### Coriolis Mass Flow Meters



Advanced flow measurement made easy.



## Introducing Coriolis Mass Flow Meters

The Badger Meter RCT1000 Coriolis mass flow meter identifies flow rate by directly measuring fluid mass over a wide range of temperatures with a high degree of accuracy. For fluids consisting of two liquids or a liquid with suspended solids, the RCT1000 Coriolis system can derive the concentration and mass of each fluid based on the density measurement. Furthermore, the unobstructed, open flow design makes it suitable for a variety of fluids such as slurries and other viscous, nonconductive fluids that are difficult to measure with other technologies.



#### Advantages:

- Unobstructed open flow design
- Low-maintenance operation with no free-moving parts
- Modbus RTU, Modbus TCP/IP, HART<sup>®</sup>, and EtherNet I/P network options
- Advanced fluid diagnostic tools
- Batching and PID control

#### Specifications:

- Pipe size: 1/16...3 in. (1.6...76.2 mm)
- Accuracy:
  - $\diamond$  Liquids: up to  $\pm$  0.1% of flow rate
  - $\diamond$  Density: up to ± 0.0005 g/cm<sup>3</sup>
- Zero stability: up to  $\pm$  0.025% of full scale
- Repeatability: up to  $\pm$  0.05% of flow rate
- Process temperature range: -40...392° F (-40...200° C)
- Wetted material: 316L stainless steel
- General area or hazardous location

# Simultaneous measurement of

- Mass flow
- Density
- Temperature



Hazardous Location Transmitter



**Advanced Software** 



## Applications

Unlike many flow measurement technologies, Coriolis mass flow meters can directly and accurately measure the mass flow of fluids over a wide range of fluid temperatures and viscosities. The Coriolis design and measurement principle allows the meter to be an exceptional device in measuring:

- Vegetable oils and fats
- Homogeneous suspensions and slurries
- · Adhesive, glue or binding materials
- Coatings and hardeners
- Dyes, fragrances, vitamins and other additives
- Oil and fuels









- Chemical
- Pet food
- Textiles
- Combustion control
- Asphalt
- Engine test stands



### How Coriolis Technology Works

Coriolis flow meters simultaneously measure mass flow rate, density and temperature. As fluid flows through the vibrating sensor tube, forces induced by the flow cause the tube to twist slightly. These small deflections are measured by carefully placed sensors. A phase shift occurs between sensor signals that is directly proportional to mass flow rate. As the fluid density varies, the resonant frequency at which the tube vibrates changes which is also measured by the sensors. Temperature is measured by an internal RTD in order to calculate thermal effects on the tube vibrating frequency.

#### **Types of Measurement**

| Mass flow rate   | Derived from the phase shift between inlet and   | l outlet sensing coils   |  |  |  |  |
|--|--|--|--|--|--|--|
| Density  | Derived from vibration frequency   |  |  |  |  |  |
| Temperature  | Measured and used to correct for changes in th   | e stiffness of the vibrating tubes   |  |  |  |  |
| <b>Internal</b><br><b>Operation</b><br>(U-Tube design) | U-Tubes  |  |  |  |  |  |
| Phase Shift  | <b>NO FLOW</b><br>Bottom View<br>$\Delta T = 0$  | FLOW<br>Bottom View<br>$\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ $\downarrow$ |  |  |  |  |
| Density<br>Frequency                                   | HIGH DENSITY   |  |  |  |  |  |
| the formation of a                                     | mass flow meters operate at low frequencies which<br>hir slugs in liquids with entrained air. This operation<br>ogeneous and provides less erratic readings. |  |  |  |  |  |



### **Controls & System Integration**

RCT1000 transmitters provide a variety of ways to integrate the meter output into new and existing operations. The batch and PID functionality enables direct control of devices, such as valves, by use of digital or analog outputs. Digital outputs can also be programmed to indicate low and high alarm conditions.

#### **Network options**

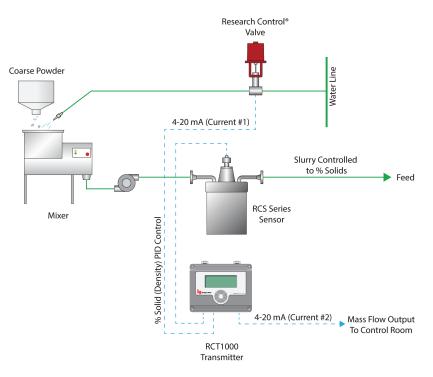
- EtherNet/IP
- Modbus TCP/IP
- Modbus RTU
- HART®

#### **PID Loop Control Example**

#### Signal outputs

- Frequency
- Pulse
- PWM
- 4...20 mA (Qty 3)

Slurries are used in many products, but the proper mix needs to be controlled. As a slurry is pumped through the Badger Meter Coriolis flow meter, the meter measures the percentage of concentrate. Based on this measurement, the PID controller output from the RCT1000 transmitter will modulate the water addition to the mixer to ensure the exact concentration is achieved. In conjunction to the PID control function, the RCT1000 transmitter can also supply analog output or network connectivity for continuous monitoring of the percentage of solids as well as flow rate information to the control room.



- Quick configuration
- Easy-to-read
   LCD screen
- Remote or integral mounting



### **RCT Console Software**

Every RCT1000 Coriolis mass flow meter comes with RCT Console software. RCT Console is specifically designed to provide users maximum operational flexibility and ease-of-use. By allowing users quick access to configure measurement parameters through the RCT Console software or the LCD interface on the transmitter, the meter can be set up and measuring flow in a matter of minutes.

RCT Console software offers much more than configuration features. Users are able to obtain advanced data logging and performance trending analysis, as well as system verification provided by the unique HealthTrack feature.



Trend Graphing

| Decate HealthTrack<br>To start HealthTrack please click on Sta<br>Constants" once and deplays their val<br>Count" these after which HealthTrack o<br>deplays these info. Click on the Preview<br>"Snapshots" taken from current HealthT | ue. The items marked as "<br>alculates Average, Range<br>v button below if you wan | ariables" will b<br>and Standard | e read "Samp<br>Deviation and | e i  |  |  |  |
|---|--|----------------------------------|-------------------------------|------|--|--|--|
| B B G Sample Count 20 121 23  |  |                                  |                               |      |  |  |  |
| liem  | Value  | Average                          | Range                         | 9a - |  |  |  |
| - 🚰 75. Density KT Factor   | 0.000218 [-]   |                                  |                               |      |  |  |  |
| - 🚰 80. Mass Totalizer  | 2549.075 lb  |                                  |                               |      |  |  |  |
| - 261, MAINCPU Crystal Frequency  | 25000000.000000 Hz   |                                  |                               |      |  |  |  |
| - 262, Voltage Reference  | 2500.000000 mV   |                                  |                               |      |  |  |  |
| <ul> <li>263. Mass increment</li> </ul>   | ?  |                                  |                               |      |  |  |  |
| <ul> <li>271. IFCPU Crystal Frequency</li> </ul>  | 25000000.000000 Hz   |                                  |                               | ۰.   |  |  |  |
| - 🚰 33. Phase   | 39.996 µs  | 40.000 µs                        | 0.018 µs                      | 0.0  |  |  |  |
| 2 56, Net mass flow rate  | 0.000 lb/h   | 0.000 lbh                        | 0.000 lbh                     | 0.0  |  |  |  |
| - 🚰 57, Net volumetric Bow rate   | 0.000 gph  | 0.000 gph                        | 0.000 gph                     | 0.0  |  |  |  |
| - 2 53, Mass Flow Rate  | 63.254 lb/m  | 63.241 lb/m                      | 0.027 lb/m                    | 0.0  |  |  |  |
| - 🚰 60. Tube Frequency  | 104.993 Hz   | 105.000 Hz                       | 0.018 Hz                      | 0.0  |  |  |  |
| TO. Density   |  |                                  |                               | ш.   |  |  |  |

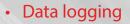
HealthTrack System Verification

| mFlo<br>mTot<br>Dens | 3.395 kg/h<br>102.348 kg<br>0.8250 gr/cc |
|----------------------|--|
| m%8                  | 0.00 %                                   |

Remote Display

| Serple | Time   | 33 Phase              | 50 Tube Frequency  | 183. Coll A Voltage         | 154. Oniver Output  | 105. Coll & Voltac |
|--------|--------|-----------------------|--------------------|-----------------------------|---------------------|--------------------|
|        | 141    | 15                    | Ha                 | eli                         | 2                   | w//                |
| 1      | 0.355  | -0.018321750685572634 | 88.507252666015625 | 60.0019416809082            | 63.021713256835937  | 55 978321075439    |
| 2      | 1.045  | 0.0089403438973424819 | 88.516281127929488 | 53 999141693115234          | 49.029747009277344  | 55-57696974609     |
| 3      | 2.075  | 0.044337108721269836  | 88.521278381347656 | 63.000080108642578          | 65.03057861328125   | 58,9730110168      |
| 4      | 3,105  | -0.059953189693523407 | 88.511688232421875 | 40.009830474853516          | 69.027748107910156  | 58,9715680613      |
| 5      | 4,134  | 0.021696289760828018  | 88.5118637084961   | 53.991420745849629          | 68.026771545410156  | 59.969928741455    |
| 6      | 5.164  | 0.0795641223182215    | 88.512863159179688 | 55 994338965257813          | 69.0417533056664063 | 58.967929540087    |
| 7      | 6.123  | 0.029011240229010582  | 08.503567260742187 | 59-2900-4003203125          | 63.006247253417963  | 53.965499677929    |
| 8      | 7.223  | 006253632307052612    | 88.510772795078125 | 53 999370574951172          | 63.035362243652344  | 58 967361452195    |
| 2      | 0.253  | 0.061536430367796437  | 00.491100412021075 | 53 200531512451172          | 63 009588928222656  | 53 9675407405      |
| 10     | 9.292  | -0 1050340011715889   | 88.511962890625    | 55/95452890625              | 6503460693358375    | 58 963081358963    |
| 11     | 10,312 | -0.015541370278596878 | 00.50120173020125  | 62.005135432373047          | 63.020430523735156  | 58 596783703363    |
| 12     | 11.341 | -0.0635964487923851   | 88.487077541894531 | 63.01631.9645507813         | 69.017707824707001  | 58 9632903523      |
| 13     | 12,137 | -0.00923190638422966  | 88.508542749023438 | 53 997470855712891          | 63.000545642069544  | 53 571458435058    |
| 14     | 13.167 | 0.11063340306282943   | 88.502738952636719 | 40.005491528320312          | 43.027137756347456  | 59.976548602294    |
| 15     | 14.196 | 0.023042159155011177  | 88.499702453613281 | 55 993961334229516          | 69.000676147460908  | 58.969009399414    |
| 16     | 15.226 | -0.057191379368305206 | 88,509368896484375 | 40.004070291983422          | 69.027626007597656  | 58.979610992431    |
| 17     | 16.256 | 0.000795749514102906  | 88.512100219726563 | 58 993301397607563          | 65 03558349608375   | 59.963150482177    |
| 10     | 17,205 | 0.006112096905706313  | 88.518013005488291 | 53 904431011523438          | 63 042220038730463  | 53.971001066455    |
| 12     | 18.315 | -0.10414709095848228  | 00.516101945000701 | 53.997970531054687          | 63.004095764160156  | 55 97052001953     |
| 20     | 19.344 | -0.034267728368235892 | 88.5077996118164   | 53 990085416503906          | 63.008200376417969  | 58.971920013427    |
| 21     | 20.031 | 0.002753609120645795  | 88.5064697265625   | 59 35407950904375           | 63 009588928222656  | 53.900729145414    |
| 22     | 21.060 | 0.0646323710680008    | 88.501480102539062 | 58 99655 15 1067 1875       | 69.027915952589544  | 58.966128302978    |
| 23     | 22.050 | 0.000642613391391933  | 88.583471374511719 | 60.015238715576172          | 63.015998548332001  | 53 555502507548    |
|        |        |                       |                    | PR. CO. LANSING CO. LANSING |                     | 1 Da               |

Data Logging



- Trending
- HealthTrack system
   verification



### About Badger Meter

Badger Meter Flow Instrumentation understands that companies cannot manage what they cannot measure—and leverages more than a century of flow measurement expertise and a technology-rich portfolio to optimize customer applications worldwide.

An industry leader in both mechanical and electronic flow metering technologies, Badger Meter offers one of the broadest flow control and measurement portfolios in the industry—a portfolio that includes eight out of the ten major flow meter technologies. Simply put, Badger Meter Flow Instrumentation provides technology to measure and control whatever moves through a pipe or pipeline—including water, air, steam, oil, other liquids and gases.

#### **Variety of Flow Instrumentation Solutions**





ModMAG® Electromagnetic Flow Meters



**Research Control®** Valves and Positioners



**Impeller Flow Meters** 



Preso<sup>®</sup> Differential **Pressure Flow Meters** 

Industrial Oval Gear Flow Meters



Hedland<sup>®</sup> Variable Area Flow Meters



Cox & Blancett® **Turbine Flow Meters** 



Flo-Tech Hydraulic Fluid Testing



Dynasonics® Ultrasonic Flow Meters



Recordall<sup>®</sup> Disc Flow Meters



Vortex Flow Meters



Flexible Network **Connectivity Options** 



- Control
- Manage
- Optimize

#### **Flow Dynamics®** calibration services



- Calibration for most meter types
- OEM production calibrations
- NIST-traceable primary standards



Note: NVLAP accreditation applies only to the Badger Meter Flow Dynamics calibration Lab, located in Racine, WI



#### Control. Manage. Optimize.

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