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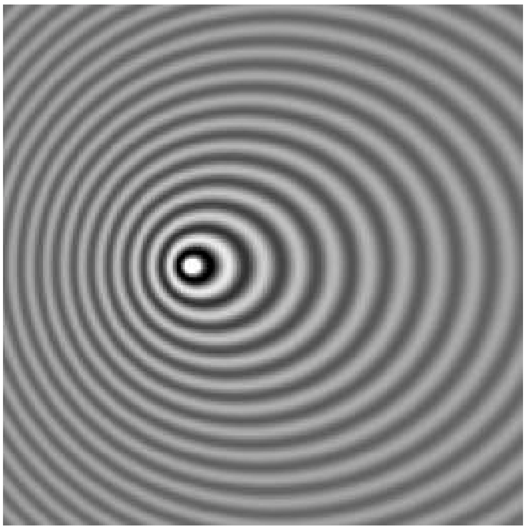
Doppler Flow Measurement



The **Doppler effect**, named after Christian Doppler, is the apparent change in frequency and wavelength of a wave that is perceived by an observer moving relative to the source of the waves. For waves, such as sound waves, that propagate in a wave medium, the velocity of the observer and the source are reckoned relative to the medium in which the waves are transmitted. The total Doppler effect may therefore result from either motion of the source or motion of the observer.

For waves that travel through a medium (sound, ultrasound, etc...) the relationship between observed frequency *f'* and emitted frequency *f* is given by:

$$f' = \left(\frac{v + v_o}{v - v_s}\right) f$$

where
v is the velocity of the waves (340 m/s for sound)
v_o is the velocity of the observer and
v_s is the velocity of the source (the thing emitting the sound)

For sign convention on velocity: a positive value is used if the motion is towards the other, and a negative value if the motion is away from the other

It is important to realize that the frequency of the sounds that the source *emits* does not actually change. To understand what happens, consider the following analogy. Someone throws one ball every second in a man's direction. Assume that balls travel with constant velocity. If the thrower is stationary, the man will receive one ball every second. However, if the thrower is moving towards the man, he will receive balls more frequently because the balls will be less spaced out. The converse is true if the thrower is moving away from the man. So it is actually the *wavelength* which is affected; as a consequence, the perceived frequency is also affected.

If the moving source is emitting waves through a medium with an actual frequency f_0, then an observer stationary relative to the medium detects waves with a frequency *f* given by:

$$f = f_0 \left(\frac{v}{v + v_{s,r}}\right)$$

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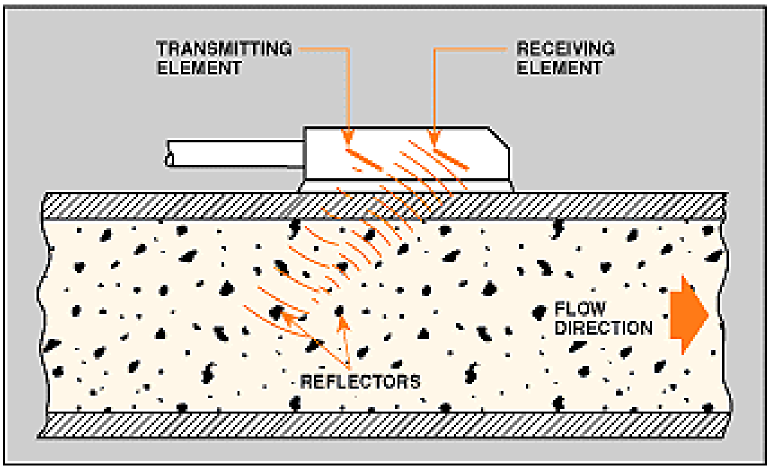
where v is the speed of the waves in the medium and $v_{s,\,r}$ is the speed of the source with respect to the medium (positive if moving away from the observer, negative if moving towards the observer), radial to the observer.

A similar analysis for a moving observer and a stationary source yields the observed frequency (the observer's velocity being represented as v_o):

$$f = f_0 \left(1 - \frac{v_0}{v}\right)$$

where the same convention applies : v_o is positive if the observer is moving away from the source, and negative if the observer is moving towards the source.

Doppler flow meters use sound the pulse reflection principle to measure liquid flow rates. Solids or bubbles in suspension in the liquid reflect the sound back to the receiving transducer with a change in wavelength and an associated shift in frequency proportional to the flow velocity.



Katronic Flow meters can be configured to operate in Doppler - NoiseTrek™ mode. This mode is particularly suitable for fluids with a high solid or gaseous content and relies on solid particles or gas bubbles to give a flow rate reading.

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

The meter will require reconfiguration to operate in this mode, but this can be done by the user without moving any other associated equipment.

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