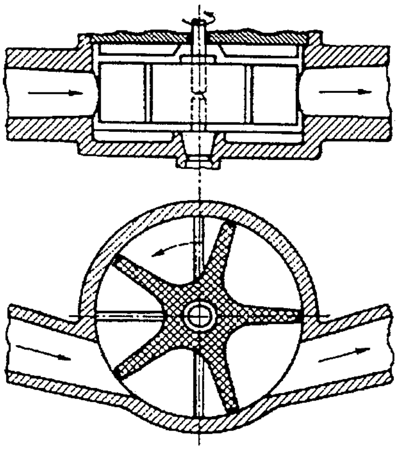


Figure 1 Single-jet sensor

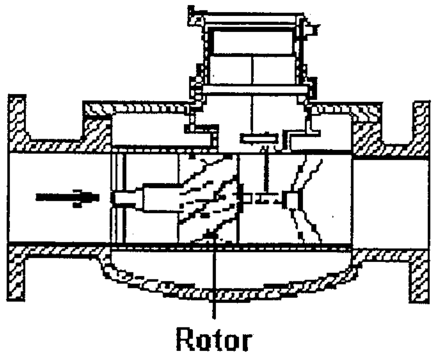


Figure 2 Horizontal Woltman sensor

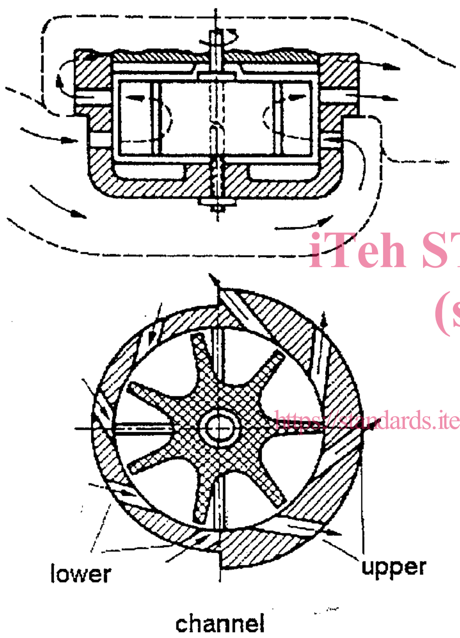


Figure 3 Multi-jet sensor

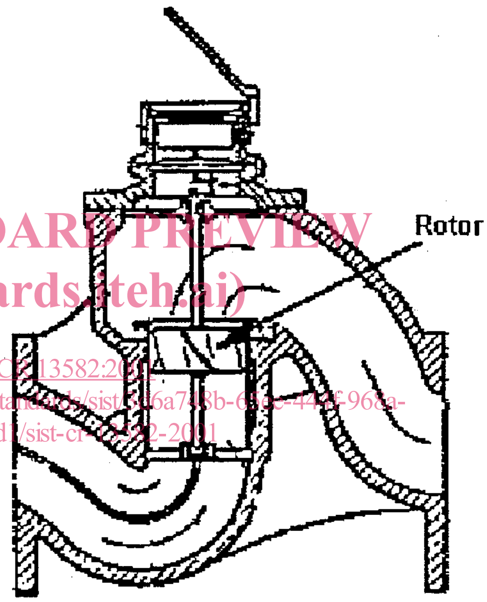


Figure 4 Vertical Woltman sensor

b) Magnetic inductive flow sensor

The magnetic inductive sensor (Magmeter) is based on Faradays' law, i.e. that a movement of a conductor through a magnetic field induces a voltage which is proportional to the speed of the conductor. In a flow sensor, the liquid is the conductor, and a certain conductivity is required in the medium. The voltage is captured by two electrodes and amplified, and then used to calculate the flow.

The inductive sensor is a very fast responding sensor and can in fact measure instantaneous flows.

The voltage (electromotive force, EMF) from the measuring pipe is very small and so an amplifier and converter are required.
The amplifier section may be located in different ways depending on the specific design of each manufacturer. Those manufacturers who have decided to locate the electronics directly on the measuring pipe, have the advantage that the signal cables are very short and easy to protect against interference. The disadvantage of this design is that the electronics are affected by the temperature of the liquid which can sometimes be very high. This shortens the service life of the electronics.

Where the manufacturer has decided to separate the electronics and the measurement pipe the problem of signal interference arises instead.

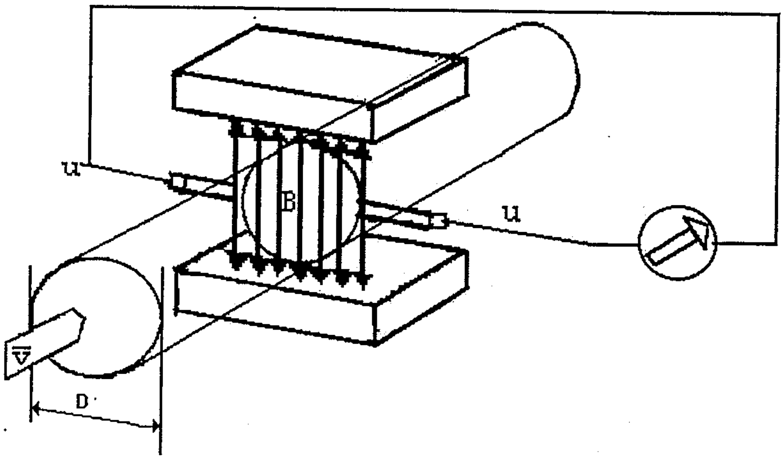


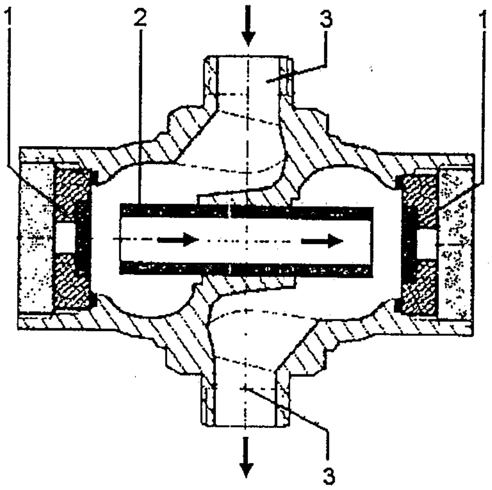
Figure 5 Magnetic Inductive-flow sensor

c) Ultrasonic flow sensor

The working principle of the ultrasonic sensor is based on the fact that a sound wave is affected in different ways if the wave travels along or against the flow direction. This can be used to measure the speed of the liquid flowing through the pipe. The ultrasound is generated and detected by piezo-electric crystals which function both as transmitters and receivers.

Several different measurement principles are involved, such as doppler frequency sensors, frequency difference sensors and transit time sensors.. There are different types of transit time sensors.

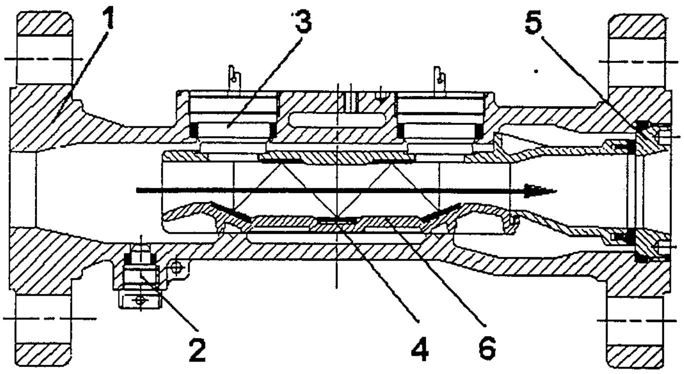
In one type the transmitter and the receiver crystals are at each end of the measurement pipe, and the flow is very disturbed through the sensor, therefore a symmetrical and swirling flow does not influence the quality of the measurement for this type. Some types of sensors are influenced by the propagation speed of the sound in the liquid, which is depending on the temperature and quality of the liquid. The temperature dependency can be compensated by a temperature sensor.



1. Piezo-electric transmitter/receiver
2. Measurement pipe
3. Pipe connection

Figure 6 - Ultrasonic sensor. - type one

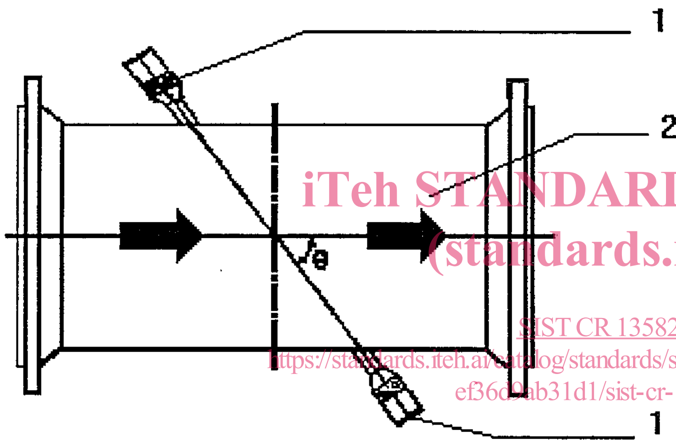
With type two, the crystals are located on the same side and are reflected through a system of reflectors.



1. Sensor housing
2. Temperature sensor socket
3. Piezo-electric transmitter
4. Reflector (total 5)
5. Brass nipple
6. Measurement lining

Figure 7 - Ultrasonic sensor. - variant two

There is another type of ultrasonic sensor where the transmitters/receivers are located on either side angled towards each other. The sensors can be single-channel (two crystals) or double-channel (four crystals).



1. Piezo-electric transmitter/receiver
2. Measurement pipe

Figure 8 - Ultrasonic sensor. - type three

d) Fluidistor flow sensor

Fluidistor sensors have a sensor housing with two alternative passages for the flowing liquid . When the flow is diverted through one channel after passing through a feedback cycle it impinges on the inlet flow so that the next part of the flow is lead into the measurement channel opposite etc. These alternations quantify the flow with a periodicity which is proportional to the volume of the flow. The frequency of alternation is read in different ways depending on the manufacturer. In one method an oscillator ball is set swinging, and a reading is taken every time the ball passes a sensor. Another method is to let the flow channel cool down a temperature sensor and from this read off the frequency of alternation. With greater flows this measurement principle is most often used as a part-flow measurement, i.e. through the use of an orifice plate where only a part of the flow goes through the measurement section itself. This type of sensor can be used both for liquids and gases.

e) Other types of flow sensors

The flow in liquids and gases can be measured using a number of different types of meters such as piston prover meters, oval wheel meters, differential pressure instruments, pitot tubes, carburettor float, compressive force, vortex meter, anemometer, etc. Differential pressure instruments and vortex meters are used mainly for large heat meters, but most of the other mentioned meters are of no interest as flow sensors for heat meters

2.4.4 Sizes and dimensions

The heat demand for each building connected to the DH-network comprises of the demand for heating and the demand for sanitary warm water.