The Case for Wide Beam Ultrasonic Flow Measurement

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The most commonly used method of flow measurement is Transit Time Ultrasonic Flow measurement. Two types available, externally mounted Diametral and insertion type Chordal, have different advantages and disadvantages. This article examines the pros and cons of the Diametral and Chordal Measurement systems, and offers a third solution.

Transit Time Ultrasonic Flow Measurement

Transit Time Ultrasonic Flow Measurement is the most common type of ultrasonic flow metering which is often used in applications such as custody transfer, marine loading and unloading and blending applications. Transit time measurement is based on the principle of sound energy traversing the fluid or gas in a pipe, both upstream and downstream, where the time difference is impacted proportionally based on the flow rate. A pulse or pulses are transmitted from the transducers through the liquid to the opposing transducer positioned further downstream.

Its popularity is mainly due to the fact that ultrasonic flow meters have a number of advantages over traditional metering methods. Ultrasonic flow meters have a number of advantages which have driven their popularity;

- Ultrasonic flow metering is non-intrusive, which means there is virtually no pressure drop.
- There is no wear to the mechanism which means reduced or even eliminated maintenance costs.
- Reduced Installation costs as a result of externally mounted sensors.
- Very large down turn ratio, typically 400:1

Diametral and Chordal Measurement systems have their unique advantages and either can produce excellent performance results when properly installed, but users must consider a number of potential performance issues with each type.

Diametral Measurement

Diametral measurement is achieved by placing two transducers an offset axial distance in line with the pipe causing the signal from one or multiple paths to pass through the centre of the pipe and velocity stream. Placing the transducers on the outside of the pipe greatly reduces installation costs. However, Diametral measurement is also burdened by the necessity of needing an accurate flow profile. Complicated upstream piping can impact the accuracy of determining the flow profile and in turn measurement errors. Ultrasonic flowmeters can be affected by distortions in the velocity flow profile that can, given the amount of distortion, lead to erroneous measurement errors. Straight upstream piping is an important factor when employing ultrasonic meters in high accuracy applications since valves can cause vortices and swirl. These disturbances can cause errors in the measurement of flow profile and result in errors in the flow measurement.

Manufacturers of ultrasonic meters determine the flow profile and correct, as far as possible, by means of a Reynolds number (a dimensionless number equal to the ratio of inertial to viscous forces). It is accepted that laminar flow is generally found for Reynolds numbers less than 2000 and turbulent flow for Reynolds numbers greater than 10,000. The laminar and turbulent regions are generally well known and proper compensation can be made to produce highly accurate measurement. Between these two regions is the transition region. This is problematic in terms of ultrasonic flow measurement since it is unpredictable and difficult to measure.

Many users and manufacturers have adopted the use of flow conditioners to help reduce or completely eliminate flow profile distortions in applications where high accuracy is required but straight pipe run is not available. However, use of flow conditioners tends to negate some advantages of ultrasonic flow meters since they are inserted into the flow stream and can increase the pressure drop.

Chordal Measurement

The second type of measurement is Chordal measurement, achieved by placing two or more pairs of transducers and is almost always performed using insert type meters in the form of spool sections. Chordal measurement can more easily determine the flow profile based on the relative readings of each chord with the use of sophisticated software. However, this type of measurement has to have cavities in the pipe wall at the location of the transducers. Such cavities can cause flow profile disturbance and can produce a self-generated misrepresentation of the flow profile that can lead to measurement errors. Chordal type meters are also subject to a build-up of paraffin within the cavities when measuring high viscosity liquids. This can create operational failures and lead to a need for corrective maintenance.

Wide Beam Technology

Wide Beam Technology is a third option which has none of the disadvantages of the two most commonly used methods. It has numerous advantages that enhance the ability of the ultrasonic meter to maintain operation in difficult applications and improve accuracy compared to normal shear mode ultrasonic meters as follow;

- It allows sonic energy to pass through a wide swath of the liquid stream, lowering the potential for the sonic beam to be interrupted by air bubbles or solids.
- Wide Beam technology effectively eliminates zero drift by utilising the sonic signature that travels down the pipe wall to the receiving transducer as a marker to any drift in the zero adjustment. This marker is fixed. Zero drift, as a result of temperature in the transducer crystals, has historically been a concern as it can impact the error of ultrasonic measurements, however this error is typically insignificant in applications with low accuracy requirements. However, this error has become more of a concern with custody transfer applications where even minutely inaccurate measurements can be very costly. Any difference between the arrival time of the pipe signal relative to the liquid signal can be adjusted on a continuous basis, effectively removing any drift not caused by actual flow.

Conclusion

Ultrasonic transit time flow meters offer unique advantages and excellent value for money for oil and gas industry applications. However, it remains important to understand the differences between the different technologies in order to make the right choice for each application, to ensure the desired level of performance against budget.