Swirl versus vortex flowmeter technology

Swirl flowmeter challenges established vortex technology

The swirl flowmeter advances vortex flowmeter 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 flowmeters operate on similar principles, but have certain advantages.

— Swirl flowmeters create their own flow profile within the meter, so they require only three straight pipe diameters upstream and one downstream. Vortex flowmeters 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 flowmeters, 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 flowmeters require lower flow velocities for proper operation, and so usually may be sized the same as the process pipe size.

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

— Swirl flowmeters offer a higher degree of accuracy, up to 0.5 % better than most vortex flowmeters 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 flowmeter 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 flowmeter adds a “twist” in conditioning the fluid, which results in the reduced installation considerations mentioned above, while improving performance.

The swirl flowmeter 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 flowmeters measures the frequency of this phenomenon at the point of maximum fluid velocity.

An increase in the flowmeter’s bore as the fluid approaches the meter outlet decelerates the fluid to its original velocity. A “deswirler” welded to the flowmeter 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 (DSP)

While not unique to vortex or swirl flowmeters, DSP converts the raw signals from the piezoelectric 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.

Complex DSP algorithms and six-band filter separate the true flow signal from noisy interferences affecting the piezoelectric sensor.

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 flowmeters 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 flowmeters 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 flowmeters has made quantum leaps in both technology and acceptance in the last 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 flowmeters, the swirl flowmeter extends the performance of these frequency generating flow devices.

### Typical applications of swirl and vortex flowmeters

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<tr>
<th>Industry</th>
<th>Applications</th>
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<tbody>
<tr>
<td>Chemical</td>
<td>Acids, solvents, specialty gases, vinyl chloride, steam</td>
</tr>
<tr>
<td>Petrochemical</td>
<td>Additives, petrol, ethylene, TiO₂, anti-fouling agents, steam</td>
</tr>
<tr>
<td>Plant engineering</td>
<td>Compressed air, steam</td>
</tr>
<tr>
<td>Food</td>
<td>CO₂, sludge water, steam</td>
</tr>
<tr>
<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>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>Deionized water</td>
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<tr>
<td>Power plants</td>
<td>Steam, condensate, natural gas</td>
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