Fluidic Flowmeters

Oscillatory Flowmeters

Oscillatory flowmeters utilize specially designed geometric shapes to create an environment where self-induced, sustained oscillations will occur. Oscillating flowmeters are inherently digital devices, that is, the basic measurement they read is a frequency. In a properly executed flowmeter, the frequency of its oscillations is proportional to volumetric flow rate. There are several categories of oscillatory flowmeters, each with a unique shape.

Volumetric Flow Rate vs. Frequency

For any point in the operating region of the flowmeter, the frequency of oscillation will be related to the volumetric flow rate by the following equation:

$$F = KQ$$

where
- F is the frequency of oscillation
- K is the calibration factor of the meter
- Q is the volumetric flow rate

K Factor

It has been found that the K factor of oscillatory meters varies with Reynolds number. Because of this, it is convenient to plot the K factor versus the Reynolds number. If the meter was perfect, it would have a constant K factor at the Reynolds numbers, but this is not the case. All oscillatory meters exhibit a K factor curve that looks similar to Figure 1.

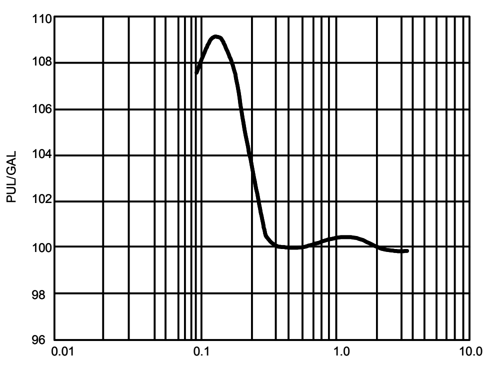

Figure 1 K Factor vs. Reynolds Number

How well the actual meter performs is a function of the design of the meter as well as the influence of the fluid flowing through it. There is a region on the curve where the K factor is essentially constant. This is the normal operating region for oscillating flowmeters. In this region the accuracy is good enough to be stated as a percent of instantaneous flow rate.

Model 140MX Fluidic Flowmeter

Momentum Exchange Flowmeters

Momentum Exchange flowmeters are based on the fluid phenomenon of momentum exchange. The momentum exchange flowmeter is similar to the Coanda flowmeter, but differs in the mechanism used to produce oscillations.

The geometric design of the momentum exchange meter body produces a continuous, self-induced oscillation at a frequency that is linearly proportional to volumetric flow rate.

The fluid oscillations are developed by the fluidic phenomenon of Momentum Exchange (MX). The geometric shape of the meter body creates a main flow of fluid which passes through the nozzle, and is directed toward one side of the meter body or the other. The force of the jet of fluid will create a flow pulse in a feedback passage. This flow pulse will travel through the feedback passage and exert a force on the main jet. The momentum of the feedback fluid will deflect the main flow in such a manner that it will exert a force on the fluid in the other feedback passage, while the feedback action is repeated and results in a sustained oscillation. The sensor located in the feedback passage detects the fluid pulses, and the sensor signal is conditioned by a signal conditioner. Figure 2 shows the cross-section of a momentum exchange flowmeter.

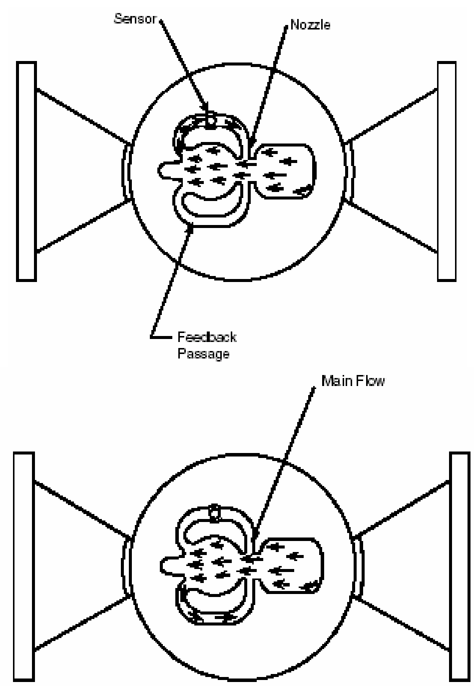

Figure 2 Cross-section of a Momentum Exchange Flowmeter

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Model 141 Fluidic Flowmeter

Coanda Flowmeters

Coanda flowmeters are based on a phenomenon first observed in 1910 by Henri Coanda. Later in 1932, Coanda did further research and quantitized the phenomenon. Coanda discovered that as a free jet emerges from a nozzle or a conduit, it will tend to follow a nearby surface and will, in fact, attach to it.

The attachment to a surface is a result of a low pressure region that develops between the free stream and the wall. As the free stream moves pas the wall, some of the fluid in that region will be entrained by the main stream. This causes the pressure in the region to decrease. As a result, the pressure in that region will begin to decrease. Because of this pressure differential, the free stream begins to deflect towards the wall. As more fluid is carried along with the main stream, the jets divert more and more to the wall unit it attaches to it.

The geometric shape of the Coanda flowmeter produces a continuous, self-induced oscillation at a frequency that is linearly proportional to flow rate. As fluid passes through the meter, it will attach itself to one of the side walls as a result of the Coanda effect. A small portion of the flow is diverted through the feedback passage and travels around to the control port. This feedback flow disrupts the attachment of the main jet to the side wall. The main jet is now free and will attach itself to the other side wall due to the Coanda effect. The feedback action will repeat itself, and in the manner the meter body produces a sustained oscillation. As the main fluid stream oscillates between the two side walls, the flow in the feedback passages cycles between zero and maximum. the cycling of the flow in the feedback passages is detected by a sensor located in one of the feedback passages, while the sensor signal is conditioned by a signal conditioner. Figure 2 shows the cross-section of a Coanda flowmeter.

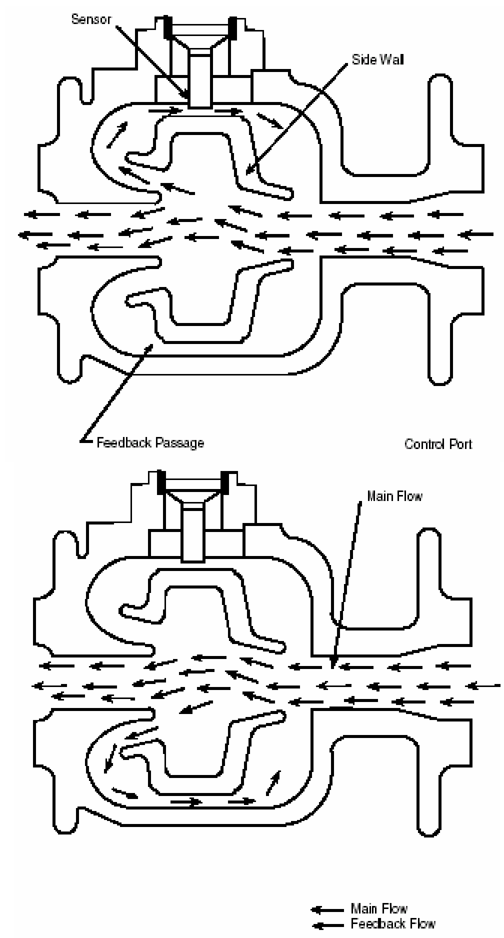

Figure 2 Cross-section of a Coanda Flowmeter