MAGNETIC FLOWMETERS

Flow Reference Section

Viscosity

Viscosity does not directly affect the operation of magnetic flowmeters, but, in highly viscous fluids, the size should be kept as large as possible to avoid excessive pressure drop across the meter.

Temperature

The liquid's temperature is generally not a problem, providing it remains within the mechanism's operating limits. The only other temperature considerations would be in the case of liquids with low conductivities (below around 3 micromhos per centimeter) which are subject to wide temperature excursions. Since most liquids exhibit a positive temperature coefficient of conductivity, the liquid's minimum conductivity must be determined at the lower temperature extreme.

Advantages of the DC Pulse Style

From the principles of operation, it can be seen that a magnetic flowmeter relies on the voltage generated by the flow of a conductive liquid through its magnetic field for a direct indication of the velocity of the liquid or slurry being metered. The integrity of this low-level voltage signal (typically measured in hundreds of microvolts) must be preserved so as to maintain the high accuracy specification of magnetic flowmeters in industrial environments. The superiority of the dc pulse over the traditional ac magnetic meters in preserving signal integrity can be demonstrated as follows:

Quadrature

Some magnetic flowmeters employ alternating current to excite the magnetic field coils which generate the magnetic field of the flowmeter (ac magnetic flowmeters). As a result, the direction of the magnetic field alternates at line frequency, *i.e.*, 50 to 60 times per second. If a loop of conductive wire is located in a magnetic field, a voltage will be generated in that loop of wire. From physics, we can determine that this voltage is 90° out of phase with respect to the primary magnetic field. The magnitude of this error signal is a function of the number of turns in the loop, and the change in magnetic flux per unit time. In a magnetic flowmeter, the electrode wires and the path through the conductive liquid between the electrodes represent a single turn loop. The flow-dependent voltage is in phase with the changing magnetic field; however, flow-independent voltage is also generated, which is 90°out of phase with the changing magnetic field.

The flow-independent voltage is therefore an error voltage which is 90° out of phase with the desired signal. This error voltage is often referred to as quadrature. In order to minimize the amount of quadrature generated, the electrode wires must be arranged so that they are parallel with the lines of flux of the magnetic field.

In ac field magmeters, because the magnetic field alternates continuously at line frequency, quadrature is significant. It is necessary to employ phase-sensitive circuitry to detect and reject quadrature.

It is this circuitry which makes the ac magnetic meter highly sensitive to coating on the electrodes. Since coatings cause a phase shift in the voltage signal, phase-sensitive circuitry leads to rejection of the true voltage flow signal, thus leading to error.

Since dc pulse magmeters are not sensitive to phase shift and require no phase-sensitive circuitry, coatings on the electrodes have a very limited effect on flowmeter performance.

Wiring

In ac magnetic flowmeters, the signal generated by flow through the meter is at line frequency. This makes these meters susceptible to noise pickup from any ac lines. Therefore, complicated wiring systems are typically required to isolate the ac flowmeter signal lines from both its own and from any other nearby power lines, in order to preserve signal integrity.

In comparison, dc pulse magmeters have a pulse frequency much lower (typically 5 to 10% of ac line frequency) than ac meters. This lower frequency eliminates noise pickup from nearby ac lines, allowing power and signal lines to be run in the same conduit and thus simplifying wiring. Wiring is further simplified by the use of integral signal conditioners to provide voltage and current outputs. No separate wiring to the signal conditioners is required.

Power

By design, ac magnetic flowmeters typically have high power requirements, owing to the fact that the magnetic field is constantly being powered. Because of the pulsed nature of the dc pulse magmeter, power is supplied intermittently to the magnetic field coil. This greatly reduces both power requirements and heating of the electronic circuitry, extending the life of the instrument.

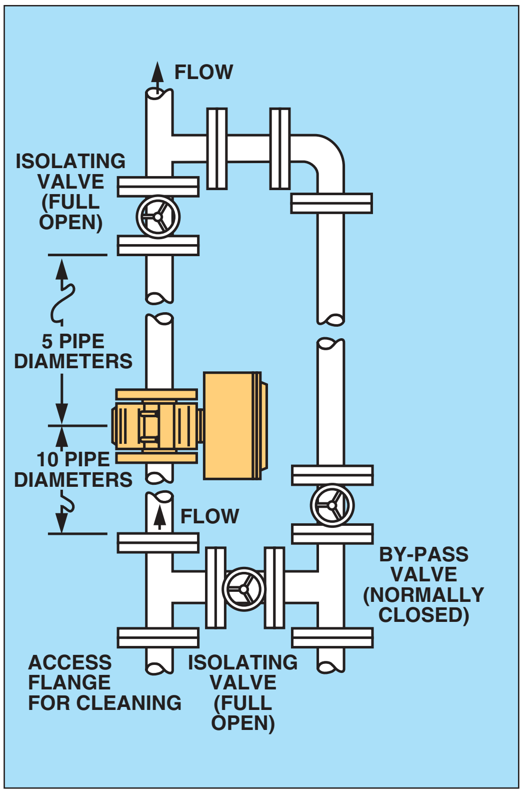

Figure 3: Vertical installation of inline meter

Auto-Zero

In traditional ac magnetic flowmeters, it is necessary after installation of the meter to "null" or "zero" the unit. This is accomplished by manual adjustment which requires that the flowmeter be filled with process liquid in a no-flow condition. Any signal present under full pipe, no-flow conditions is considered to be an error signal. The ac field magmeter is therefore "nulled" to eliminate the impact of these error signals.

In the case of FMG-700 Series Magmeters, automatic zeroing circuitry has been included to eliminate the need for manual zeroing. When the magnetic field strength is zero between pulses, the voltage output from the electrodes is measured. If any voltage is measured during this period, it is considered extraneous noise in the system and is subtracted from the signal voltage generated when the magnetic field is on. This feature insures high accuracy, even in electrically noisy industrial environments.

Installation

Magnetic flowmeters are designed for easy installation. FMG-700 Series Magmeters are ideal substitutes for the flanged spool type meter, which are heavier and significantly more expensive. The thin wafer style of the FMG-700 Series allows them to be slipped between standard flanges, without the need to cut away pipe to make room for the meter. Furthermore, the low weight of the meter means that, in many cases, no additional pipe supports are required after meter installation. Recommended piping configurations include the installation of by-pass piping, cleanout tees and isolation valves around the flowmeter

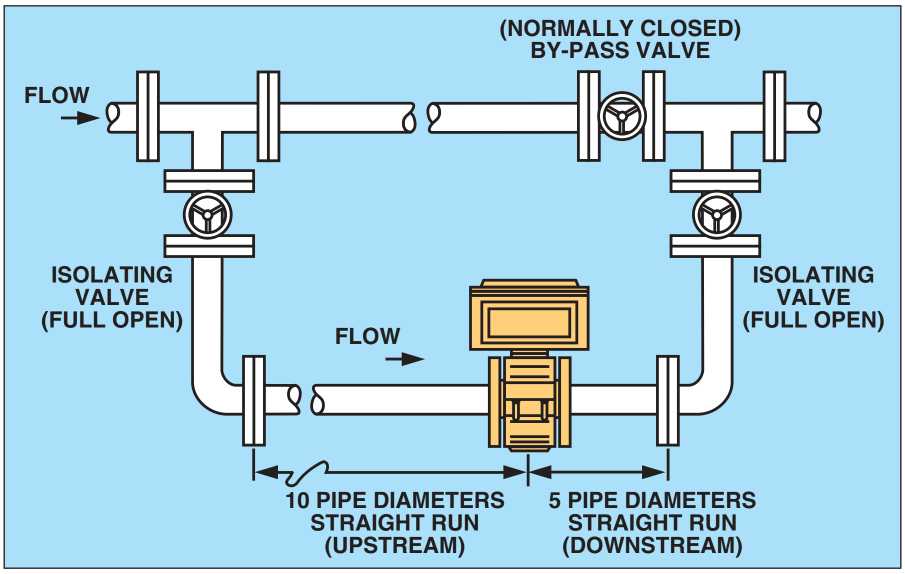

Figure 4: Horizontal installation of in-line meter

(Figures 3 and 4).

With insertion-style magmeters, even greater reductions in weight and cost have been achieved. Installation is accomplished by threading the piping system into the tee fitting supplied with the meter, or by drilling a tap into the line to accept the fitting that comes with the meter.

Prior to installation of the meter, the following recommendations and items of general information should be considered.

First, before installing a magmeter, it is important to consider location. Stray electromagnetic or electrostatic fields of high intensity may cause disturbances in normal operation. For this reason, it is desirable to locate the meter away from large electric motors, transformers, communications equipment, etc., whenever possible.

Second, for proper and accurate operation, it is necessary that the flowmeter be installed so that the pipe will be full of the process liquid under all operating conditions. When the meter is only partially filled, even though the electrodes are covered, an inaccurate measurement will result.

Third, for magnetic flowmeters, grounding is required to eliminate stray current and voltage which may be transmitted through the piping system, through the process liquid, or can arise by induction from electromagnetic fields in the same area as the magmeter. Grounding is achieved by connecting the piping system and the flowmeter to a proper earth ground system. Unfortunately, this is not always done properly, resulting in unsatisfactory meter performance. In conductive piping systems, a "third wire" safety ground to the power supply and a conductive path between the meter and the piping flanges are typically all that is required. In non-conductive or lined piping systems, a protective grounding orifice must be supplied to provide access to the potential of the liquid being metered. Dedicated or sophisticated grounding systems are not normally required. Detailed information concerning proper flowmeter grounding is provided with the owner's manual that comes with each flowmeter.

Finally, the position of the flowtube in relation to other devices in the system is also important in assuring system accuracy. Tees, elbows, valves, etc., should be placed at least 10 upstream and 5 downstream pipe diameters away from the meter to minimize any obstructions or flow disturbances.