White Paper

Micro Motion High Temperature Solutions Best Practices

EMERSON™

Warning:
Do not use saturated steam

Introduction

The purpose of this document is to provide Customers with additional guidance and best practices when using and installing a High Temperature Coriolis meter with the objective of extending the lifetime of the equipment and avoiding downtime.

It is important to read all the sections of the document as best practices and recommendations overlap.

Safety Moment

When working with high temperature and extreme high temperature applications make sure you wear the appropriate PPE as defined by your organization.

1 – Maximum Sensor Temperature Rating

Standard Temperature Sensors. Both F-Series and Elite Series standard temperature sensors are rated to 400 °F (204 °C), and they are capable of performing at that maximum temperature for short excursions but there are internal components that may degrade or fail if operating continuously close to 400 °F.

High Temperature Sensors. Alternatively, High Temp sensors (designated with FXXXA, FXXXB, CMFXXXA, or CMFXXXB) are rated for continuous operation up to their maximum design temperature of 662 °F (350 °C).

Ultra-High Temperature Sensors. Ultra-High Temperature sensors (designated with CMFXXXC and CMFXXXE) are only available through ETO. Available base models are CMF200C/E, CMF300C/E and CMF400C/E which are rated for continuous operation up to their maximum design temperature of 800 °F (426 °C).

2 – Insulation

An insulation jacket is often recommended or required to maintain product quality and ensure best measurement performance.

Applying a heat jacket does not affect the hazardous approvals or temperature ratings marked on our meters. The max surface temperature indicated by a temperature code (ATEX uses T1-T6 for instance) only applies to the external surface temperature of the meter caused by the meter itself. In the case of heated jackets, the external heat is simply seen as a contributing factor to the process fluid temp.

Best Practice #1: Leave a gap between the insulation jacket and the electronics and avoid insulating near or over electronics.

Best Practice #2: Avoid insulating over junction boxes to prevent overheating of the internal terminal blocks and to allow for future wiring access without removing the jacket.

Additional Guidance.
Please contact your Sales Representative to place an order for an insulation jacket or for additional guidance. Insulation jackets can be bought directly from one of the following vendors, but special requests require to be evaluated through the Engineered to Order (ETO) process. Micro Motion currently works with three different vendors to supply high quality insulation jackets for Coriolis meters.

The three following steam jackets deliver robust and reliable jacketing to ensure sufficient and consistent heating for the process. Need to be always mounted with extended electronics.

- **Jacket Option 1.**
  Vendor: Emerson supplied by Shannon Global Energy Solutions.

  Application:
  Best fit for all industrial applications.

  Product Details:
  - The standard heating from Emerson, listed in the price list.
  - An ETO Request for Quote From is NOT required for these jackets as it is a standard model.
  - Design temperature = 150 °C
  - Design pressure = 215 bar
  - Insulation jacket (fiberglass-filled thermal blankets) with tubes SS in option (304 or 316 - diameter = 3/8" - Single and double-sided tubing available - model code: STMKTXXXXX).
  - For the corresponding Steam Heat Kit with Insulation Jacket available model codes are STMKXXXX.
  - For more information specifically on tubing with this fabric jacketing, see details in the next section “3 – Heat Tracing” (Heat-Tracing for these jackets also include thermal tubing).

Example photo of this type of jacket.

Vendor Website: https://www.emerson.com; http://www.blanket-insulation.com
Contact your Sales Representative.

- **Jacket Option 2.**
  Vendor: Emerson supplied by WWV Wärmeverwertung.

  Application:
  Best fit for process maintenance.

  Product Details:
  — An ETO Request for Quote Form is required to provide a quote.
  — Tubes with a sheet metal enclosure around it.
  — Temperature: 350 °C
  — Pressure: 150 bar
  — Dual casing for maximizing heat transfer and heat retention. 50–80 mm thick insulation along with primary tracing ensures minimal heat loss.
  — Available in two designs for below 2" and meter size 2" and above.
  — Available with galvanized Carbon Steel or Stainless Steel.
  — Sensors below 2" provided with jacket pre-installed in the factory. Sensors above 2" provided with jacket to be installed on site.
  — Can be used with steam, hot water, hot oil heating systems (or any heat transfer fluids), or cold oil for cooling system.

For meters below 2".

For meters 2" and above.

	Primary Layer	Secondary Layer
For meters >2"	Steam tubing attached to the sensor	Metal cover with 50–80 mm insulation
For meters >2" and below'	Steam tubing around the meter	Metal cover with 50–80 mm insulation
Material	316SS tube	Galvanized CS or Stainless Steel case

Vendor Website: https://www.de/en/
Contact your Sales Representative.

- **Jacket Option 3.**
  Vendor: Emerson supplied by CSI Thermal Process Management.

  Application:
  Best fit for temperature critical applications.

  Product Details:
  — An ETO Request for Quote Form is required to provide a quote.
  — Aluminum housing (aluminum jacketing with cement filler / double sided heating).
  — Design temperature = 400 °C (in option)
  — Design pressure = 40 bar (in option)
  — Jacket pre-installed in the factory for ease and quick meter installation on customer site.
  — Can be use with steam, hot water, hot oil heating systems (or any heat transfer fluids), or cold oil for cooling system.

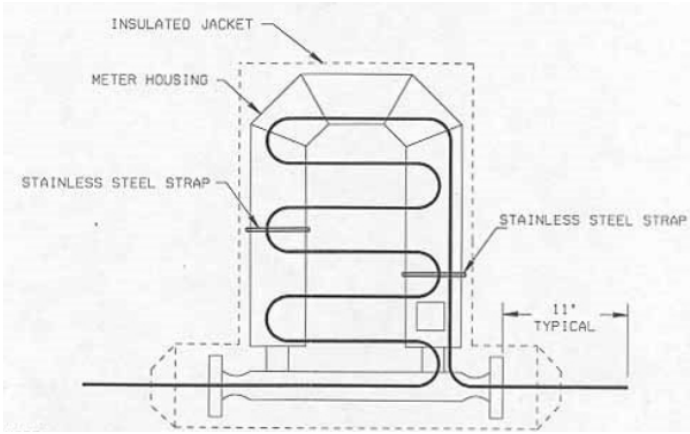
Example photo of this type of jacket.

Vendor Website: https://www.csiheat.com
Contact your Sales Representative.

Product Details:
— Flexibility to offer various end connections (steam tubing process connections) in various sizes and shapes including flanges of different ratings and NPT fittings.
— Ability to change the jacket design to fulfill specific customer needs such as covering of the process flanges with insulation jackets or tracing/tubing around the manifold region if necessary.
— Insulation thickness can be varied from standard 80 mm
— Possibility to have varying sizes of steam tubing with standard being ½"
— Optional Transport Packing.
— Optional Heat Kit Drawing/ Documentation.

All customizations need to be clearly specified at the quote stage.

3 – Heat Tracing



Best Practice #1: In environments where heat tracing is essential (i.e. arctic and subarctic outdoor installations), it is imperative that the sensor and surrounding piping be fully heated before introducing a fluid that can freeze in the tubes. Not enough heat tracing or pre-heating can cause the sensor to plug or be damaged. Special attention should be given to the flanges and manifold areas as these are the only parts of the flow path that are directly exposed to the ambient environment. The sensor RTD can be used as a good indication of the heat tracing temperature penetration, even when the tubes are empty.

Best Practice #2: Some customers may take the additional step of heat tracing the sensor in addition to insulating it. There are three (3) typical heating mediums used for heat tracing piping systems: steam, hot oil, or electric tape. Both steam and hot oil obviously require a fully separate fluid supply, pump, and tubing, whereas electric tape is adhered to the piping and sensor and must be powered by a controlled electrical current to maintain a set temperature.

Additional Guidance.

- For standard sensors, Micro Motion's Steam Heat Kits (models STMKTXXXXX) include tubing to cover 1-side of the sensor case.
- An ETO can be used to specify a 2-sided steam kit for standard sensors if preferred.
- For High Temp and Ultra High Temp sensors, Steam Heat Kits (models STMKTXXXXXA) include tubing long enough to cover 2-sides of the sensor case.

Note: Micro Motion's heat trace offerings do not include pumps, fittings, external temperature measurements, or spare tubing.

4 – Electrical Heat Tracing

Electrical Heat Tracing is only available via Engineered to Order (ETO) and requires an ETO Request for Quote for every customer request. Electric power supplies and thermostats are standard with electrical heat trace offerings.

Note: Micro Motion has evaluated the electromagnetic effects of applying electric heat tape in various patterns and concluded it has no effect on any internal components or the measuring capabilities of a Coriolis meter.

Best Practice #1: We highly recommend the entire piping system needs to be assessed for heat tracing in accordance with the customer's specific process and procedures, not only the Coriolis meter.

5 – Vibration

High temperature sensors use ceramic coil components which require a very tight clearance to properly detect tube movements. The components are more susceptible to damage due to vibration or fluid hammering (often experienced when mounted on mobile trailers or trucks, or by Clean-In-Place or Steam-In-Place processes).

Best Practice #1: The released design with a "shorten" height of CMF200A/B and CMF300A/B sensors, significantly stiffens the sensor to minimize the effect of vibration or liquid slugs coming down the line at high velocity for those applications where vibration cannot be eliminated.

Design Updates for CMF200 (A/B)

Design Updates for CMF300 (A/B)

Best Practice #2: Externally, use common process and pipe design practices to avoid fluid hammering. Internally, short tube meters help mitigate fluid hammering effects.

6 – Smart Meter Verification (SMV)

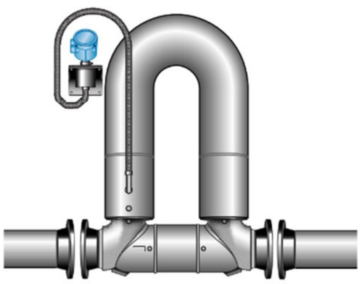
With the release of 800 core software 4.2, and 5700 software 3.0, SMV now has the ability to run properly on high temperature applications as long as the SMV test is initiated under the same conditions each time (i.e. same temperature and pressure). The first time that SMV is run in the field, an SMV "field reference point" will be established as an offset the factory baseline to the known good field conditions.

Best Practice #1: SMV is required for high temperature operations, all subsequent tests should be conducted at similar operation conditions. A field reference factor needs to be established. Once the SMV field baseline is established, running an SMV test under different process conditions may cause false SMV failures (i.e. during shutdowns or while empty).

Best Practice #2: Micro Motion recommends waiting to run an initial SMV test for High Temperature meters for at least 2-4 weeks after operating at high temperature. Running the initial SMV test prior to operating at elevated temperature for some time may establish an offset in the SMV field reference point, causing false SMV failures in the future.

7 – Best Practices for Specific Applications

Asphalt
In general, High Temperature sensors should be used for all Asphalt applications due to reasonable expectation of over-temping standard meters. Under normal operation, the temperature set-point for asphalt is typically between 350 °F and 380 °F (176 to 193 °C) but can easily peak over 400 °F (204 °C) if not well monitored.



Best Practice #1: High temp sensors are often mounted Tubes-Up to simplify mounting on trailers or trucks, and to allow for self-draining (asphalt actually isn't very viscous at normal operating temperatures (-4 to 10 cP above 350 °F). Tubes-Up can be used for liquids as long as the following considerations are taken:

- This orientation will create a high point in the line which will naturally allow bubbles to collect if allowed. Bubbles, or gas voids, can cause measurement errors.
- For liquids with reasonable viscosity, like asphalt, the fluid itself should naturally purge the tubes of any gas voids while flowing (a minimum velocity of 3 ft/sec is suggested upon charging the meter to ensure all bubbles are properly purged). Liquids with very low viscosities should be avoided in this orientation.
- Maintaining inlet head pressure and downstream backpressure will minimize the measurement effect of any bubbles that remain in the liquid.

Best Practice #2: Performing a zero-calibration is recommended when operating at process conditions far from our lab calibration (roughly 70 °F, and 30 psig). In order to perform a zero-calibration, the meter must be brought to operating conditions (temperature, pressure) and the flow must be stopped briefly.

- This typically requires locating block valves upstream and downstream of the meter to prevent any fluid from draining out of the tubes during the zero-calibration procedure.
- Care should also be taken to ensure no bubbles are entrained in the liquid during zero-calibration, as they will naturally collect at the high point (in the measurement portion of the sensor) and may cause an offset.

Best Practice #3: If the meter will be installed on a mobile trailer, care should be taken to prevent vibrational shocks and hydraulic hammering from being transmitted to the meter.

- Open valves slowly
- Use cushioned mountings (such as Stauff clamps)
- Add flexible piping joints (bellows) if deemed necessary
- For mobile or trailer mounted applications, use new Short height ETO's for CMF200A or CMF300A. Please read Chapter on Vibration.

Molten Sulfur

Molten Sulfur is pure Sulfur (99.5%+) that is heated past its melting point around 250 °F. This is a very good application for Coriolis, and one for which we have a proven track record of success. Molten Sulfur typically requires a special amount of consideration because it has a tendency to solidify if allowed to cool or overheat – which leads to a volatile viscosity profile. At typical operating conditions (270 to 300 °F) it has a viscosity less than 10 cP, but can quickly spike near 800 or 1,000 cP if it polymerizes above 325 °F, or crystallizes below 240 °F. For molten sulfur applications Micro Motion recommends using C22 materials.

Best Practice #1: If the sensor tubes are full and the Sulfur cools enough to crystallize (less than 240 °F), continuing to vibrate the tubes against the abrasive crystals for long periods of time may cause damage to the tubes (up to and including tube rupture). Most customers working with Sulfur have good control of their temperature and utilize built-in alarms to act quickly if temperature loss occurs, but for those who want to further protect their Micro Motion sensor investment it may be preferable to add an ETO to shut down the drive coil if the temperature drops below a certain setpoint (maybe 240 °F). ETO's are currently available, please contact your Sales Representative or Flow Support Group for more information about the specific ETOs we offer for you particular meter configuration.

Superheated Steam

Unlike saturated steam (for which Vortex meters are typically a best-fit), Coriolis meters are ideal for measuring superheated steam due to their inherent direct mass measurement capability (which does not require the additional compensations of temperature, pressure, compressibility, or composition).

Best Practice #1: High Quality insulation and/or heat tracing is HIGHLY recommended for superheated steam applications to avoid losing valuable process temperature and reduce the risk of condensation forming.

Best Practice #2: Steam or liquid traps should be utilized upstream of the sensor to avoid liquid hammering due to liquids forming during shutdowns or boiler upsets.

Other Steam Injection Cleaning

Other Steam Injection Cleaning Processes could be as an example, the decoking process within an ethane cracking furnace: to assure that coking is minimized and does not impact the reliability and efficiency of the cracking process within the furnace, a de-coking or cleaning process has been the best maintenance practice a plant operator can do. In the de-coke process, steam or air is injected into each furnace pass which increases the fluid velocity. This will cause any coke buildup to be broken off and captured further downstream. The time between de-coking operations is dependent on several factors and will be determined by past experiences and live performance metrics of the yield efficiency. As time goes forward and yield efficiency drops, the need for de-coking becomes important.

To best protect equipment during the de-coke process, we will discuss a few best practices that will offer process operators the best opportunity to run efficiently and protect the process from damage during the de-coking process.

Here are a few best practices about the de-coke process:

Best Practice #1: Train plant operators about the de-coking process and stress the importance of the slow transition to steam, especially if the process is done manually.

Best Practice #2: If possible, automate the de-coke process just like the standard process. Many plant designs still have the de-coke process as a manual one. Automation can assure this process is done properly and will limit the impact damage can have on equipment.

Best Practice #3: Install ethane feed flow meters upstream of the steam injection point to protect the device's sensitive sensors from possible water hammer damage caused by steam coming in contact too quickly with condensate.

- If a flow meter and control valve are downstream of the steam injection point, make sure to slowly open the manual steam valve (targeting 30-45 minutes to reach max temperature and flow rate) to minimize the impact of condensate flashing in the line. This will reduce the temperature shock that occurs when going from the ethane feed to the de-coke steam which can be upwards of 130C temperature change.

Best Practice #4: Assure all steam lines, injection lines, drain lines, and process lines have the ability to drain condensate and eliminate low points that could collect condensate. The draining of condensate should occur just prior to the de-coking process. As discussed earlier, automation can make this a very simple process.

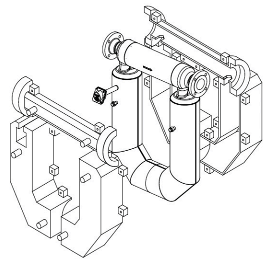
Best Practice #5: During the switch back to ethane as the feedstock after de-coking, assure all flow meters, valves, and process lines are empty of condensate to prevent possible process upsets.

8 – Installation

This section provides installation best practices for High Temperature and Ultra High Temperature Coriolis Flow Meters.

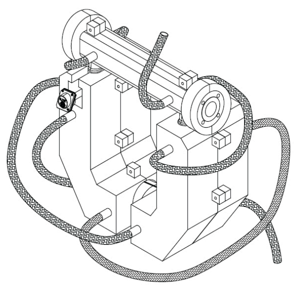
Best Practice #1: For a general guide to Hi-temp Coriolis flow meter installation, the heat tracing module is required to be installed on the outside of the sensor. Metal heat jacket or heat tracing tube can be selected to conduct even and sufficient heat treatment to the sensor.

Best Practice #2: Metal heat jacket are typically needed for temperature critical applications due to the increased efficiency. Take into consideration metal heat jackets are very heavy and space consuming.



ControlHeat jacket for larger sensors.

Best Practice #3: If metal heat jacket is adopted, please follow its installation guidance, refer to Installation Manual **P/N MMI-20013331**.



Jumpovers installed on a multi-segmented ControlHeat jacket.

Best Practice #4: If heat tracing tube is adopted, the heat tracing pipe shall be evenly distributed or wound on both sides of the sensor, and the flange neck shall also be covered, refer to Installation Manual **P/N MMI-20013331.**

Best Practice #5: Keep the heat tracing tube away from the junction box of the sensor. Do not cover the junction box of the sensor and leave appropriate gaps, when wrap the insulation material around the sensor. Transmitter needs to be placed away and secured properly following the maximum ambient temperature limit for electronics as the guideline.

Best Practice #6: The sensor should be fully and evenly preheated before performing operations to prevent flow path from getting plugged which could cause damage.

Best Practice #7: Verify the sensor temperature by temperature reading on the transmitter. After the sensor temperature reaches or exceeds the fluid operating temperature, the process fluid is passed through the sensor.

Best Practice #8: Avoid external vibration or shock when transporting, storing, and installing high temperature sensor.

For additional information on Emerson's products, visit Emerson.com/MicroMotion

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