GUIDANCE NOTE – GN 13
Volume Flow Rate Measurement by Non-Invasive Flow Meters

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VOLUME FLOW RATE MEASUREMENT BY NON-INVASIVE FLOW METERS

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Volume Flow Rate Measurement by Non-Invasive Flow Meters

Introduction - What is a non-invasive flow meter?

In some instances, especially on existing systems in older properties, there may not be the provision to enable the conventional method of volume flow rate measurement using a manometer; either because flow measuring devices (FMDs) have not been installed or the test points on the FMDs are broken or blocked. In these cases, non-invasive flow measurement devices such as Ultra-Sonic Flow Meters (USFM) can be used as an alternative method of measuring volume flow rates.

USFMs are available in two types; transit time and Doppler. Both technologies feature clamp on transducer arrangements that will measure volume flow rates from outside of the pipework, without the need to physically insert test probes into FMDs.

Transit Time - Ultra-Sonic Flow Meter

Transit time USFMs are the most commonly used type for the measurement of volume flow rates on heating and cooling water systems. They measure the difference in time from when an ultra-sonic signal is transmitted from the first transducer until it crosses the pipe and is received by the second transducer. A comparison is made of upstream and downstream measurements. If there is no flow, the travel time will be the same in both directions. When flow is present, sound moves faster if traveling in the same direction and slower if moving against it. Since the ultra-sonic signal must traverse the pipe to be received by the sensor, the liquid cannot have any significant amounts of solid or bubbles, otherwise the high frequency sound will be abated and too weak to travel across the pipe. The difference in the upstream and downstream measurements taken over the same path is used to calculate the flow rate through the pipe.

Doppler - Ultra-Sonic Flow Meter

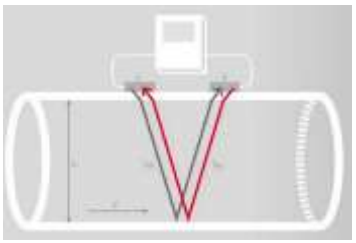
Doppler type USFMs operate on the principle of the Doppler effect, which was documented by Austrian physicist and mathematician Christian Johann Doppler in 1842. He stated that the frequencies of the sound waves received by an observer are dependent upon the motion of the source or observer in relation to the source of the sound.

A Doppler USFM uses a transducer to emit an ultrasonic beam into the stream flowing through the pipe. For the meter to operate, there must be solid particles or air bubbles in the stream to reflect the ultrasonic beam. The motion of particles shifts the frequency of the beam, which is received by a second transducer. The flow meter measures the frequency shift, which is linearly proportional to the flow rate.

Installation of Ultra-Sonic Flow Meters

Accurate and error-free measurement relies upon proper mounting of the equipment. It guarantees that the sound signal will be received under optimal conditions and will be evaluated correctly. Because of the variety of applications and the different factors

influencing the measurement, there can be no standard solution for the positioning of the transducers.



The “V” configuration is recommended for most installations. This arrangement places the two transducers on the same side of the pipe within, approximately, a diameter of the pipe from each other. A rail attachment can be used to clamp onto the pipe and allows the transducers to slide horizontally to position them to the calculated distance apart. Other configurations are possible, and the manufacturer’s installation guide should be consulted where appropriate.

Sufficient straight length of pipe (as stipulated by the manufacturer) at the measuring location is essential to guarantee an axisymmetric flow profile in the pipe for good measurement accuracy. If sufficient straight lengths of pipe aren’t available, measurements can still be obtained, but the certainty of the measurement will likely be compromised.

Try to avoid measuring:

- in the vicinity of deformations and defects of the pipe
- in the vicinity of bends/elbows, reducers, valves and welding seams etc
- where deposits could be building up in the pipe

Pipe preparation:

- Clean any dirt and dust from around the area of the pipework where the transducers are to be placed
- Remove loose paint and rust with a wire brush or file

Note: Firmly bonded paint does not necessarily need to be removed, provided that the flowmeter indicates sufficient signal strength.

In order to obtain acoustical contact between the pipe and the transducers, acoustic coupling paste is applied to the centre of the contact area of the transducers.

The correct position of the transducers will be influenced by the following factors:

- General condition of the pipe
- Pipe diameter
- Material
- Lining
- Wall thickness
- Medium (liquid) flowing in the pipe
- Presence of gas bubbles and solid particles in the medium

These factors must be accounted for during installation in order to calculate the transducer separation distance (usually calculated by the equipment, refer to the

manufacturer's installation guide). In addition, all ultrasonic flow meters require that the pipe is full. A Doppler USFM on a partially filled pipe will continue to generate flow measurements if both transducers are mounted below the fluid level in the pipe.

Large temperature changes in the pipe or any significant vibration may affect the alignment of the transducers and acoustic coupling to the pipe.

Whilst elements such as flow profile, type of liquid and pipe material could have an influence on the measurement, the electronics of modern USFMs can compensate and adapt to changes in order to provide reliable measurements.

What are the benefits to non-invasive flow measurement?

Whilst it is good practice to install conventional FMDs, USFMs can offer many benefits, especially on older or existing systems, such as:

- No interruption to system operation
- No risk of leakage or contamination of the pipe and medium
- No expensive alterations needed
- Non-intrusive flow measurement can be a safer alternative to conventional FMD, when measuring high temperature mediums
- They can provide repeatable and accurate results even in non-ideal conditions

CAUTION: Be aware of hot surfaces when mounting and using USFMs with heating, especially medium and high temperature applications. A risk assessment should always be carried out before commencing work on any hot water system.

Helpful Link - https://www.youtube.com/watch?v=upO3H8V6eng&feature=youtu.be