Doppler Applications Guide

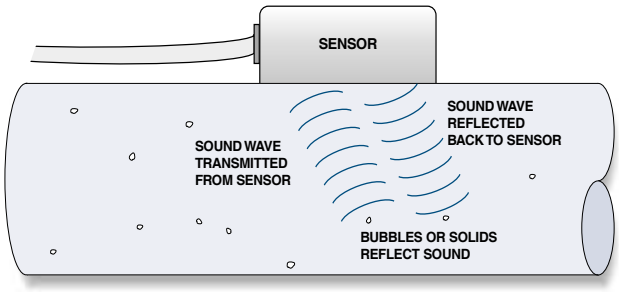
DFM-IV Doppler Flow Meter • PDFM-IV Portable Flow Meter • DFS-II Flow Switch

Greyline's Doppler flow instruments offer important advantages:

- No contact with the measured liquid
- No obstruction to flow - No pressure drop
- Sensor mounts easily on the outside of a pipe
- Can be installed while the pipeline is in use
- Insensitive to pressure, specific gravity and conductivity
- Do not require pipe metering sections
- Do not require consideration of material compatibility with the liquid

INTRODUCTION

DFM ultrasonic, clamp-on flow meters measure flow velocity by detecting the change of frequency of ultrasonic echos returned to the sensor.



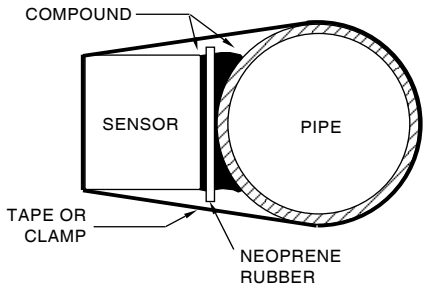
The advanced DFM sensor contains two piezoelectric crystals in a stainless steel housing. One crystal transmits ultrasonic pulses at a precise frequency which are reflected back to the receive crystal from gases or solids in the liquid. Because the fluid is in motion the returned echo arrives back at the sensor at an altered frequency (called the Doppler effect). The instrument's electronics monitor and convert this frequency change into velocity flow readings.

Greyline's Doppler sensors withstand accidental submersion in liquids (to 10 psi). Electronics enclosure size and construction varies depending on the model or options which are selected. Refer to specific literature for the instrument which you are considering. Greyline flow meters are rated to maximum flow velocity of 40 ft/sec (12.2 m/sec).

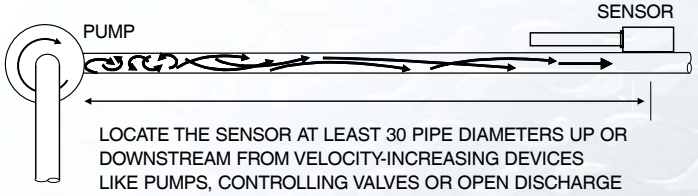
APPLICATIONS BACKGROUND

LIQUIDS CONTAIN SOLIDS AND GASES - Flow of most liquids can be measured with a Doppler instrument. Successful applications range from water to ore slurries. The measured liquid must contain solids or gas bubbles in concentration of 75 ppm or greater with a minimum size of 100 microns, and flow at a velocity greater than 0.25 ft/sec (0.08 m/sec).

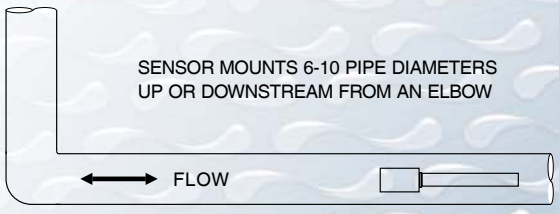
SENSOR COUPLING - The transducer can be attached semi-permanently to the pipe with silicone coupling compound. A coupling compound kit and stainless steel clamp is supplied with each Greyline instrument.



SENSOR POSITIONING - The sensor must be mounted away from velocity increasing devices such as pumps, controlling valves, orifice plates, venturis, or pipe inlets and discharges. These devices cause release of gas bubbles in the fluid and readings nearby will indicate higher velocity. Normally flow will be evenly distributed 30 to 40 pipe diameters away from the velocity increasing device. Determine an appropriate up or downstream sensor mounting location by onsite experimentation.



Elbows, flanged connections and tees introduce desirable conditions of an evenly distributed flow profile with some air or gases entrained in the flow. Sensor mounting 6 to 10 pipe diameters up or downstream from these disturbances is generally optimum.



PIPE MATERIAL - Sound conductivity varies according to the density of the pipe wall material. Porous materials such as concrete or wood cause sound attenuation and Doppler performance may be erratic. Steel, PVC, cast iron, copper, aluminum, fiberglass and other plastic and metal pipes are generally ideal, with minimal sound attenuation.

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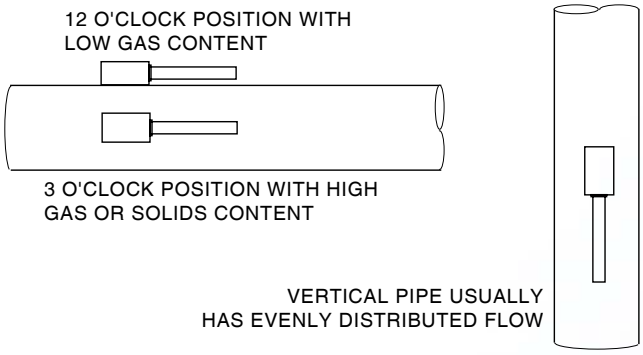
Applications Guide for Doppler Flow Measurement and Control from Outside a Pipe

Avoid pipes with loose insertion liners where sound transmission may be broken by air gaps. Sound refraction may occur with some liner materials such as cement or coal tar as the Doppler signal travels through different densities of the liner and the pipe wall. The resulting error will be constant and can normally be corrected by calibration adjustment in situ.

EFFECTS OF PIPE DIAMETER AND FLOW PROFILE - Greyline Doppler sensors are designed to mount on pipes ½ inch (12.5mm) diameter or larger.

Accuracy of the instrument may be affected by the flow profile. In liquids with a high concentration of solids the Doppler signal may not penetrate very deeply into the flow stream before being reflected back to the sensor. Because fluids tend to move more slowly at the pipe wall than in the center, accuracy may be reduced, particularly if measured on a long horizontal pipe run. For best performance locate the sensor 6 to 10 diameters downstream from an elbow where the flow is evenly distributed.

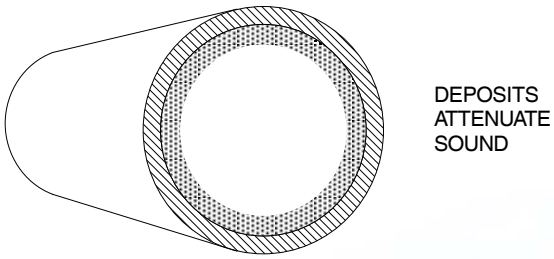
VERTICAL OR HORIZONTAL PIPE - Vertical pipe runs are recommended for sensor installation. They generally provide evenly distributed flow conditions. On horizontal pipes the sensor should be mounted at the 3 or 9 o'clock position to avoid concentrations of gas at the top of the pipe and solids at the bottom. Where minimal gas bubbles are present, the sensor should be mounted at the 12 o'clock position on horizontal pipes.



FLOW VELOCITY - Doppler accuracy and signal strength is reduced at very slow velocities (1.0 ft/sec, 0.3 m/sec or less). Engineers usually design piping systems for velocity in the 2-10 ft/sec (0.6 -3 m/sec) range which is ideal for Doppler instruments.

FLUID TEMPERATURE - Within the sensor's rated tolerances of -40 to 200°F, -40 to 93°C (or optional high temperature models: -40 to 302°F, -40 to 150°C) accuracy will not be affected more than 0.3%. Higher or lower temperatures may damage the sensor.

DEPOSITS - Scale or sediment deposits reduce the pipe cross-section resulting in high flow volume readings. Deposits can also cause sound attenuation and reduce Doppler signal strength.



NOISE INTERFERENCE - Greyline Doppler flow meters are designed to lock on to the strong Doppler return signal and to ignore most broadband noise. Using the built-in signal strength indication you can adjust the instrument's Sensitivity to help lock out readings from noise in difficult applications.

ELECTRICAL INTERFERENCE - High voltage sources, variable speed drive inverters or DC motors in close proximity to the Doppler sensor, cable or electronics can interfere with the Doppler signal. All cable in and out of the instrument enclosures should be installed in grounded metal conduit.

PIPE VIBRATION - Severe pipe vibration may cause the Doppler to interpret noise caused by the vibration as a Doppler signal. Because the Doppler sensor is in motion on the vibrating pipe, it may detect a frequency shift even if the liquid inside the pipe is not flowing. An onsite test is recommended where pipe vibration is expected.

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