Measurement challenges: Oil and gas upstream sector

The challenges of Oil and gas metering of upstream sector commences from the producing wells and end at refinery delivery point. Accuracy, stability and standardization are the vital components of these metering systems.

Flow measurement is vital at different levels of operational activity which includes measurement of well fluid from source, processing and dispatch to various customers. The material balance in every stage can bring out the variations and pinpoint losses for immediate corrective steps.

Well fluid flow measurement challenges

Measurements of well fluids is the most complex because of varying fluid properties and quantities. The complex well fluid from the producing well generally comprises oil, gas, water, sediments and contaminants. Present measurement system does not take into account the presence of sediments and contaminants separately.

A more accurate flow measurement is required especially when producing from marginal fields for improved production management.

Usage of flow measurement in subsea condition is a major challenge since extreme physical environment prevails in subsea like low temperature and high pressure. Variation in well fluid composition (water cut, sand ingress) must be accounted for while selecting the proper flow meter since subsea intervention is a costly affair.

The inability to predict the flow pattern theoretically in gas wells may lead to inaccurate flow measurement of well fluid which also emphasize the importance of proper selection of flow meter.

Oil and gas flow measurement during processing

Oil and gas are measured in units of volume, and volume varies by temperature and pressure, so flow must be calibrated and corrected to give accurate measurements at standard temperature and pressure. In E&P industry, it is common to have multiple production points and single delivery/ custody transfer point .The problem starts when production centers and delivery point uses different type of metering systems. Regular calibration and proving of flow meters are important for transport of large quantities of oil and gas as small errors add up to significant quantity which may lead to revenue loss.

The processed crude measurement becomes more problematic with the presence of gas in unstabilised crude and accounting of water cut. The online water cut meters has the element of human intervention. The accounting of net crude become complex in the absence of complete automation from measurement of total volumes and finding the net volumes after discounting water cut and presence of gas .

Liquid presence with a gas flow induces a DP meter to produce a higher differential pressure than would exist if the gas flowed alone. This results in an over measurement of the gas flow. The generic Coriolis, turbine and ultrasonic meters will in general incur significant gas flow rate measurement errors for traces of liquid entrainment with the gas flow. The effect of wet gas flow on single phase flow meters

make it difficult to get accurate flow measurements using traditional single phase flow measurement techniques.

Flare gas measurement

Although gas flares typically have very low flow rates, they experience intermittent periods of very high flow. Thermal mass meters face many problems due to this high dynamic gas flow, which also contains liquids. Gas released from flare stacks contains many different compounds. Flare gas composition changes continuously, affecting the accuracy of traditional flare metering. For instance, moisture and wetness affect the readings of thermal mass flow meters.

Ultrasonic flow meters are cost prohibitive, and can be prone to measurement errors when there is a high level of carbon dioxide in the gas stream. Turbine meters have a restricted measurement range, whereas high back pressure is a problem in orifice meters.

SCADA – SAP integration for transparency

ONGC has now introduced the zero human intervention concept in our offshore platforms resulting in reducing the reconciliation losses. The metering data is picked up from the meters directly to SCADA and later integrated to the SAP systems for production accounting. This brings complete transparency in reporting of production dispatches at Production stations. The challenge is to bring the online receipts at the tanks of refinery through the SCADA.

Ideal measurement systems may encompass the single point monitoring of all dispatches and receipts through SCADA with online mass balance. This will reduce the losses, pilferages and reduce reconciliation factors.

SOME SOLUTIONS :

1) *Wet gas meters for gas flow measurement*
   The wet gas flow meters can generally be grouped into three generic types. The first generic design uses a DP meter with the additional measurement of the permanent pressure loss (or "head loss"). The relationship between the two measurements, i.e. the traditional DP and the head loss gives enough information to predict the two unknowns, i.e. the gas and liquid flow rates. The second generic design uses two dissimilar gas meters with different responses to wet gas flows in series. The different meter performance allows a comparison between the two meter outputs and a measurement by difference technique to be employed. The third generic design uses a DP meter with phase fraction devices (e.g. gamma ray, microwave, capacitance devices etc), embedded in the meter body. Cross referencing the output of the multiple instruments allows derivation of the gas flow, liquid flow and water cut.
2) *Cone meters for Gas, Liquid & Steam flow*
   It consists a centrally located cone inside the tube. The cone interacts with the fluid flow, reshaping the fluid's velocity profile and creating a region of lower pressure immediately downstream of itself. The pressure difference, exhibited between the static line pressure and the low pressure created downstream of the cone, can be measured via two pressure sensing taps. One tap is placed slightly upstream of the cone, the other is located in the downstream face of the cone itself. The pressure difference can then be incorporated into a derivation of the Bernoulli equation to determine the fluid flow rate. The cone's central position in the line optimizes the velocity profile

of the flow at the point of measurement, assuring highly accurate, reliable flow measurement regardless of the condition of the flow upstream of the meter. With its DP built-in flow conditioning design, the Cone Flow Meter is especially useful in tight-fit and retrofit installations in which the long runs of straight pipe required by Orifice Plates, Venturi Tubes, and other technologies are either impractical or unavailable.

3) *Optical meters for Flare measurement*

   The Optical Flow Meter uses laser beams to measure the gas flow by sensing the velocity of microscopic particulates naturally occurring in the gas. Which is not dependent on thermal conductivity of gases, variations in gas flow or composition of gases. The operating principle enables optical laser technology to deliver highly accurate flow data, even in challenging environments which may include high temperature, low flow rates, high pressure, high humidity, pipe vibration and acoustic noise. They are very stable with no moving parts and deliver a highly repeatable measurement over the life of the product. Because distance between the two laser sheets does not change, optical flow meters do not require periodic calibration after their initial commissioning.