# DOPPLER ULTRASONIC FLOW METERS

## Operating Principle

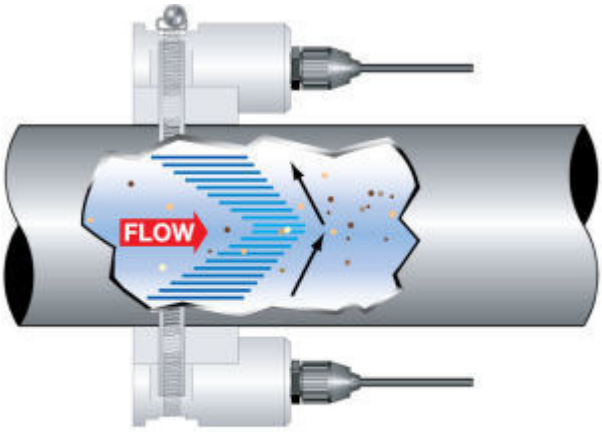


Figure 1

Each Doppler flow meter utilizes two piezoelectric crystals contained within either two separate transducer heads (Figure 1), one transducer head (Figure 2) or the probe tip of the insertion model. Sound is transmitted from one of the crystals, reflected by useful sonic reflectors suspended within the liquid and recorded by the receiving transducer. If the reflectors are moving within the sound transmission path, sound waves will be reflected at a frequency shifted (Doppler shift) from the transmitted frequency. The difference between the reflected frequencies and transmitted frequencies is directly proportional to the speed of the sonic reflectors, resulting in a liquid flow rate that is converted to various user defined measuring units.

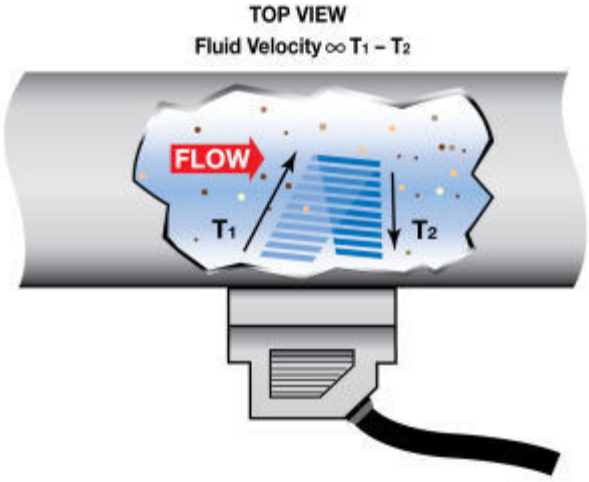


Figure 2

Successful application of Doppler ultrasonic flow meters relies on three physical constraints:

1. **The liquid flowing within the pipe must contain 100 ppm of useful sonic suspended reflectors** - dissolved solids do not generate reflections and are not relevant.
   - The speed of sound of the reflector must vary by greater than 10% from that of the liquid carrier.
   - Particles must be large enough to cause longitudinal reflection. Particles greater than 35 micron size meet this criteria.
   - In typical applications, there is often a distribution of particle sizes. If the volume of particles greater than 100 microns is 25% of the overall particle volume, then the reflectors are adequate for a Doppler ultrasonic flow meter.
   - The reflecting material must travel at the same velocity as the fluid for good accuracy.

Upward flowing pipes running at low velocities may not carry heavier reflectors at the same velocity as the carrying liquid - leading to inaccurate flow measurements.

2. **A significant portion of the ultrasound energy generated by the transducer must reach the sonic reflectors.** In the case of a clamp-on transducer, the ultrasonic transducer must be acoustically coupled to the outside of a pipe (using grease or RTV couplant) and the pipe must permit ultrasound to pass without significant attenuation. Most pipes constructed of solid, homogenous materials meet this qualification. Pipes that cause application difficulty include concrete pressure pipes, wooden stave pipes, Teflon-lined pipes and fiberglass reinforced pipes. Pipes that do not readily pass ultrasound are candidates for the DP7 insertion probe transducer.
3. **The pipe must be completely filled with liquid when measurements are made.** The DFX microprocessor assumes that the pipe is completely full when it calculates flow rate. Use on partially-filled pipes may result in inaccurate readings.