Swirl flowmeter challenges established vortex technology
By Steve Pagano

The swirl flowmeter advances vortex flow technology by improving accuracy, simplifying installation, increasing turndown, and reducing cost of ownership. Over the last 30 years, vortex flowmeters have become standard fixtures for many industrial process applications, especially for measurement of gas and steam flowrates. Swirl meters operate on similar principles, but have certain advantages.

- Swirl meters create their own flow profile within the meter, so they require only three straight pipe diameters upstream and one downstream. Vortex meters typically require a minimum of 15 diameters upstream and five downstream to develop a proper flow profile for accurate measurements. So the swirl flowmeter better fits applications with tight piping requirements.

- When applying vortex meters, the user typically chooses a flowmeter reduced by one or two pipe sizes from the process pipeline size. This ensures that the flowmeter experiences the higher velocities required across the desired flow range, but adds piping reduction and expansion costs. Swirl meters require lower flow velocities for proper operation, and so usually may be sized the same as the process pipe size.

- Swirl meters have a turndown ratio of up to 30:1, while most vortex meters are limited to 20:1 turndown ratios. Additionally swirl meters can perform to viscosities of up to 30 cp while vortex meters are generally limited to 8-10 cp maximum.

- Swirl meters offer a higher degree of accuracy, up to 0.5% better than most vortex meters in gas applications.

For these reasons, swirl flowmeters have been gaining ground on vortex flowmeters and are currently experiencing double-digit growth.

Adding a twist

The swirl meter operates under the same technology as the vortex flowmeter. It takes advantage of vortex shedding principles that occur when a flowing fluid comes up against a bluff obstacle in its path. Additionally, the swirl meter adds a “twist” in conditioning the fluid, which results in the reduced installation considerations mentioned above, while improving performance.

The swirl meter forces incoming fluid through a fixed swirl-inducing element located at the upstream inlet of the meter body. The “swirler” imparts a tangential velocity to the fluid, and then accelerates the flow via a reduction in the meter body bore. The primary fluid rotation caused by the swirler has at its core a low-pressure zone. This low-pressure zone is thrown into a secondary rotation proportional to flow rate. The same piezoelectric sensor as used in ABB’s vortex meters measures the frequency of this phenomenon at the point of maximum fluid velocity.

Figure 1. Swirler imparts a tangential velocity to the fluid and minimizes flow profile requirements.

An increase in the meter’s bore as the fluid approaches the meter outlet decelerates the fluid to its original velocity. A “deswirler” welded to the meter body near the outlet eliminates the tangential velocity imparted to the fluid at the inlet. This avoids affecting operation of other downstream instrumentation.
Digital signal processing

While not unique to vortex or swirl meters, DSP converts the raw signals from the piezo sensor into a usable output without the noise-related interferences usually associated with analog devices. DSP as implemented by ABB allows faster processing, using complex algorithms that outperform conventional signal processing. In addition, ABB employs a six-band filter that separates noise from the true flow signal to a much higher degree than single bandpass filters.

Using this approach, technicians can isolate external noise that may occur under less than desirable conditions. They can make appropriate tuning adjustments within the meter itself. Without this degree of signal processing, false signals could compromise the performance of the flowmeter and overall measurement scheme.

Employing digital electronics also affords advanced control of startup and integration of maintenance functions that required discrete equipment in the past. ABB’s DSP design incorporates two EPROMS to store the meter characteristics, allowing electronics replacement without the necessity of manual reprogramming. An onboard frequency generator allows easy startup and diagnosing of process issues without need for additional test equipment.

Some caveats

While both swirl and vortex shedders offer a wide measurement range, they cannot measure fluid flows down to a true zero. Some minimal fluid velocity must be present to act upon the piezoelectric sensing element. So these meters may not register low levels of fluid movement in the pipeline. For this reason swirl and vortex meters are not readily suitable to batch processing with start and stop flow actions. In some cases continuous flow with a diverter can overcome this consideration.

Both swirl and vortex meters are also susceptible to external interference such as pipe vibration, EMF, and hydraulic noise. Interference occurs if these disturbances are within the frequency range of the meter and of higher amplitude than the flow signal itself. The meter may confuse the disturbance with a flow signal, reporting a false flow rate.

As discussed above, sophisticated digital signal processing can filter elements of these conditions, but the best cure is to treat the root cause of the interference by removing the disturbing influence. So when such disturbances arise, users should check into piping vibration, anchoring, location, and proximity to electrical devices.

Flow measurement with swirl and vortex meters has made quantum leaps in both technology and acceptance in the last eight years. Using a simple law of nature, measurement of steam and gas processes becomes less complicated, while providing a degree of reliability that surpasses the typical DP orifice measurement found in these applications. Building upon the principles underlying vortex meters, the swirl meter extends the performance of these frequency generating flow devices.

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<th>Industry</th>
<th>Applications</th>
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<tbody>
<tr>
<td>Chemical</td>
<td>Acids, solvents, specialty gasses, vinyl chloride, steam</td>
</tr>
<tr>
<td>Petrochemical</td>
<td>Additives, petrol, ethylene, TiO₂, anti-fouling agents, steam</td>
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<tr>
<td>Plant engineering</td>
<td>Compressed air, steam</td>
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<tr>
<td>Food</td>
<td>CO₂, sludge water, steam</td>
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<td>Pulp and paper</td>
<td>Compressed air, steam</td>
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<tr>
<td>Metal</td>
<td>Coolant circuits, air, protection gases,</td>
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<td>Pharmaceutical</td>
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<td>Power plants</td>
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