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Ethylene Pipeline Measurement via Coriolis Flow Meter

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Introduction

Ethylene is transported in large quantities by pipeline as a supercritical or dense phase fluid. Typical pipeline pressure is above 1000 psia which allows ethylene to maintain a supercritical state at ambient temperature during shipment and storage.

Pipeline ethylene quantities have historically been measured in mass units (e.g., pounds per hour) by orifice meter. Orifice meters require regular maintenance to verify plate dimensions and pressure/differential pressure transmitters are calibrated at some interval. Taking a meter run out of service for maintenance poses potential safety risks (e.g. ethylene volatility) which must be carefully mitigated.

Pipeline operators have been looking for alternate maintenance-free supercritical ethylene measurement solutions. Coriolis mass flow meters with advanced on-line diagnostic functions provide a safe maintenance-free alternative to orifice metering in supercritical ethylene pipeline measurement.

Ethylene Meter Run Decomposition

High temperature and pressure ethylene can decompose forming methane and carbon. Decomposition is a chemical reaction that releases heat which can fuel additional decomposition.

Ethylene is a highly flammable fluid and when exposed to air can form an explosive mixture. Auto ignition is possible at high temperatures. A low-pressure nitrogen purge of any piping taken out of service for maintenance is used to prevent an ethylene air mixture. The workflow process for refilling an ethylene pipeline must prevent a decomposition event due to high temperatures produced by rapidly compressing the ethylene vapor (adiabatic heating).

An ethylene meter run decomposition incident was documented and shared at an AIChE Spring Meeting and Global Congress on Process Safety-March 23, 2010:

"An ethylene decomposition occurred on the evening of May 15, 2008 during an ethylene plant turnaround. Ethylene was being supplied to downstream consumers via the pipeline through a metering station adjacent to the ethylene plant. The metering header consists of two meter runs to allow maintenance without flow interruption. The incident occurred when placing the off-line meter run in service. The off-line meter run was inventoried with low pressure nitrogen and 1100 psi ethylene was introduced through a large gate valve. The subsequent quick pressurization resulted in an adiabatic compression of the nitrogen which initiated an ethylene decomposition in the pipe. The decomposition propagated through the header and was apparently quenched at a filter station in the meter run. The decomposition did not propagate into the supply pipeline. The decomposition was recognized by smoldering paint and hot pipe in the meter run. The initial response was to take the second meter line back out of service. A hot spot in the stagnant piping indicated a continuing non-propagating decomposition taking place. Action was taken to re-establish flow through the pipe with the hot spot to cool the pipe. The hot spot continued for approximately three hours before no additional heat was detected. The affected pipe was then isolated and inspected for damage and cleaned.

The incident investigation revealed both physical and system failures, resulting in several recommendations."

Smart Meter Verification

Smart Meter Verification is an on-line, advanced diagnostic function that verifies the Coriolis flow meter, transmitter and interconnecting wiring while a meter is in normal operation. Meter measurement is not impacted while Smart Meter Verification is running. Smart Meter Verification can be initiated on demand or scheduled to run automatically.

Coriolis flow meter integrity is field verified by calculating meter tube stiffness at the inlet and outlet pickoff coils. The Coriolis meter is exposed to five frequencies, and the frequency response is used to determine tube stiffness. A comparison is made between the post installation (in situ) measurements and the stored factory baseline measurements. See Figure 1.

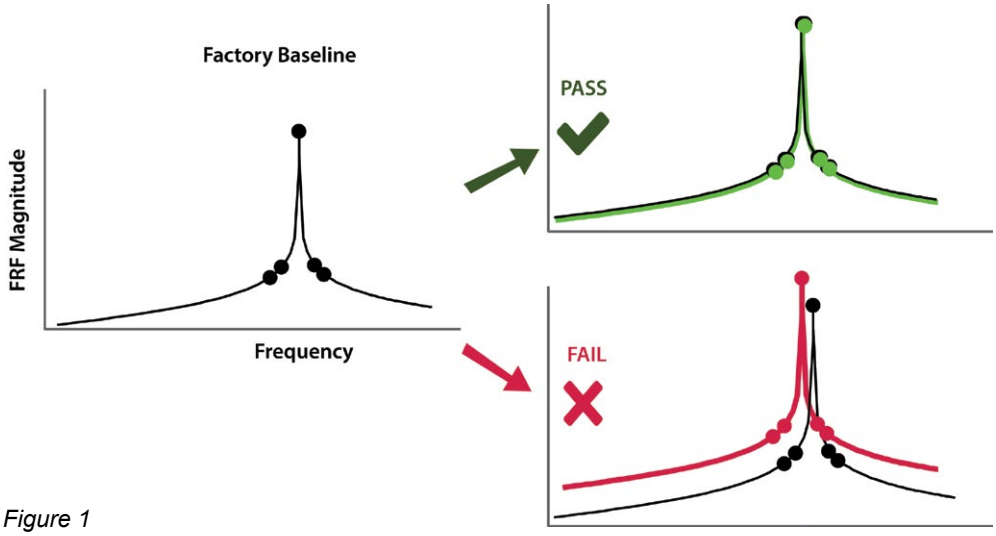

Figure 1

Additional Smart Meter Verification diagnostics test the integrity of the Coriolis meter electronics, interconnecting wiring and transmitter functionality. Successful completion of Smart Meter Verification provides a high level of confidence Coriolis flow meter measurement is within the specified accuracy.

Coriolis Flow Meter Solution

A “pay and check” configuration of Micro Motion ELITE Coriolis mass flow meters may provide an ideal solution to ethylene measurement. A single meter run is composed of two meters in series (one pay and one check meter) and multiple meter runs can be used to increase measurement capacity. See Figure 2.

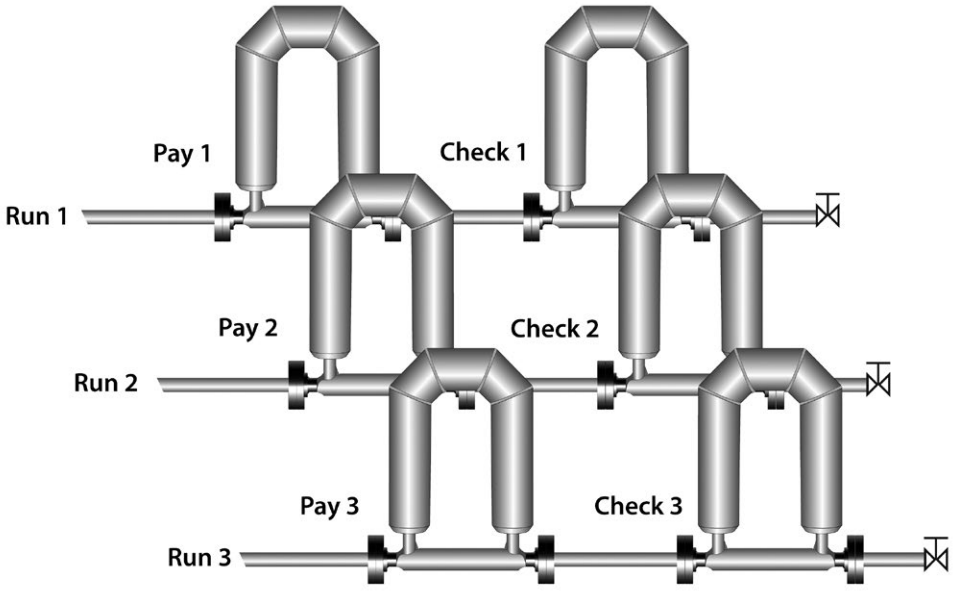

Figure 2

Pay and check meters are monitored for user-defined deviations in measurement. Smart Meter Verification is scheduled to run on a regular basis for each meter during operation. No routine maintenance activity is implemented when measurement deviation is within limits and meters pass Smart Meter Verification tests. Benefits of Coriolis measurement in ethylene measurement service include improvements in operational safety and human resource allocation due to the elimination of routine maintenance activities.

Micro Motion has extensive application engineering knowledge applying Coriolis meters to supercritical ethylene. Customers are encouraged to engage Micro Motion for meter sizing and selection.

Conclusion

Supercritical ethylene can become volatile under certain abnormal process conditions. Safe supercritical ethylene measurement during shipment and storage represents challenges for pipeline operators. Minimizing maintenance on supercritical ethylene operations is a key driver for meeting health, safety and environment (HSE) objectives.

Coriolis mass flow meter technology utilizing advanced on-line diagnostics provides a maintenance free alternative to legacy ethylene measurement. Legacy ethylene orifice meter measurement requires regular maintenance which can lead to recordable HSE incidents and occupies limited human resources.

Minimal best practice standards regarding supercritical ethylene flow measurement by Coriolis flow meters currently do not exist. Operating companies are implementing Coriolis ethylene meter solutions by agreement between involved parties.

References

American Chemistry Counsel, “Product Stewardship Guidance Manual”, December 2004

American Institute of Chemical Engineers (AIChE), “Ethylene Decomposition in Meter Header” presentation, AIChE Spring Meeting and Global Congress on Process Safety, March 23, 2010

“Ethylene Decomposition in Meter Header - Sabine River Works Olefins Unit - Orange, Texas” Accessed 11/18/2019

https://www.aiche.org/academy/videos/conference-presentations/ethylene-decomposition-meter-header-sabine-river-works-olefins-unit-orange-texas

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