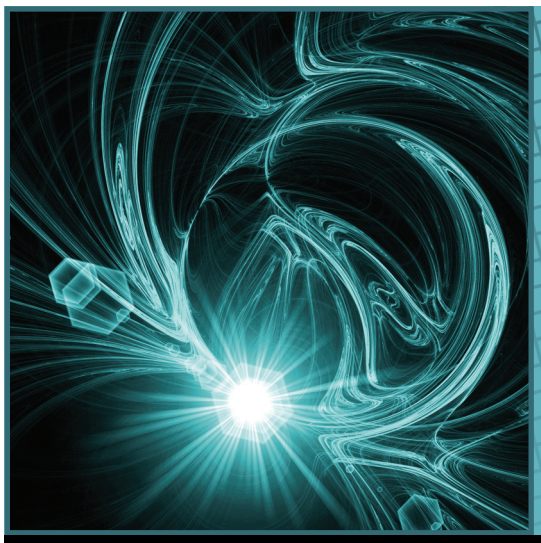


Low and Ultra-Low Mass Flow Metering and Control

David Bowers MInstMC, Coriolis Product Manager, Bronkhorst UK
1 Kings Court, Willie Snaith Road, Newmarket CB8 7TG
Tel: 01223 833222 • Web: www.bronkhorst.co.uk

Hazardous Area, IECEx and ATEX approval II 2 G Ex d e IIB T6 (Zone 1), Coriolis meter offers gas and liquid flow rate measurement from milligrams per hour together with single-point responsibility for flow control utilising on-board PID control and batching software via close-coupled valve and/or directly controlled pump.

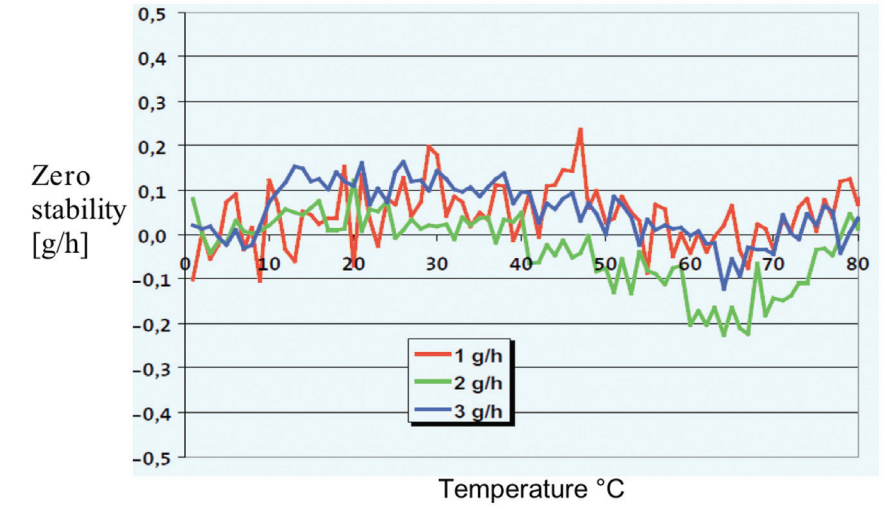
Numerous applications include batching, dosing, continuous feed, master/slave and blending across the Oil and Gas, Chemical, Pharmaceutical, Power, Paint Spraying and Bio-waste industries.

In the past Coriolis Mass Flow technology has been described as the near-perfect measurement technique, however, with physical constraints limiting zero stability there has for many years been a low flow cut-off below which any flow simply has not been measured or controlled. In simple terms, current Coriolis flow tubes designed for kilograms per hour ranges will inevitably struggle to overcome the inherent mass of the tube and attached actuator together with the further inaccuracies added by the frequency-shift sensing device. These issues can create a zero-point instability error zone that at worst masks ultra-low flow and at best creates unacceptable error at low flow. Of course when measuring 2000 kilograms per hour this is of little consequence but when needing to measure grams per hour it can be critical. Rather than measuring down from relatively higher flows Bronkhorst has turned the dilemma upside down and designed an instrument to measure upwards from ultra-low flows based on an extremely stable zero point. The Bronkhorst Coriolis instrument has a new patented sensor that utilises optical technology to enhance the signal caused due to the Coriolis forces. This allows for a full scale range as low as one gram per hour whilst range-ability of that same instrument, due to the 2000:1 turn-down, allows that same full scale range to be extended into kilograms per hour. The product series as a whole also has top end ranges into the thousands of kilograms per hour.

Having focused on low end Mass flow measurement Bronkhorst then added a whole series of additional features that come as standard. Principal amongst these is the on-board integrated PID that completes the loop with a direct controlled valve or indeed a directly controlled pump. This capability ensures very fast response times to step changes and, with further additional features of the cutting-edge software, allows the user to define the exact response required for any given application. Furthermore, integrated alarms, a totaliser, batching/dosing control, temperature and density outputs allows multiple parameters to be pulled together into one discrete package.

The instrument has been designed for bi-directional flow measurement and communication signals that include analogue, RS-232 and optional RS-485 field-bus protocols such as Profibus-DP, DeviceNet, MODBUS, and FLOW-BUS. Finally, an important consideration for the oil, additive and analytical industries is that the sensor and block can be temperature controlled to avoid such consequences as waxing, solidification, condensation or constituent drop-out.

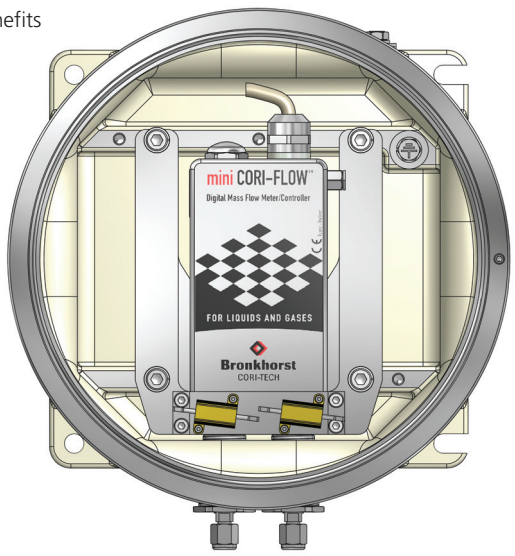
Application Example – ATEX Zone 1 Oilfield Chemical Dosing. The Bronkhorst solution provides a complete "plug and play" mass flow meter-controlled dosing system, directly driving a precision pump, that regulates an exact amount of oilfield chemical (such as demulsifier, corrosion/wax/scale inhibitors, biocides, etc) with programmable step changes and alarm functions for high and low dosing conditions e.g. the response alarm can automatically stop the pump unit if the supply is being starved by an upstream blockage or if the feed tank has run dry. In the gas industry, Bronkhorst instruments have been employed for the dosing of reagents, inhibitors, methanol and glycol, the injection of odours into gas streams and the highly accurate addition of tracer gases for leak detection purposes.



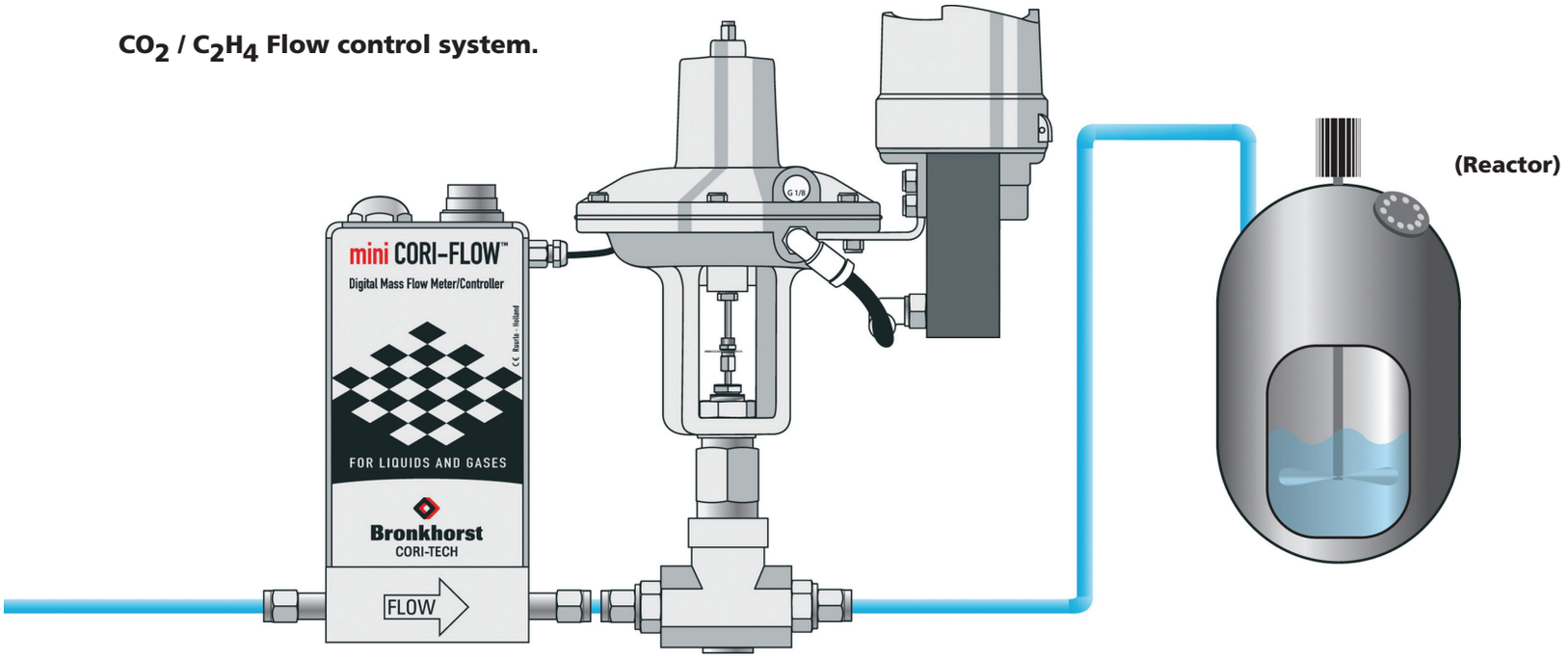
Zero stability and reproducibility of mini CORI-FLOW model M13

Application Example – ATEX Zone 1 Pharmaceutical Tablet Coating. Various segments of the pharmaceutical industry require varying pump technique solutions. In some instances the benefits of non-invasive technology such as peristaltic pumps are vital and Bronkhorst has a wealth of experience of extending the boundaries for what is achievable with such devices. In other cases, the requirements of the process require differing pump characteristics and here too Bronkhorst has the benefit of many years of experience with a broad range of complimentary manufacturers. This experience, and a close co-operation on research, allowed a tablet coating process on mainland Europe to be optimised to such an extent that the return on investment could be seen within weeks. Over-dosing was eliminated, wastage was significantly reduced and set-up time between batches also reduced. In addition, data logging of multiple parameters from the system fulfilled the needs of ever more stringent regulation.

Application Example – ATEX Zone 1 Chemical Industry Batch to Continuous Flow. The economics of converting manufacturing techniques from a high flow batch process to a low flow continuous process have been well documented elsewhere, however, the principal benefits are seen to be reduced inventory, tighter quality control, greater sustainability, shorter production cycles and improved containment. Clearly, the low flow capability of Bronkhorst Coriolis Instruments fits perfectly into this initiative especially when enhanced control functions are required. Furthermore, it has been found that the transition from extremely low flows – often used to prove the chemistry or concept – to the low to medium flow rates eventually required by the production process can be realised using the same flow control instrumentation.



CO_2 / C_2H_4 Flow control system.



Mini CORI-FLOW™ with pressure actuated control valve

Application Example – Supercritical Gas Measurement and Control. Fluids like carbon dioxide (CO_2) and ethylene (C_2H_4) are difficult to measure when they move towards the inter-phase stage between being a liquid and a gas. For example, for CO_2 this occurs at temperatures greater then 20 degrees Celsius and pressures higher than 30 bar a. Under these conditions physical properties like density (ρ) and heat capacity (Cp) change very rapidly as a result of pressure or temperature variations. This makes an accurate flow measurement based on volumetric principle, very difficult. Bronkhorst Coriolis technology offers a solution due to the true mass flow measurement, independent of the physical properties of the fluid. The true mass flow of the molecules is measured, regardless of whether the fluid is in the gas phase, in liquid phase or somewhere in between. Experience in the field has proven that this principle of measuring is very accurate and reliable. For control applications Bronkhorst can offer a Coriolis Mass flow Controller in combination with a metal sealed control valve.

Application Example – Bronkhorst works in close collaboration with it's' customers and often acts as a technology partner to improve, enhance and sometimes radically overhaul processes and systems. Current interesting developments include deriving entrained powder mass flow by measuring total mass and subtracting the mass of the carrier gas and also the synchronous dosing of solvent based fragrances for the perfume industry. The latter is actually very interesting as the driver for the project is primarily the Health & Safety within the working environment of the employees as the use of open topped vessels mounted on load cells can be replaced by sealed vessels using continuous Mass flow measurement and control, thereby eradicating escaped volatiles and increasing productivity. A by-product to the change is that the final product quality is improved as the constituents do not degrade and change character during the manufacturing process.

In summary, the requirements of mass flow measurement and control of gases and liquids can now be met utilising the Bronkhorst range of Coriolis instrumentation and Control systems. Accurate and stable measurement, independent of fluid properties, is the core function within full control systems that also offer density and temperature output as standard. On-board PID control and batching/dosing technology ensures fast, repeatable and accurate process solutions that also allow for single vendor responsibility.

Features:

- Direct mass flow measurement independent to the fluid properties.
- Fast and stable measurement and control with PID control
- High accuracy, excellent repeatability for gases and liquids
- Multi-range via digital interface or pc based software
- Additional density and temperature measurement outputs
- Bi-directional Mass flow measurement
- Optional integrated temperature control
- IECEx and ATEX approval II G Ex d e IIB T6