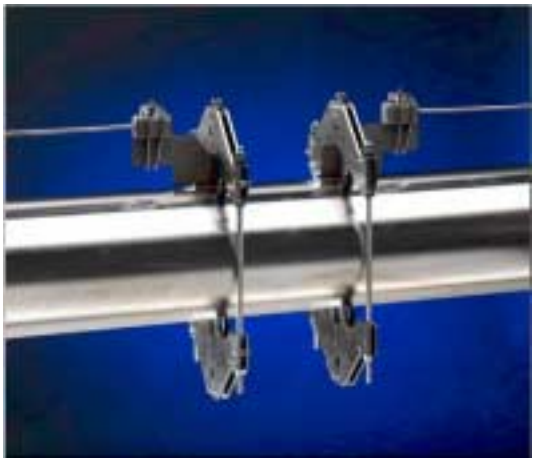
Application Note

Industry	Petrochemical / Refining
Application	High temperature non-invasive flow measurements
Product	Clamp-on ultrasonic flowmeter for permanent installation in either hazardous or safe areas

Description of the Application

For a number of years now, engineers have used clamp-on flowmeters as a problem-solving tool for applications where more traditional methods are, impractical, costly or hazardous. However there is one area where a non-invasive measurement system could be ideal that up until now has not been represented; high temperature flow measurements.



New WSA System Installed on Pipeline

Katronic flowmeters have always had the capability to measure pipelines with a temperature of up to 300°C for short periods and 200°C for permanent installation but there have always been applications where the operating temperature far exceeds this. Furthermore, the maximum operating temperature of hazardous area ATEX certified sensors is 120°C therefore limiting the usefulness of the technology.

This situation is about to change, as Katronic Technologies are now able to offer a measurement solution for high temperature pipeline in both hazardous and non-hazardous areas. The Waveguide Sensor Assembly or WSA for short is a newly developed mounting system for the Katronic flow sensors that allows the measurement of pipes with an operating temperature of up to 500°C in safe areas and 400°C in hazardous areas.

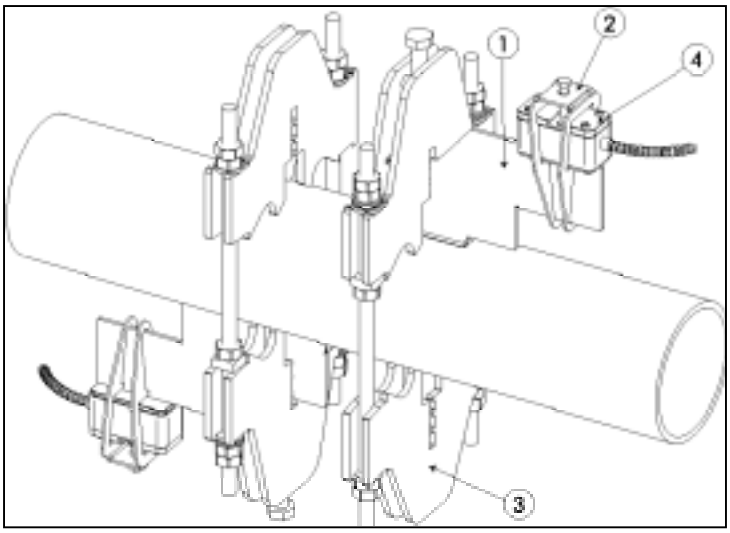
Customer Advantages

- Easy, quick and cost-effective installation to existing pipelines
- No cutting of pipes necessary / No process shut-down
- Can be used on pipes up to 500°C
- Can also be used on very cold pipes with an operating temperature as low as -190°C
- Installation on pipes of different material and various diameter
- Capable of measuring flow rates up to 25 m/s without any change in the meter settings
- Sensor adjustment possible with the flowmeter in operation
- ATEX certified for use in Zone 1 hazardous areas
- For measurement of all hydrocarbon and chemical products
- Easy integration into existing or future control systems possible
- Maintenance free, very high MTBF (mean time between failures)

Equipment Specification

Flow transmitter options:	KF 160 (for installation in Zone 1 areas) KF 140 (for installation in the control room)
Clamp-on flow sensor options: (Hazardous Area)	Type Q4N-Ex for pipes < 400 mm Type M4N-Ex for pipes 100 … 6500 m
Clamp-on flow sensor options: (Standard High Temp. Sensors)	Type Q3E for pipes < 400 mm Type M2E for pipes 100 … 6500 mm

System Overview



The WSA is composed of the Waveguide Buffer Rod System coupling plate (1).

The transducers clamping assembly for positioning of the sensor and fine-tuning of the position once the system is in operation (2).

A pipe-mounting clamp (3), together with an acoustic coupling foil for firm attachment of the sensor assembly to pipes of various diameters.

The metallic coupling plate between the transducer (4) and the pipe minimises sensor attenuation and provides a nearly loss-free acoustic bond to the pipeline, thus ensuring reliable measurements. At the same time, its cooling effect creates a temperature difference between the surface of the pipe and the coupling surface of the transducer. This guarantees that the allowed transducer temperature is not exceeded.

System Operation

As can be seen from the illustration below, this Waveguide system maintains the surface temperature of the sensors remains within the normal operating range whilst ensuring that the excellent measurement capability of the flowmeter does not suffer as a consequence. This is a difficult process as it is essential to ensure the optimal conditions for the transmission of the ultrasonic signal.

In the first thermal camera image, it can be seen that the WSA has been mounted to a pipe with a surface temperate of 250°C. In spite of the elevated operating temperature, the sensors shown in the second image are maintaining a surface temperature of 44.4°C a gradient across the sensor assembly of more than 200°C.

Application References:	**System 1**	**System 2**
Company:	Dow Chemicals	BP Chemicals
Application:	Measurement of aromatic isocyanates production	Measurement of boiler feedwater
Pipe:	300 mm diameter, steel	350 mm
Temperature range:	> 250°C	Up to 300°C
Replaced equipment:	New-build	Nucleonic Measurement System

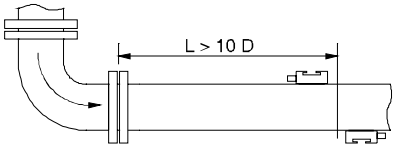
Frequently Asked Questions (FAQ's)

1 – What are the standard Up / Downstream distances for an ultrasonic flowmeter?

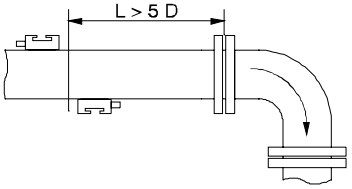
The first thing that needs to be stated here is that the amount of available straight pipe does not dictate whether the flowmeter will be able to measure flow or not, it does however have an effect on accuracy. The recommended distances vary depending on disturbance source; this is always quoted as a factor of number of pipe diameters. A "standard" distance would be 10 x OD on the inlet and 5 x OD on the outlet, (See below). For more specific information see Katronic Technical note "Selection of Measuring Point".

Disturbance source: 90 °-elbow

Inlet
L ≥ 10 D



Outlet
L ≥ 5 D



2 – What is the lowest temperature that a clamp-on flowmeter can measure?

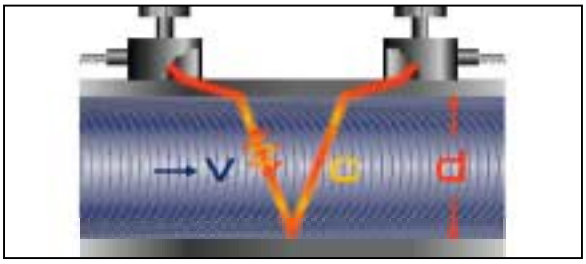
The lowest temperature that the flowmeter can measure is not dictated by the flowmeter or sensor specification but by the pipe condition. The problem with low temperature applications is ice formation; this can cause the sensors to migrate from the installation position and can cause air to be trapped between the sensor and the pipe causing loss of measurement. The new WSA is being tested on cryogenic systems with an operating temperature as low as -190°C and as the sensors are not in contact with the pipeline this situation can be avoided. Katronic have also supplied sensors for installation on pharmaceutical applications with an operating temperature of -50°C.

3 – Can transit-time flowmeters measure on Duplex piping?

It has been reported that clamp-on flowmeters have a problem obtaining measurements on Duplex pipes. This is not the case with the KATflow flowmeters, as we already have several installations on Duplex pipes, including the BG Group system shown on page 2.

4 – What is better; Doppler or Transit-Time?

Unlike Doppler flowmeters, Transit-time devices are not dependent on there being solid or gaseous particles in the liquid. This means that a transit time meter is able to measure clean liquids such as demineralised water or methanol.



Transit-time measurement principal

As well as differences in performance, transit-time meters would also have a better measurement uncertainty than a Doppler-type meter. The transit-time measurement principal is inherently more accurate as it deals in the constants of time and distance rather looking for a frequency shift generated by flowing particles and gas bubbles as is employed in Doppler systems.

As can be seen from the diagram (left) in transit time measurements a matched pair of ultrasonic flow sensors is located at a known distance apart on the surface of the pipe.

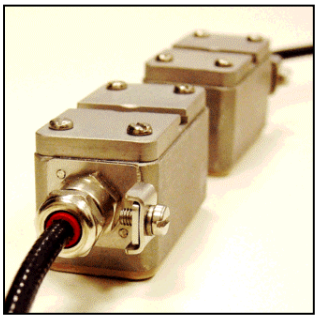
Both sensors emit and receive the ultrasonic pulses and the transmitter unit analyses the time difference between the signals. The measurement of the flow velocity is directly proportional to the difference in the time between the emitted and received ultrasonic pulses.

The new range of KATflow flowmeters employ the latest developments in advanced signal processing technology and are therefore able to measure liquids such as effluent, sludge and paint where previously a Doppler meter would have been compulsory. This is possible without compromising the superior accuracy or reliability expected from a transit-time flowmeter.

In spite of some limitations the Doppler measurement method does still have role to play in the measurement of very heavy sludge applications or pipes with severe aeration. It is for this reason that all of the KATflow flowmeters incorporate a secondary Doppler-based measurement method for rare applications where the Transit-time principal is not able to obtain readings.

5 – Are the KATflow meters suitable for hazardous areas?

The KF160 and Q4/M4-Ex sensors (pictured below) are fully ATEX certified and suitable for use in Zone 1 areas including offshore platforms. The classifications of the instruments are:



M4N-Ex Hazardous area sensors

KF160 Transmitter: EEx de IIC T6

M4N-Ex and Q4N-Ex sensors: EEx m II T4-T6

6 – Why are the ultrasonic flowmeters not certified for ATEX Zone 0 (IS applications)?

In order to produce a flowmeter and sensors that was suitable for use in a Zone 0 area it would be necessary to decrease the voltage supplied to the sensors. If this were done sensor performance would be diminished to such an extent that it would no longer be possible to measure more difficult applications such as heavier solid content liquids or the flow rate in thicker-walled pipes.

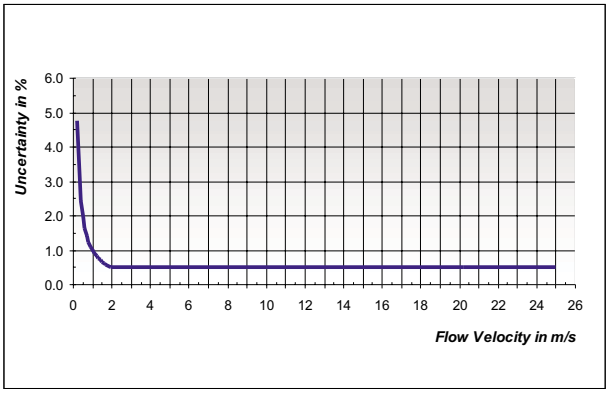
It is rare that a flowmeter would need to be installed in an area classified as Zone 0 (where explosive gases are present 100% of the time) as flow measurement is not often required within vessels or enclosed spaces. It was thus decided that it was preferable to maintain the reliability of the flowmeter rather than to risk reducing performance in order to meet a standard that would not be required under normal operating conditions.

7 – What uncertainty can a clamp-on flowmeter achieve?

The measurement uncertainty of the Katronic flowmeters is 1-3% of measured value for volumetric flow and 0.5% of velocity.

An accuracy of 0.5% of volume can be achieved by carrying out a process calibration. No clamp-on flowmeter can achieve an uncertainly of less than 1% without a process calibration being carried out.

As can be seen from the graphic (on right) the flowmeter has an excellent turndown (1:100) and rangeability (1/2500) and maintains its accuracy even at very low flow velocities.



For more information, please contact:

Katronic Technologies Ltd.
23 Cross Street
Leamington Spa
Warwickshire
CV32 4PX
GREAT BRITAIN

Telephone: ***+44 (0)870 3000 110***
Fax: ***+44 (0)870 3000 111***
E-mail: ***info@katronic.co.uk***
Web: ***www.katronic.co.uk***