

SONARtrac® Flow Meter Technology – General Concepts

SONARtrac® Flow Meter Technology

Sonar flow technology is a new class of industrial flow meters, utilizing measurement principles that are distinct from all conventional flow meter technologies. CiDRA's SONARtrac flow meters utilize patented sonar-based array processing techniques to "listen" to, and interpret pressure fields generated by turbulent pipe flows. The SONARtrac family of flow meters provides accurate and reliable non-intrusive and robust flow measurement for a wide range of single phase and multiphase flows. SONARtrac flow meters are available in "clamp-on" configurations that install on existing process lines, eliminating the process disruptions associated with installing other types of flow meters.



The Legacy of Sonar-Based Flow Measurements

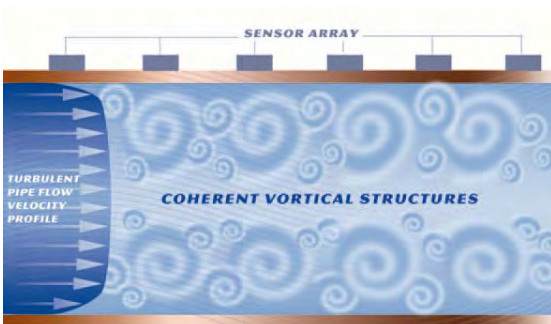
Sonar techniques have been used for more than 40 years in underwater acoustic applications, such as submarine detection and tracking. CiDRA's proprietary technology was initially developed for flow measurement in one of the world's most demanding environments: downhole, offshore oil and gas production. For this application, users require accurate, reliable and maintenance-free operation for the life of the well due to the inaccessibility of the meter once deployed downhole. CiDRA has engineered the SONARtrac family of flow meters for similar performance on industrial flow applications.

How Sonar Flow Meters Work

Sonar flow processing employs two separate, but synergistic measurement techniques. The first technique measures volumetric flow rate by monitoring turbulent "eddies" within the process flow. The second technique measures the speed at which sound propagates through the fluid to provide compositional information.

Volumetric Flow

Turbulent pipe flows are highly complex. Predicting the details of any turbulent flow is one of nature's great, unsolved problems. However, much is known regarding the statistical properties of such flow. Turbulent pipe flows contain self-generating coherent vortical structures, often termed "turbulent eddies". These eddies remain coherent for several pipe diameters as they convect down the flow line, breaking down into smaller and smaller eddies until their energy is dissipated.



SONARtrac flow meters use a patented approach, based on well-established and mature sonar array processing techniques, to measure the velocity of these turbulent eddies as they convect past an array of sensors.

By "listening" to the pressure fields associated with the movement of eddies, SONARtrac flow meters determine the speed at which these eddies travel past the array of sensors.

Volumetric flow rate is determined using a Reynolds number-based calibration procedure, which links the speed of the coherent turbulent structures to the volumetric flow rate. Accuracies of $\pm 0.5\%$ are achievable in most applications with either the clamp-on or ported pressure configurations.

Compositional Measurement

SONARtrac flow meters also offer the added capability of providing information on the composition of single phase and multiphase flows by detecting the speed at which sound waves propagate within the pipe. This approach is particularly synergistic with the SONARtrac volumetric flow meter in that the sound speed measurement and the phase fraction measurement can often be recorded using the same hardware required for the volumetric flow measurement. For example, in a two-component mixture, with knowledge of the density and sound speed of the two components, the measured sound speed can be used to determine the volumetric fraction of the two components. Sound speed measurement can be used for a wide variety of applications, such as: entrained air in paper pulp slurries, polymer slurries, the wetness of saturated steam, the oil/water fraction in oil and gas production, and the mass loading of particles entrained in air. This combination of volumetric flow and composition measurement provides the operator with a new level of insight into the process.

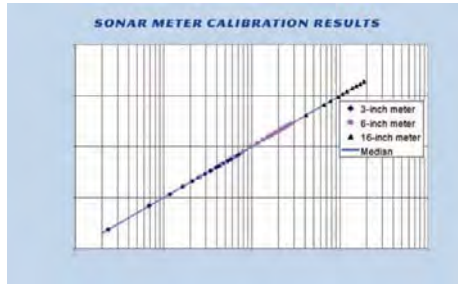
Broad Range of Flow Conditions and Pipe Sizes

SONARtrac flow meters provide accurate and reliable flow rate measurements in pipes from 1 inch to 60 inches in diameter and flow velocities ranging from 2 ft/s to over 200 ft/s in either direction, depending on application. In fact, the SONARtrac flow meter has measured airflow velocities up to 500 mph. These meters perform equally well on single and multiphase flows, including slurries, gas entrained liquids, and air-conveyed particulate flows. This wide rangability of the SONARtrac family of flow meters offers the potential for many users to standardize on one flow measurement technology, eliminating the need to support and maintain multiple flow meter technologies to address multiple applications.

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No Obstruction in the Flow, No Pressure Loss, No Clogging

Many conventional flow meter technologies such as vortex meters, orifice plates and flow nozzles inherently create pressure drops by introducing obstructions in the flow path. Parasitic pressure loss associated with these meters increases process energy consumption. Sonar measurement principles are based on the naturally occurring turbulence of the flow; therefore no internal obstruction is required, eliminating pressure loss and potential for clogging. For many applications, installation, energy and other operational savings allow a SONARtrac flow meter to pay for itself in a matter of months.



Accuracy

The data presented in the chart, on the left, shows the volumetric flow rate measured by the calibrated SONARtrac flow meters plotted against reference flow from an industry-recognized flow meter calibration facility. Using a single Reynolds number calibration spanning the operating range of three flow meters of different pipe diameters, the sonar meter measured the volumetric flow rate to within 0.5% accuracy.

Reliability

SONARtrac flow meters are designed for reliability. The non-intrusive design means there is no risk of clogging or fouling. These flow meters have no moving parts. SONARtrac flow meters are robust to clean and dirty liquids, slurries, and multiphase conditions such as entrained air.

The SONARtrac family of flow meters have the ability to operate robustly over a wide range of process fluids, distinguishing it from other types of flow meters. For example, unlike ultrasonic meters, SONARtrac flow meters do not rely on the propagation of high frequency acoustics through process fluids. As a result, SONARtrac meters are not affected by scattering effects which can be problematic with ultrasonic meters operating in dirty liquids and multiphase slurries. In addition, unlike magnetic flow meters, SONARtrac meters are not influenced by the electrical properties of process fluids, performing equally well on both conducting and non-conducting fluids.

Ease of Use

The SONARtrac flow meter user interface allows for remote programming using a PC or laptop, or locally from a keypad. The user enters the necessary inputs, such as pipe diameter and properties of the flow. Volumetric flow rate can be displayed locally or transmitted to a PC using RS232 or RS485 digital outputs, HART communications protocol or to a DCS system via standard 4-20 mA current output. The instrument is housed in an epoxy coated, NEMA4 or NEMA4X rated enclosure with local backlit LCD display.

Low Cost, Convenient Installation

The SONARtrac Clamp-on Flow Meter can be installed easily and directly onto the existing pipeline, so there is no process downtime. The sensor array is completely integrated into a lightweight, corrosion-resistant housing and clamped onto the pipe with minimal pipe preparation, requiring far less time and expense than a spool piece insertion. The clamp-on feature allows for installation of the meter without shutting down the process, saving production time and money.

For certain applications, flow meters with flush-mounted ported pressure transducers can be installed with standard NPT fittings directly into the existing pipe section. Alternatively, a spool piece with flush-mounted ported pressure sensors can be provided.

Applications

- Oil Sands Processing
- Minerals Processing
- Power Generation
- Chemical
- Pulp and Paper
- Consumer Products
- Water and Wastewater Treatment
- Pharmaceutical
- Food and Beverage Industry

Improve Your Process

If you are interested in learning more about how CiDRA's SONARtrac family of flow meters can improve your process, increase efficiency, decrease your downtime, and decrease process variability, call our applications engineers at **(877) cidra77**.

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