National Engineering Laboratory

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Case Study:

Accurate Flare Gas Measurement

Measurement Errors in Upstream Oil and Gas Flare Systems

Issue

Flares are necessary to quickly dispose of hydrocarbon gas in emergencies. Flaring gas releases harmful carbon dioxide (CO2) emissions as well as methane (CH4). These emissions are strictly regulated under the EU Emissions Trading Scheme (ETS), which places stringent limits on the amount of CO2 emissions operators can release year on year. Producers are required to measure the amount of CO2 released by flares within certain accuracies, and ensure the amount released stays within their emissions quotas.

Ultrasonic flow meters (USMs) are commonly installed in flare systems to measure the amount of gas flared as they provide a very high turndown ratio (ratio of maximum to minimum flow rate) which is required for flaring applications.

Although this large turndown ratio is very useful for flare metering USMs are very sensitive to installation effects, particularly swirl. Generally, in flare metering systems single path USMs are used (due to cost) and these meters are particularly sensitive to installation effects.

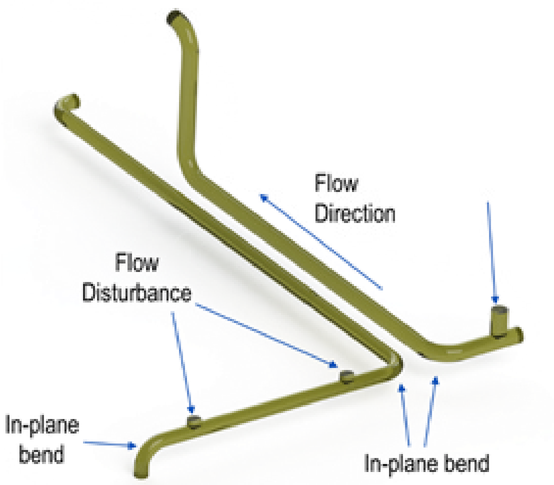

Figure 1: CAD Model of A Typical Flare Metering Line

Approach

TÜV SÜD National Engineering Laboratory flow experts created a Computer Aided Design (CAD) model of the client's flare stack and meter installation using Computational Fluid Dynamics (CFD). This was used to determine the true metering error under a range of operating conditions. These included the low-level controlled flaring used to maintain the flare pilot light, general plant leakage, and high-level unplanned emergency flaring (blowdown).

Solutions

Modelling the flare and meter installation enabled a true evaluation of measurement uncertainty in the field.
It was found that the configuration of piping at the installation produced flow distortions, namely swirl in the vicinity of the USM transducer path. This resulted in metering errors in the region of 50%.
The use of CFD allowed correction factors to be established to correct for the installation errors present. These correction factors can be supplied directly to the flow computer to allow an online, real time correction of the USM.

Benefits

Correcting for the meter errors brought measurements within the EU ETS uncertainty limits. Breaching these limits could have led to fines of several million pounds per field.
False over-reading of the meter could have led to costly management decisions, such as shutting down (or reducing) production to comply with EU ETS emission allocations and/or purchasing unnecessary CO2 allowances.
The meter did not have to be physically moved, therefore no downtime was required, and the correction is carried out in real time on the flow computer which requires no additional hardware or software.

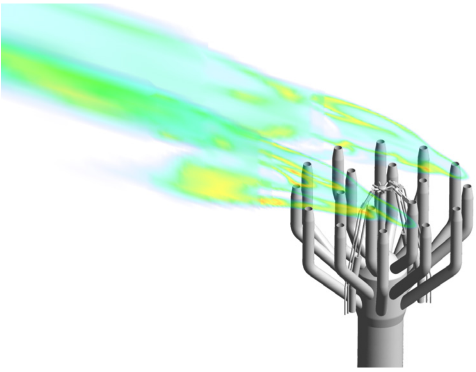

Figure 5: Example of Combustion Optimisation Performed Using CFD

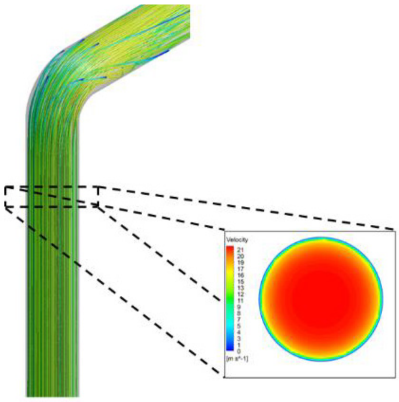

Figure 2: Example of Flow Profile Downstream of In Plane Bend (only a small deviation from fully developed flow)

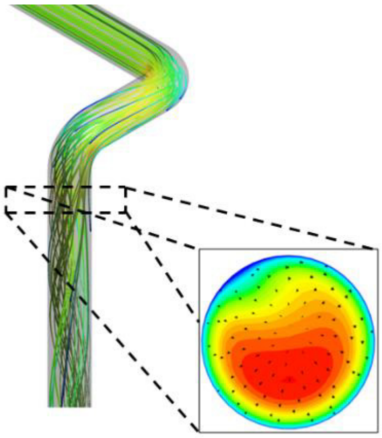

Figure 3: Example of Flow Profile Downstream of Out of Plane Bend

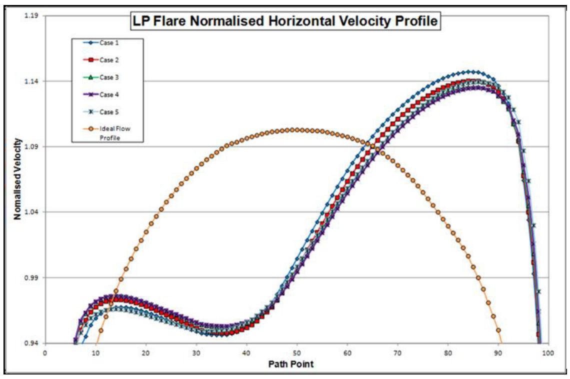

Figure 4: Example of Ideal Flow Profile vs As Found Profile At The Meter

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