Using Coriolis Flow Meters for Critical Phase Ethylene Measurement

Introduction

Coriolis meters have been used for critical-phase ethylene measurement for many years. One of the first formal studies was conducted in Europe in the late 1990's. The study showed excellent mass flow performance over a wide range of temperature and pressure conditions, which will be discussed in this paper. Density and volumetric flow are not considered since ethylene is (almost) always measured in mass units.

Coriolis meters offer many advantages over other technologies:

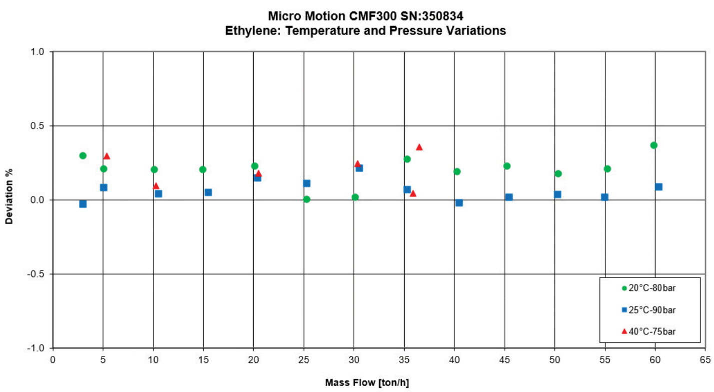
- Low installed costs due to one device vs. multiple devices to cover the full flow rate range (in contrast to turbine and density meters, for instance)
- Safe for operators and the environment as the process is not exposed to the atmosphere (as compared to orifice plate inspection/change)
- Easy installation with no extra pipe supports, straight-run or flow conditioning necessary
- Low maintenance due to no moving parts
- High accuracy (low uncertainty) over a very wide range of operating conditions.

Results show that Micro Motion meters accurately measure critical-phase ethylene at all measurement points from 4000 to 130,000 lbs/hour (2 to 60 t/h).

Test conditions from:

- 70 to 100 °F (20° to 40 °C)
- 750 to 1300 psi (52 to 90 bar)
- Density ranged from 9 to 21 lbs/ft^3 (150 to 350 kg/m^3)

Testing showed that the CMF300 water calibration transfers directly to critical-phase ethylene within ±0.25%. An example of the test results is found in the following graph:



Installation and Orientation

Installation requirements are minimal. Since ethylene is generally very pure, there is little possibility of contaminants (water for instance) to be present in the fluid which might collect in tubes. Therefore, any orientation is acceptable; orient the tubes in a way that is most convenient for the user.

Performance is not affected by mounting flange stress and/or pipe alignment with current Micro Motion meters. Follow good piping practices and align the piping with the meter to avoid damage.

Maximum Velocity

Fluid velocity up to 130 ft/s (40 m/s) is acceptable. When rates are high enough to exceed 130 ft/s, consider installing the next larger meter or use parallel meters. When installing CMF350 and larger meters, Engineered-to-Order (ETO) software is necessary for optimal performance. Please contact the factory for specific ETO numbers that need to be included at the time of order.

Fluid Property Effects

Emerson has installed hundreds of Micro Motion Coriolis meters in critical-phase ethylene with great success. The number of installations has given us the opportunity to study the ethylene application and fully understand the challenges of measuring ethylene. It is well known that ethylene density is highly variable and difficult to characterize. For this reason, Coriolis meters are an ideal choice for measurement since they measure mass flow directly and are unaffected by changing density. However, as pipelines have increased in size, new measurement challenges have been identified that need to be considered when selecting the appropriate Coriolis meter size.

In addition to difficult-to-characterize density, the velocity-of-sound (VoS) of ethylene is also highly variable, especially around the critical pressure. Coriolis meters are not affected by changing density, but in meters larger than CMF300 the changing VoS can have an effect that can be corrected internally in the transmitter for non-ideal fluids like ethylene, ethane, and carbon dioxide. Sizes CMF350 and larger should use the ETO software that automatically corrects for the VoS changes. The ETO works for all pressure and temperature ranges of ethylene, including around the critical temperature and pressure point.

Pressure effect

Pressure inside the meter can cause a small effect on meter's measurement. Compensating pressure effect is easily accomplished by either configuring a known fixed pressure value into the transmitter, or by connecting a pressure transmitter to input a live pressure measurement into the Coriolis meter transmitter.

The HCDP can be calculated at the regulated sample pressure (typically 20 PSIG/100 kPa) and compared to the ambient temperature. If the HCDP begins to track the ambient temperature, it can indicate that the heavy components are falling out in the sample lines.

Mass Measurement Uncertainty

VoS is not a measurement concern for meters CMF300 and smaller. Overall uncertainty, under all operating conditions is approximately ±0.25%. CMF300 performance is especially impressive when operating at critical pressure where VoS is changing very rapidly.

Meters CMF350 and larger require ETO software that automatically corrects for VoS. When the software is activated, uncertainty is ±0.25%.

AN-002391 Rev A

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