ULTRASONIC DOPPLER FLOWMETERS

Flow Reference Section

Introduction

The ultrasonic Doppler flowmeter incorporates a technology offering an increased range of applications. Because of its non-invasive nature, no pressure drop is created, and this type of flowmeter can be used to measure the flow of fluids and slurries which ordinarily cause damage to conventional sensors.

The basic principle of operation employs the frequency shift (Doppler Effect) of an ultrasonic signal when it is reflected by suspended particles or gas bubbles (discontinuities) in motion. This metering technique utilizes the physical phenomenon of a sound wave that changes frequency when it is reflected by moving discontinuities in a flowing liquid. Ultrasonic sound is transmitted into a pipe with flowing liquids, and the discontinuities reflect the ultrasonic wave with a slightly different frequency that is directly proportional to the rate of flow of the liquid (Figure 1). Current technology requires that the liquid contain at least 25 parts per million (PPM) of 30 micron or larger suspended particles or bubbles.

A typical system incorporates a transmitter/indicator/totalizer and a transducer. The transducer is mounted on the exterior of the pipe. It is driven by a high frequency oscillator in the transmitter through an interconnecting cable. The transducer generates an ultrasonic signal which it transmits through the wall of the pipe into the flowing liquid. The transmitter measures the difference between its output and input frequencies and converts this difference into electronic pulses which are processed to provide an analog indication and a voltage or current output signal. Additionally, the pulses are scaled and totalized to provide flow quantity.

The transmitter frequency power levels and transducer configuration are selected to accommodate a wide variety of liquids, pipe sizes, percentage of solids, and pipe liners.

The transmitter also incorporates circuitry which allows adjustment of the signal threshold, permitting elimination of undesirable ambient noises (both mechanical and electrical). As a result, instrumentation is possible in a variety of locations subject to high levels of sonic, mechanical, and electrical noise.

Accuracy

Without Field Calibration

The accuracy of a flowmeter operating on the Doppler principle is mainly a characteristic of flow velocity profile integration by the ultrasonic wave. The ability to do this is basically a function of: percentage of sound reflectors (solids and bubbles), their size, variation and distribution, the line size, and the flowmeter's design features. Therefore, it is unrealistic to state a general accuracy without knowing the full application details and the transducer selection.

With Field Calibration

The accuracy of this method with a field flow calibration can be as high as ±1% plus the accuracy of the flow calibration on the actual application at given conditions.

Clean Liquids

As noted, the basic ultrasonic Doppler flowmeter requires that the liquid to be measured contain a minimum of at least 25 PPM of suspended solids or bubbles at least 30 microns or larger in size. The transducer frequency for these requirements is 1 megahertz. Lower frequencies require more PPM and a larger micron size. Until recently, 25 PPM of suspended solids or bubbles of at least 30 microns or larger, constituted the cleanest measurable application. The FD-7000 ultrasonic flowmeter has bridged the gap towards the use of cleaner liquid applications. Requiring no solids or entrained gas, this type of flowmeter can work on applications the typical ultrasonic Doppler meter cannot measure. The principles of operation are similar, with the exception that the Doppler signal is reflected by turbulent swirls in the liquid rather than by solid particles or bubbles. Because of this, the FD-7000 can only be used where there are no suspended solids or bubbles in the fluid. The unit is specially calibrated must be installed one to three pipe diameters downstream of a 90° elbow. The FD-7000 is one of the very few flowmeters not requiring a straight upstream pipe run.

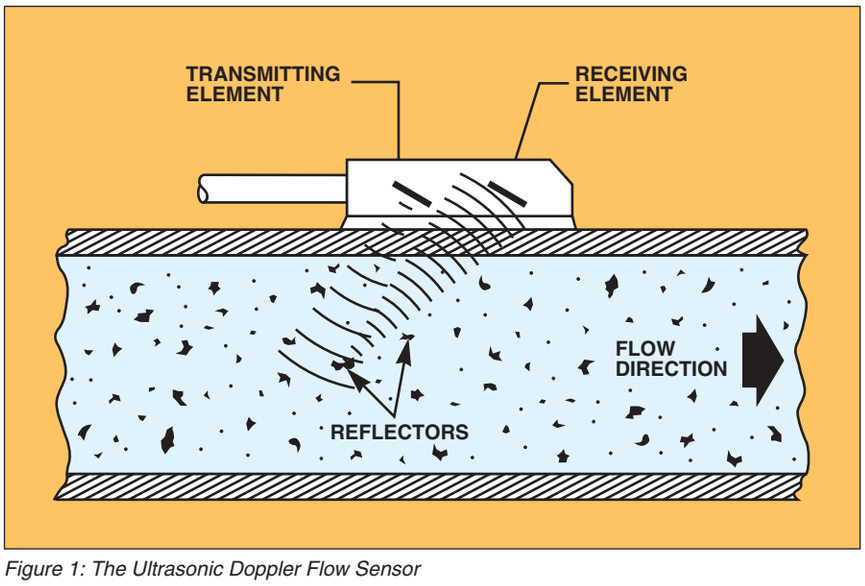

Figure 1: The Ultrasonic Doppler Flow Sensor