Innovations in Mass Flow Meters
Boosting Process Efficiency in
Batch & Continuous Operation

Royal Society of Chemistry Symposium 2013: Practical Continuous Flow Technology
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Emerson Process Management
Agenda

- About Emerson
- Discovery & theory of operation in brief of Coriolis mass flow meters
- Coriolis mass flow meters in the low flow space to serve the continuous operations in Specialty chemicals
- Optimized operations in batch process: Precise measurement in presence of entrain air/gas while batching and blending
- Save Time: Preventive maintenance with Smart Meter Verification that reports health of the meter in 90sec
- Filling simplified: minimizing product give away and fill times as short as 0.3 sec
- Emerson’s global applications, service and sales support
Emerson Organization

- Process management systems
- Safety instrumented systems
- Process control and automation software
- Asset management, maintenance and reliability

Systems & Solutions

Measurement & Analytical
- Pressure, temperature, level and flow measurement
- Analyzers
- Gas chromatographs

Valves & Regulators
- Control valves, and valve-related instrumentation
- Regulators
Discovery of Coriolis Flow Meter

Gustave Gaspard Coriolis
1792-1843
Engineer and mathematician.
Described in 1835 the Coriolis Effect in “Sur les equations du mouvement relatif des systemes de corps”.
Coriolis acceleration is given by:
\[ A_c = 2 \cdot \omega \cdot V \]

Micro Motion invented the first practical Coriolis flow meter in 1977

800,000 Coriolis Mass Flow Meters sold globally

Can affect the outcome!
During a no flow condition, there is no Coriolis effect and the sine waves, induced by the Pickoffs, are in phase with each other. The time difference between the sine waves ($\Delta T$) is directly proportional to the mass flow rate.
Specialty Chemical with Micro Motion Coriolis Flow Meters

**Fast**
- Direct Mass measurement to achieve the right Stoichiometric ratio
- Precise measurement for most difficult applications like fluid with entrained gas which would require measurement methods like weigh scales
- Meter health report in 90 sec

**Economical**
- Repeatable measurement ensures consistency and prevents batch rework
- No maintenance over the life of the meter due to absence of moving parts
- Highly stable meter design requires no recalibration over its lifetime

**Flexible**
- 40:1 Turndown enabling flexibility in scale up or down without compromising on measurement
- No recalibration required for multiple process fluids
- Accurate density/concentration measurement enables check of process fluid quality and also switch over time
Eli Lilly processing plant in Clinton, Ind., uses a fermentation-based process to produce a number of animal health products

- **Measurement Used:** Traditional DP meters in the solvent recovery process served well but reached end of life

- **Issues:** Maintenance, upsets and planned shutdowns reduced the uptime to 80%

- **Measurement upgrade:** Needed to upgrade the instruments to provide greater accuracy and reliability. Two wire Coriolis was an obvious choice for the upgrade

- Once the device was in place, we immediately found that feed flow rates were about 100 liters/minute higher than expected.

- The mass balance information will enable us to optimize the process, maximizing solvent recovery while minimizing energy costs

- We hope to improve the efficiency of the process by at least 5% if not much more
# Serving Low Flow Space

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<th>Specifications</th>
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<td>Liquid: ±0.05% Gas: ±0.35%</td>
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<td>Max Flow</td>
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<td>Repeatability</td>
<td>±0.05%</td>
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<td>±0.025%</td>
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The control loop is only as good as the inputs it receives from the field instruments.
Application with our Small Coriolis Flow Meters

- Batching/dosing of dyes, fragrances, flavorings
- Filling of cosmetic and pharmaceutical products
- Pilot plants, R&D and labs
- Precision spray coatings
- Vacuum thin film coating
- Fiscal Transfer

Mini/Micro Channel Heat Transfer Laboratory
Oklahoma State University – Mechanical & Aerospace Engineering

Low Flow Rate Control System Cart for Pharmaceutical Manufacturer
Serving the Industry

Ammonia Gas Feed to Polymerization Reactor

Cryogenic Liquid (-163 °C)

Pilot Plant test Skid

Small Additive Batching Paint Manufacturer

Chemical/Liquid Additive Delivery

Engineering laboratory for in testing compressor efficiency
Batching & Blending with Micro Motion

Empty full empty batching or blending in presence of entrained gas

- Low tube frequencies reduce measurement errors
- Unmatched MVD transmitter technology
- Installation best Practices
Coriolis – Multiphase Vibration

- **Single Phase**

- **Two Phase – High Viscosity**

- **Two Phase – Low Viscosity**

- **Two Phase – High Frequency /High Viscosity**
**Batching & Blending With Micro Motion**

**Activity:** Blending for shampoo – Dove, Clear, Elidor

**Measurement Challenge:** Required measurement of Silicone under vacuum

**How they measured it:** Used weigh scales or load cells

**Aim:** To increase automation and install two additional mixers

**Instrument Challenge:** No Coriolis meter they tried worked!

**How they achieved it:** Successfully installed Micro Motion Coriolis meter when nothing else seemed to work

Source: Unilever, Turkey
"Our tests concluded that Micro Motion ELITE Coriolis flowmeters are the only meters that can successfully measure silicone feedstock flow with high density bubbles"

"The meters maintained measurement accuracy despite operating in the -700 mbarg vacuum needed in this application"

Atilla Bozkaya, Unilever project control and system design engineer

http://www.plantengineer.org.uk/article/46674/Coriolis-meters-are-Turkish-delight-for-Unilever-plants-.aspx

Batching & Blending With Micro Motion

- Assured quality of final product, and enhanced health and safety
- Reduced operating costs by 17%
- Saved 10 to 15% in production time
- Reduced raw material waste by 1 to 2%
- Reduced energy usage
- Reduction is waste by saving of 7035 pcs of waste empty barrels per year
Stiffness is a key factor in calibration

- For both density and mass flow
- If stiffness changes, density and flow calibration factors have changed (measurement is altered)

Tube stiffness can change from a customer’s process
Using Verification in the Field

Operation at Local Display

Operation with Host

Extended proving cycle with Smart Meter Verification

- No Interruptions to Process or Measurement
- Simple Operation with One Person
- Schedule or Run on Demand
- Robust and Comprehensive Check of Calibration
**Batching & Blending Success in Czech Republic**

- **Application:** LDL Paste with high amount of oxygen

- **Challenge:** No other Coriolis Mass flow meter worked for this application

- **Emerson Solution:** CMF300 + 2700 Transmitter with Smart Meter Verification.
Minimize Product give away and save costs with simplified wiring and practically no maintenance

- Fill multiple fluids and container sizes with one meter
- Fast changeover time
- Immune to temperature shocks from CIP or SIP process
- No regular maintenance or calibration required
- Monitor online density or concentration

A patented algorithm compensates for pump speed & valve closure times to get the right amount – every time

24 head rotary machine built by Pneumatic Scale Corp. for Colgate
Filling with Micro Motion Filling Mass Transmitter (FMT)

- Based in Parma, Italy, GF S.p.A. designs and manufactures high technology filling equipment and quality control systems.
- Requirement was to have fillings in the range from 0.5g to 5Kg

Marco Serventi, Sales Manager, GF S.p.A

Installed FMT filling mass transmitter with Micro Motion ELITE and H series

- Outstanding performance even in 0.3 sec fills
- Real time quality and performance data such as: Time to Fill, Amount Filled, Density and Temperature

“In this highly competitive market, we are always looking for ways to improve the performance of our machines”. “The high reliability and accurate results provided by the Micro Motion instruments have now been validated by GF customers over a number of successful applications

Marco Serventi, Sales Manager, GF S.p.A
Global Applications, Service and Sales support

• European Application Support team based in Netherlands for expert technical advice and troubleshooting

• Life cycle care offers
  ✓ Start up Service for installation and commissioning
  ✓ Factory-trained and certified technicians for on-site troubleshooting and maintenance
  ✓ Technical Training – Factory, Regional or on-site offered in local language
For More Information:  Stand No: 3H15

Thank You

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