Measurement and control of the lowest liquid flow quantities

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To optimise measurement and control accuracy for low liquid volumes, Coriolis sensors are often the prime technology choice. Providing a true mass flow reading with accuracy down to ±0.2%, these devices are also highly repeatable. Coriolis technology is suited to applications that must ensure precise flow control, whether to meet quality requirements in food & beverage products or maximise efficacy of a medicine. However, high accuracy over low liquid volumes can also save costs long term when expensive media is involved.

Troy Stehr, Industry Account Manager – Lab & Medtech at Bürkert, explores the technology behind Coriolis mass flow meters and controllers.

When you next enjoy a packet of potato crisps, you almost certainly won't notice a difference in flavour from one crisp to the next. This is thanks to the highly accurate dosing of relatively low volumes of strong yet concentrated flavouring, and the consistency in taste is an essential aspect of ensuring consumer quality.

Accurate control of low volume liquid dosing is also vital to ensure the safety and potency of food additives, such as thiamine (vitamin B1) and vitamin D in fortified breakfast cereals. This also applies to pharmaceutical products, and to ensure optimal drug effectiveness while preventing overdosing, in medicines ranging from liquid capsules to vaccine injections, here too, exacting accuracy is imperative.

Before such products reach their end users, they will typically undergo controls. If inaccurate dosing is identified, down to the smallest possible volume, this could impact an entire production batch. When expensive media is involved, the investment in technology to prevent this situation becomes essential.

Coriolis effect

To achieve high accuracy fluid control and metering for applications like these, the original theory came from the nineteenth century Parisien mathematician and scientist, Gaspard-Gustave de Coriolis. He discovered an effect that relates to an inertial force acting on objects in motion within a rotating system. In the field of liquid and gas flow, Coriolis control and metering devices involve a suspended, S-shaped measuring tube, set in high-frequency magnetic vibration by an exciter coil.

When a liquid flows through the tube, the liquid's inertia acts on the tube's vibration, causing what's known as a phase shift. This vibrational change is directly proportional to the mass flow of the liquid, and is measured by two sensors, positioned at each end of the tube. The higher the flow rate, the greater the oscillation deflections of the measuring tube.

This process can also provide a density reading of the flowing liquid by measuring the vibration frequency, instead of the oscillation deflections. The higher the density, the lower the frequency. In fact, with a Coriolis-based device, it's possible to simultaneously measure mass flow, volumetric flow, density and temperature.

High accuracy

In recent years, technology has allowed the Coriolis principle to be used for increasingly lower flow rates, enabling dosing of the smallest volume of liquids, precisely, quickly, and repeatably. Bürkert's Type 8756 mass flow meter/controller,

based on the Coriolis effect, has a flow rate accuracy reading as low as ±0.2%. This is achieved with a repeat accuracy deviation of just ±0.1% for a flow rate up to 25 kg/h, or ±0.05% repeatability for a flow rate up to 120 kg/h.

Crucially, this reading is based on true mass flow, independent from the impact of the media, pressure, or temperature. Compared to other mass flow meter technologies, this means much higher accuracy. A thermal mass flow meter, for example, is accurate to around ±1%, and also requires recalibration for every new fluid type introduced. However, this type of mass flow meter takes a volumetric reading that is then corrected to mass, a device based on the Coriolis effect measures mass flow directly in milligrams, grams, and kilograms.

Maximising productivity

The Type 8756 can also be supplied with an integrated batch controller, providing extremely fast measurement and control for fast dosing, which increases productivity. With a dosing range as low as 0.05g…100g, a dosing time of 0.05s…7s can be achieved. Productivity is also enhanced through a digital connection, meaning that dosing processes are reproducible. This digital approach means that all ingredients and quantities can be recorded and documented, which is advantageous to save time in set up, as well as for conformance purposes.

To develop a highly accurate and productive system, where there is an external pressure source, Bürkert combines the Type 8756 Coriolis flow sensor with a matched control valve suited to the process specification. This could range from a proportional valve for continuous pulsation free flow delivery, through to a Lorentz actuator valve for extremely fast dosing applications.

When an external pressure source isn’t available, Bürkert combines the Coriolis flow sensor with a gear pump. Pump speed is controlled by the Coriolis device itself to

generate the precise pressure required for the desired flow rate. The fine teeth of the gear pump give continuous and extremely smooth flow delivery. To achieve modular mass flow control, it's also possible to combine the Coriolis mass flow meter/controller with wider pump technologies, like peristaltic pumps, syringe pumps, or motor speed controllers.

Low total cost of ownership

While Coriolis technology is often the first choice for applications that demand optimum accuracy, even for applications where the stakes for the process outcome aren't as high, investing in Coriolis technology can be advantageous to reduce costs long term.

For example, municipal water companies often insert a small quantity of orthophosphoric acid into sections of the water supply network that involve lead piping, in order to prevent water contamination. Control accuracy down to 0.2% is not required for this process itself, but because of the high cost of orthophosphoric acid, minimising the quantity used can save significant costs over time. Coriolis technology can also be used in measurement for cost-saving purposes to ensure suppliers deliver agreed volumes and concentrations of liquid media.

Even if accuracy still isn't a concern for a low volume liquid control and metering application, Bürkert can provide a broad choice of other technologies. Alternatively, for applications that require even greater accuracy for smaller doses than Coriolis devices can provide, the new µLDC technology is the next step.

Watch our latest video with a demonstration of our new Mass flow controller Type 8756 and its highly precise control and measurement of liquids here

Image captions:

Image 1: Bürkert's Type 8756 mass flow meter/controller, based on the Coriolis effect, has a flow rate accuracy reading as low as ±0.2%. This is achieved with a repeat accuracy deviation of just ±0.1% for a flow rate up to 25 kg/h, or ±0.05% repeatability for a flow rate up to 120 kg/h.

About Bürkert

Bürkert Fluid Control Systems is one of the leading manufacturers of control and measuring systems for fluids and gases. The products have a wide variety of applications and are used by breweries and laboratories as well as in medical engineering and space technology. The company employs over 2,200 people and has a comprehensive network of branches in 35 countries world-wide.

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