Ultrasonic Transit Time Method

Engineering and physical principles of non-invasive SONOFLOW® flow sensors

TECHNICAL NOTE

SONOTEC

With the drive to utilize more efficient processes and the need for contamination-free measurements, the demand for non-invasive measuring technologies is increasingly high. For this reason, SONOTEC® provides this information to guide through some basic facts about how non-invasive ultrasonic flow sensors actually work and what their operational advantages compared to invasive and intrusive measuring methods are.

Advantages of Clamp-on Sensors

Non-invasive & Non-intrusive

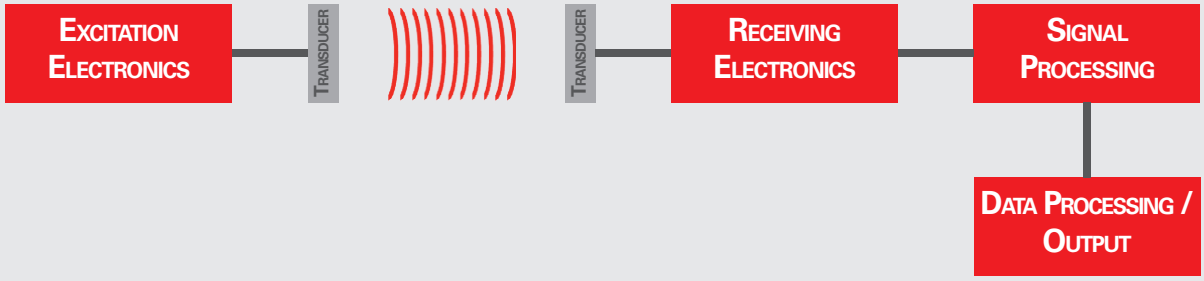
Whereas non-invasive devices do not physically affect the flowing liquid and are simply clamped from outside onto the tube, invasive devices directly affect the fluids and are thus not free of contamination. Intrusive sensors, in turn, "intrude" into the liquid channel. This method can cause disturbances or asymmetries of the flow profile and thus corresponding with incorrect measurements.

SONOFLOW® CO.55 clamp-on sensors combine the best features of being both, non-invasive and non-intrusive. They do not:

- protrude into the flow to cause turbulences,
- come into contact within the liquids and
- generate any pressure losses.

Engineering Principles of Ultrasonic Flow Sensors

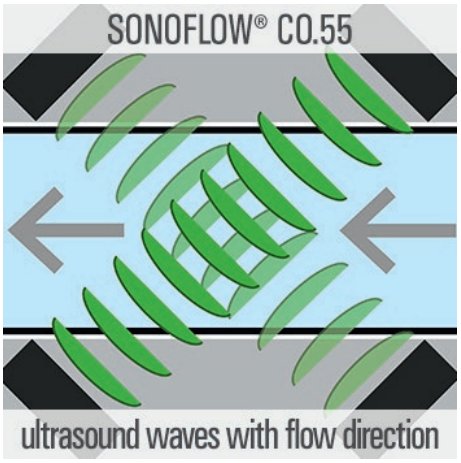
Ultrasonic transducers are the heart of any ultrasonic flow sensor. They consist of piezoelectric ceramics or composites that expand or contract when a DC voltage is applied, depending on the sign of the voltage (inverse piezoelectric effect). By applying an alternating voltage, the piezoelectric expands and contracts periodically and emits a sound wave corresponding to the excitation frequency. This sound wave is sent out as a pulsating ultrasonic beam from an excitation transducer and is detected by a receiving transducer. The signal is evaluated electronically and output via various signal outputs (digital + analog).

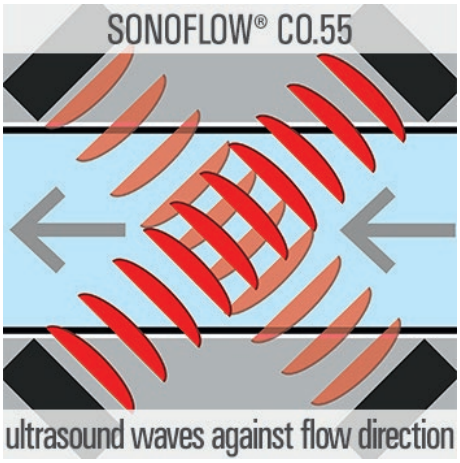


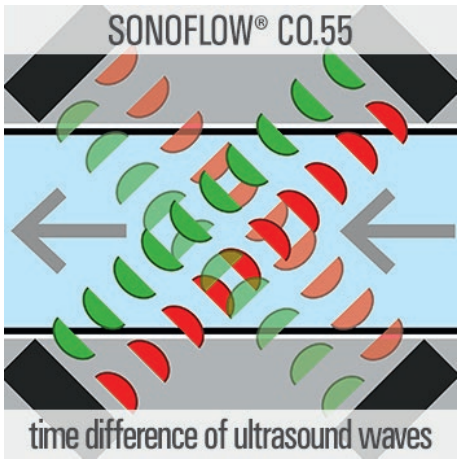
Physical Principles of Ultrasonic Transit Time Flow Sensors

There are different ways how ultrasonic signals can be utilized to calculate flow rates. The SONOFLOW® CO.55 sensors work on the basis of the transit time difference measurement method. This method causes neither a pressure drop in the tube nor a risk of leaks. When appropriately calibrated, transit time can work on almost all liquids viscosity, density, color and electromagnetic properties of fluids. Ions and particulate matter are not required to calculate the measurement.

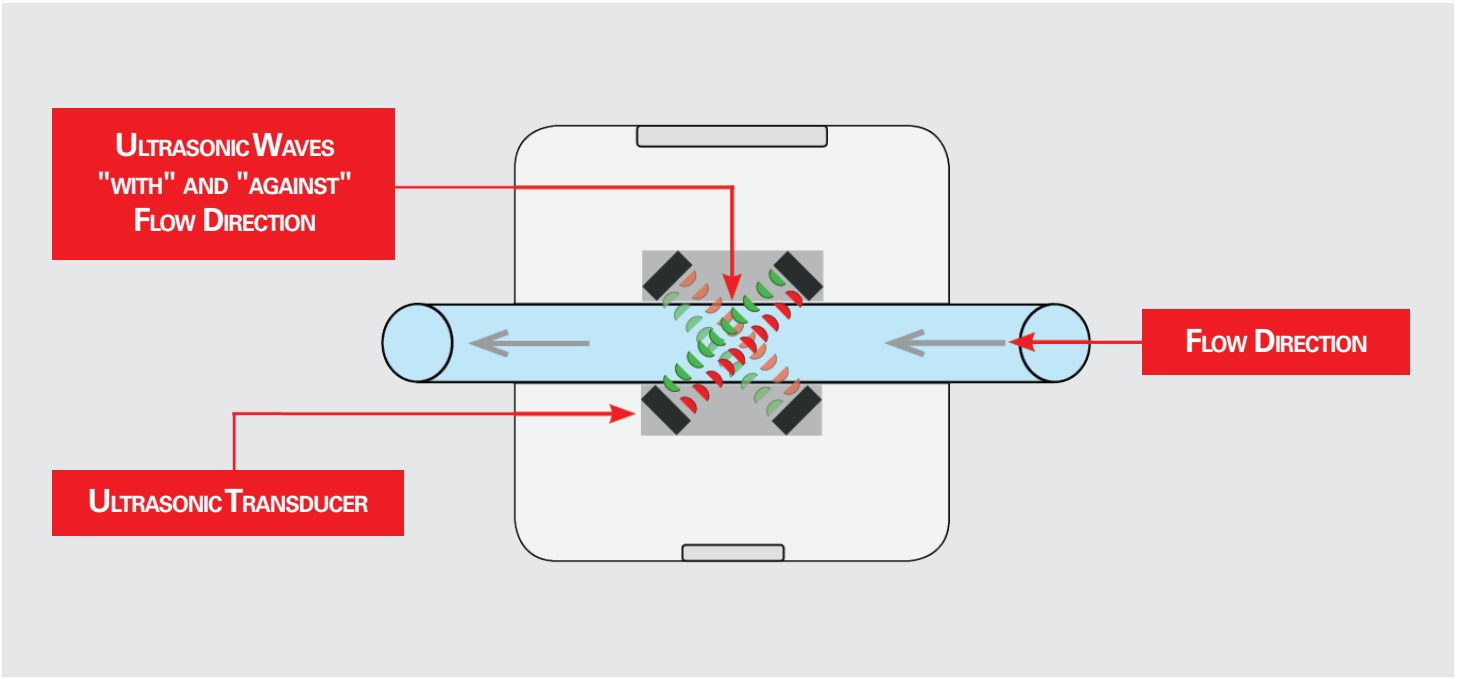
How does the transit time difference measurement actually work?







The transit times in and against the flow directionof a medium are measured with high precision by time-to-digital converters. In the direction of flow, the transit time of an ultrasonic wave is faster than in the opposite way. Like a sport boat, which moves in and against the flow direction of a river. A simple difference of both times allows a determination of the flow. In the case of the SONOFLOW® CO.55 sensor, the transmitted sound waves are sloped through the liquid. To improve the measuring effect, two measuring parts are used. Four ultrasonic transducers are arranged in an X-pattern. The transducers emit pulsating ultrasonic waves in a given frequency from one side to the other. The resulting transit time difference is directly proportional to the mean flow velocity. The flow volume results from the product of this mean flow velocity and the cross-sectional area of the tubing.



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