Next Generation Vortex Meters

To understand where vortex flow meter technology is going, it is essential to understand the principle of vortex shedding.

A bluff body submerged in a flowing fluid sheds the boundary layer from its surface and generates alternating whirl vortices in the backward stream called the Von Karman Vortex Street. An example of this is wind blowing across a flagpole, causing the flag to flutter. This is attributed to Von Karman vortices. In the case of a vortex meter, the bluff body is the shedder bar. The frequency of the vortices is directly proportional to the flow velocity, and demonstrated with the following formula:

$$\text{Vortex frequency (f)} = \frac{\text{Strouhal number (St)} \times \text{Flow velocity (v)}}{\text{Vortex shedder width (d)}}$$

Strouhal number is the ratio between the vortex interval and vortex shedder width. Usually, a vortex interval is about six times the vortex shedder width, while the Strouhal number is its reciprocal value equal to 0.17. The Strouhal number remains constant when Reynolds number (Re) is within a certain range. Reynolds number is defined as the relationship between fluid velocity, viscosity and specific gravity, as shown in the following formulas for liquids and gases, illustrating the state of flow:

Equation for liquids

$$\text{Re} = \frac{3160 \times \text{Flow Rate} \times \text{SG}}{\text{Viscosity} \times \text{Pipe ID}}$$

Equation for gas and steam

$$\text{Re} = \frac{6.316\ (\text{Flow Rate})}{\text{Viscosity} \times \text{Pipe ID}}$$

With the Yokogawa Yewflo vortex flow meter, the Strouhal number (St) is constant when Reynolds number (Re) is between 20,000 and 70,000,000. Therefore, as long as Re falls within this range, the vortex shedding frequency is not affected by fluid viscosity, density, temperature or pressure, unlike many other meter technologies.

In addition to being immune to the aforementioned process conditions, Yewflo has a standard accuracy of +-0.8%, repeatability of 0.2%, wide range ability as high as 40:1, no square root extraction, no moving parts, no zero point fluctuation and minimal pressure loss. In the case of the Yokogowa vortex flow meter, the robust nature of Yewflo's shedder bar, with trapezoidal cross section, implies, and has proven over time, long term dimensional stability to the point of achieving a calculated MTBF in excess of 200 years. There are no thin welded diaphragms that could be effected by over pressure, over speed, H_2S permeation or stress corrosion cracking, and there are no ported passages that have the potential for plugging. As a result, in non-corrosive and

Continued on next page

Next Generation Vortex Meters *(cont'd)*

non-abrasive service, the meter's internal geometry, and in turn, the meter's K-factor, can be expected to remain constant for the life of the meter. To verify zero drift, one could obtain the shedder bar width and meter bore diameter at the time of manufacture. The user could remove the meter at any time, and measure these dimensions. If they agree with the measurements made when the meter was originally calibrated, the meter's K-factor should be unchanged and there is no need to proceed with recalibration, thereby eliminating costly meter proving. Industry Canada approval was obtained for meter sizes ranging from 1.0" to 2.0", and pressure ratings to 900 ANSI for natural gas applications.

It is no secret that external noise caused by pipe vibration and hydraulically generated noise from pumps, valves and pipe bends can disturb vortex measurement, and limit the final dynamic range of the flow meter. To further reduce the effects of noise superimposed on the measuring signal, Yokogowa has released their new DIGITAL Yewflo vortex meter. It utilizes advanced processing algorithms known as Spectral Signal Processing (SSP), resulting in accuracies of 0.75%. SSP analyzes the incoming signals and applies an intelligent amplification circuit, based on measured frequency and predicted process conditions. Start up tuning is eliminated even in noisy environments, resulting in reduced maintenance time. Stable, accurate flow measurement is attainable at flow rates well below 20,000 Re. Expanded diagnostic capabilities provide alarms for process anomalies like entrained gas in liquid, and the optional integral RTD makes it capable of providing multi variable outputs, including steam mass flow rate calculated using steam tables and measured temperature with fixed pressure. *(see figure 1)*

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Multi-variable Option - Flow & Temperature

- Built-in temperature sensor
  - Protected in shedder bar
  - +/- 1deg C (liquid, +/- 2 deg C (gas / steam); RTD Pt 1K ohm
- Multi-variable option
  - Flow & temperature values displayed
  - Dual output (flow: pulse, temp: 4-20)
- Steam mass flowrate calculation
  - Mass flowrate calculated using steam table and measured temperature (fixed pressure)
  - +/- 2% of rate accuracy

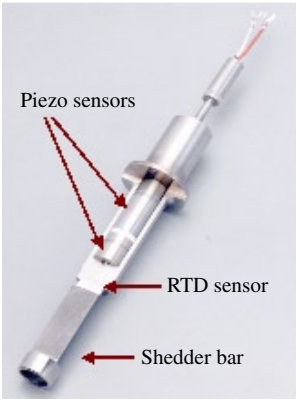

Figure 1