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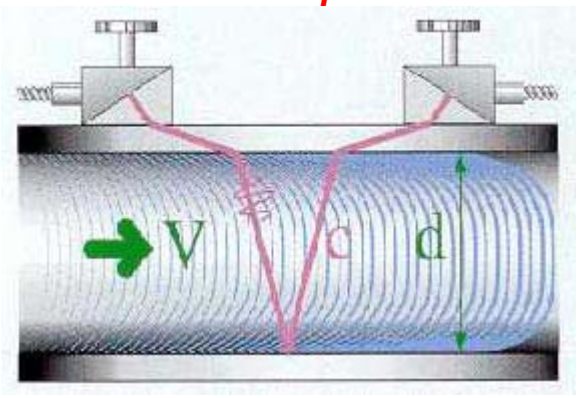
Clamp-on Ultrasonic Flowmeters - Measuring Principle

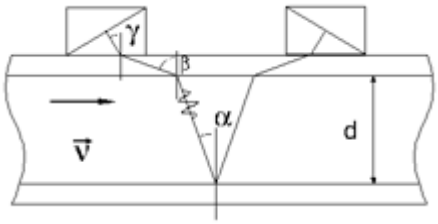


The flow measurements are made by penetrating the pipe with ultrasound. Time differences, frequency variations or phase shifts of the ultrasonic signals caused by the flowing liquid are subsequently evaluated.

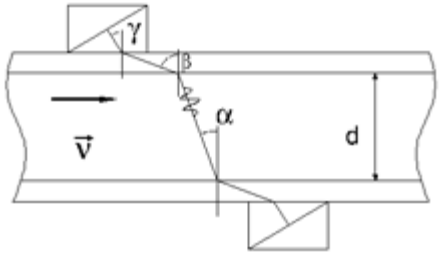
The measurement of flow is based on the principle that sound waves traveling in the direction of flow of the fluid require less time than when traveling in the opposite direction. The difference in transit times of the ultrasonic signals is an indication for the flow rate of the fluid. Since ultrasonic signals can also penetrate solid materials, the transducers can be mounted onto the outside of the pipe. Fast digital signal processors and sophisticated signal analysis guarantee reliable measuring results even under difficult conditions where previously ultrasonic flowmeters had failed.

Transit-time principle

Transit-time flowmeters utilize two transducers, which function as both ultrasonic transmitters and receivers. The transducers are clamped to the outside of a closed pipe at a specific distance from each other. This distance is calculated by the flowmeter after all pipe and medium parameters have been entered into the instrument.

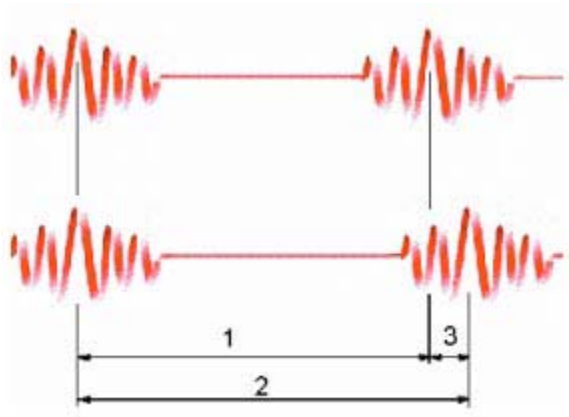


Reflection Mode



Diagonal Mode

The transducers can be mounted in reflection or in diagonal mode. This selection is based on pipe and liquid characteristics.



The flowmeter operates by alternatively transmitting and receiving ultrasonic signal pulses between the two transducers. The ultrasonic signals are first transmitted in the direction of the fluid (1) and then against fluid flow (2). Since sound energy in a moving liquid is carried faster when it travels in the direction of flow than against it, a time difference (3) between the signals' time-of-flight will occur. If the fluid is not moving, the time difference is zero and the flowmeter will indicate zero flow. The transit-time (or time-of-flight) of the signals is accurately measured in both flow directions and the difference in time calculated. The time difference of the ultrasonic signals is proportional to the flow velocity in the pipe. The measured flow velocity is multiplied with the cross-sectional area of the pipe; hence the flow rate of the fluid can be calculated. Using the transit-time technique, accuracies of 1 % of measured value can be achieved without process calibration.

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Doppler - NoiseTrek™ principle

For cases, where the liquid is not sonically conductive, i.e. for liquids with a very high solid or gaseous content (> 10 % of volume), a secondary measuring principle, called Doppler - NoiseTrek™, similar to the Doppler principle is incorporated into clamp-on ultrasonic flowmeters.

The Doppler - NoiseTrek™ mode actually relies on particles or gas bubbles flowing with the liquid in order to give a flow rate reading.

Ultrasonic pulses are transmitted into the fluid causing a frequency shift in the received signal. The amount of frequency shift, which is evaluated, is proportional to flow velocity.

No special transducers are required for the clamp-on ultrasonic flowmeters to operate in Doppler - NoiseTrek™ mode. Both the reflection and diagonal transducer mounting method are suitable. The accuracy of the flowmeter operating in Doppler - NoiseTrek™ mode is less than when working in transit-time mode.