

Flare Gas: Ultrasonic Flow Measurement in a Vacuum

Flare Gas

A gas flare, or “flare stack”, is a gas combustion device used in industrial plants such as petroleum refineries, chemical plants, natural gas processing plants, oil or gas production sites, and landfills. In industrial plants, flare stacks are primarily used for burning off flammable gas either released by pressure relief valves or as a byproduct of chemical processing.

In general, the flaring of waste gas is an environmental concern that must be reported to state or federal agencies to ensure compliance with the unit’s operating permit. Here is where metrology comes into play; Instrumentation is required to monitor flow, temperature, and pressure of the pipelines feeding the flare stack, with the data gathered being used for verification of operation within permitted limits.

Often the gasses to be flared are corrosive resulting in premature failure of traditional (wetted) flowmeter elements. The natural solution for such applications would of course be clamp-on ultrasonic flowmeters except that flare gas applications typically operate at very low pressures, in many cases at a slight vacuum.



Redundant clamp-on flow sensor installations on Kynar spool

Clamp-On meters used on gas require pressures of 100 PSI or greater to ensure sufficient gas density for transfer of ultrasonic energy into the flow stream. Gas; being a low density / low sonic velocity medium conflicts with steel, (the typical pipeline material) a high density, high sonic velocity medium. The interface between these two opposing mediums produces a significant disparity in acoustical impedance that is difficult for ultrasonic energy to bridge, therefore most of the energy reflects back into the pipe wall. This is the reason gas density needs to be increased, and for the requirement of the pipe damping film (CC129) utilized with gas meters.

Enter plastic

A material such as Kynar (PVDF) is only about 22% the density of steel, with a sonic velocity approx. 4 times slower. These factors produce an acoustical impedance that's a significantly better "match" to a gas medium; better enabling transfer of acoustic energy across the interface even at atmospheric or lower pressure. Kynar brings the added benefits of its ability to withstand the corrosive nature of the waste gasses, plus there is no need for the pipe damping film.

Case: A chemical company in Texas

A major chemical company was looking for a new solution for their vent gas applications in their Flameless Thermal Oxidizer (FTO) system. The system is divided between wet gas vents and dry gas vents; a main header for each side channels flow from knockout pots to one of two reactors via branching pipelines. The complete system included 6 measurement points (2 Headers and 4 branch lines) how-



Redundant FUG1010 meters housed in a stainless enclosure along with Siemens pressure and temperature instruments

ever EPA requirements mandated redundant measurement of the reactor feed lines bringing the total number of points to ten.

Historically these measurements had been made by Pitot Tube (Annubar1) flowmeters; but frequent failure of these devices due to plugging, led the customer to look for an alternative technology. The pipeline pressures of this system are typically about 14 PSIA (a slight vacuum). This pressure would normally disqualify a clamp-on gas system if the pipe was metallic. Siemens proposed using Kynar spools instead as these would permit transmission of an ultrasonic signal. A demonstration test confirmed the concept sufficiently for the customer to proceed.

Kynar spools were fabricated to mate with the existing piping configuration. The spools included a 10" sch. 80 wet-gas header, an 8" sch. 80 dry-gas header and 2 each 8" sch.80 wet-gas and 6" sch. 80 dry-gas reactor feed lines. Initial commissioning of the SITRANS FUG1010 meters took place in January of 2016, the Pitot tubes remained in place until the customer was satisfied with the performance of the clamp-on systems. The Kynar spools were relatively short to enable fitting to an existing location, but as a result the location of the spools was anything but ideal with little to no upstream straight run. The Pitot tubes occupied a much more desirable location high on the flare stack. Additionally, the limited length of the spools created difficult conditions for mounting redundant transducer installations. Nevertheless, the SITRANS FUG1010's were successfully put into service and performed admirably even with the convoluted piping configuration.

Upgrading the System

Continuous good performance of the SITRANS FUG1010's on these applications convinced the customer to forge ahead with plans to relocate them to areas where flow profile conditions would better meet flow measurement requirements. Their plan was to replace the Pitot tube spool sections with newly fabricated Kynar spools and move the SITRANS FUG1010's to these locations. This modification would provide the SITRANS FUG1010's with the recommended 20 diameters of upstream straight run on a vertical pipe section. The new spools would also be fabricated with stronger flanges to better ensure the integrity of the piping system.

The customer installed the new spool sections in place of the Pitot tubes during an outage in January of 2019, relocating the SITRANS FUG1010 flowmeters to the new location. In addition to the SITRANS FUG1010 meters, Siemens pressure and temperature instruments were also utilized to monitor the gas medium.

Recommissioning took place in March of 2019, a process that went off without a hitch. In the new locations flow readings between the redundant meters of each spool section proved to be more stable and comparable due to the improved flow profile conditions. At Siemens' suggestion the customer will look into performing an averaging function in their SCADA since the redundant measurements produce the equivalent of a dual-beam system.

Documentation

To meet EPA reporting requirements the customer requested a method for NIST traceable field verification of flowmeter integrity. To meet this requirement an existing field verification procedure was modified and updated to be compatible with the current SITRANS FUG1010 systems. Customer personnel will be indoctrinated on how to perform these verification checks in order to provide these reports to the EPA on an annual basis.

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