ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 3, March 2015

Multiphase Flow Metering in Oil and Gas Industry

Saurabh Goswami

Project Quality Manager, Chevron Corporation, Houston, TX, USA

Abstract: This study summarizes the research work with reference to the multiphase flow metering in oil & gas industry. One of the challenging problems that the Oil & Gas industry has been dealing with for several years is accurate and reliable multiphase flow rate measurement in a three-phase flow. This type of flow is common while producing oil and gas wells. Transporting of crude oil and petroleum products to refineries, storage tanks, and other delivery points, metering of the fluid is essential for determining flow rate, volume, and cost. Crude oil is mixture of oil, gas, seawater and sand. Therefore, two- and three-phase metering systems require for metering. Conventional metering system is expensive and requires cumbersome test separators, high maintenance, and field personnel intervention. These conventional solutions do not lend themselves to continuous metering. Moreover, with diminishing oil resources, oil companies are now frequently confronted with the need to recover oil & gas from marginally economical reservoirs. In order to ensure economic viability of these accumulations, the wells may have to be completed subsea, or crude oil from several wells sent to a common central processing facility.

Keywords: Oil & Gas, Metering, Offshore, Sub-sea.

I. INTRODUCTION

Conventional metering systems require the constituents or "phases" of the well streams to be fully separated upstream of the point of measurement. Multiphase metering techniques are developed to improve measurement limitations of conventional metering systems those require gravity based test separators. Flow metering is conducted routinely to monitor the flow rates from wells and forecast production. The flow metering data are used for reservoir management, production diagnostics and field allocation. To obtain accurate and consistent flow measurement from conventional well testing systems, the equipment requires high maintenance, field personnel intervention, and time to perform tests.

Oil Companies are looking at the multiphase metering technology as a method for reducing the cost of flow metering and improving the quality of the flow metering. Since multiphase metering systems can operate without the need for phase separation, they can be made into compact and lightweight systems. The small footprints and lightweight advantages can produce significant savings, especially in offshore where size and weight may result in additional installation costs.

II. MULTIPHASE FLOW METERING

Conventional methods for metering oil and gas can now be replaced by a simpler, more economic technology known as MULTIPHASE FLOW METERING. Multiphase metering allows the measurement of gas; oil and water directly from the wellhead without separate them. This allows production to be measured directly from the wellhead, producing variable oil, water and gas streams, including a range of flow regimes from wet gas to gassy liquid. It eliminates the capital costs of the separator to measure oil & gas production as well as the tanks, valves, level sensors and flowmeters. It is no longer necessary to separate the flow regime in order to provide accurate measurements of oil, gas and water.

III. MULTIPHASE FLOW

Multiphase flow is a complex phenomenon which is difficult to understand, predict and model. Common single-phase characteristics such as velocity profile, turbulence and boundary layer, are thus inappropriate for describing the nature of such flows.

Flow regimes vary depending on operating conditions, fluid properties, flow rates and the orientation and geometry of the pipe through which the fluids flow. The transition between different flow regimes may be a gradual process. The determination of flow regimes in pipes in operation is not easy. Analysis of fluctuations of local pressure and/or density by means of for example gamma-ray densitometry has been used in experiments and is described in the literature. In the laboratory, the flow regime may be studied by direct visual observation using a length of transparent piping. Descriptions of flow regimes are

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 3, March 2015

therefore to some degree arbitrary, and they depend to a large extent on the observer and his/her interpretation.

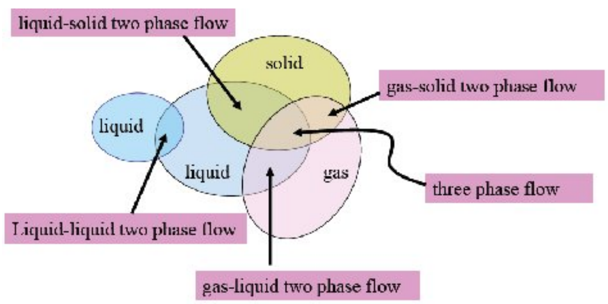

Fig. 1 Types of Flow

The main mechanisms involved in forming the different flow regimes are transient effects, geometry/terrain effects, hydrodynamic effects and combinations of these effects.

• Transients occur as a result of changes in system boundary conditions. This is not to be confused with the local unsteadiness associated with intermittent flow. Opening and closing of valves are examples of operations that cause transient conditions.

• Geometry and terrain effects occur as a result of changes in pipeline geometry or inclination. Such effects can be particularly important in and downstream of sea-lines, and some flow regimes generated in this way can prevail for several kilometres. Severe riser slugging is an example of this effect.

• In the absence of transient and geometry/terrain effects, the steady state flow regime is entirely determined by flow rates, fluid properties, pipe diameter and inclination. Such flow regimes are seen in horizontal straight pipes and are referred to as "hydrodynamic" flow regimes. These are typical flow regimes encountered at a wellhead location.

All flow regimes however, can be grouped into dispersed flow, separated flow, intermittent flow or a combination of these.

• **Dispersed flow** is characterized by a uniform phase distribution in both the radial and axial directions. Flow regime effects caused by liquid-liquid interactions are normally significantly less pronounced than those caused by liquid-gas interactions. In this context, the liquid-liquid portion of the flow can therefore often be considered as a dispersed flow. However, some properties of the liquid-liquid mixture depend on the volumetric ratio of the two liquid. Examples of such flows are bubble flow and mist flow.

• **Separated flow** is characterized by a non-continuous phase distribution in the radial direction and a continuous phase distribution in the axial direction. Examples of such flows are stratified and annular (Figure 2). The flow regimes are all hydrodynamic two-phase gas-liquid flow regimes.

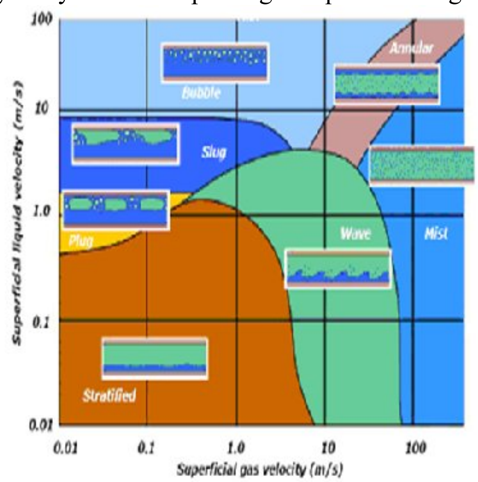

Fig. 2 Two-phase Horizontal Flow

• **Intermittent flow** is characterized by being non-continuous in the axial direction, and therefore exhibits locally unsteady behaviour. Examples of such flows are elongated bubble, churn and slug flow (Figure 3). The flow regimes are all hydrodynamic two-phase gas-liquid flow regimes.

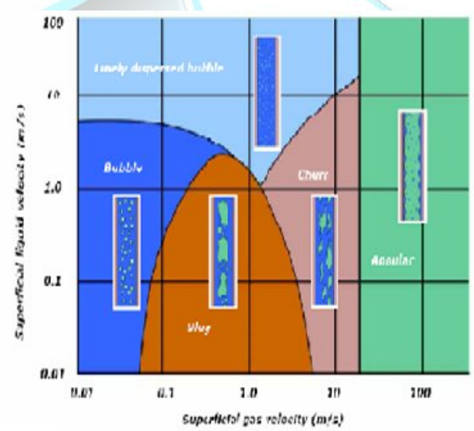

Fig. 3 Two-phase Vertical Flow

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 3, March 2015

IV. Applications

A) General Well Surveillance and Monitoring

Prior to the advent of multiphase flow measurement technology, it was normally impractical to monitor the state of flow from an individual well on a continual basis. Furthermore, short-term changes could not normally be detected by using flow line and a separator with periodic flow metering to observe well performance.

Multiphase flow meters have changed all this. Eliminating the separator has meant that the performance of the well could be monitored in real time, and the ability to place the meter right at the wellhead has provided the opportunity to see changes as they take place. Not only does measurement by separators using periodic flow metering reduce the opportunity to see these instantaneous changes, but the dynamics of separators actually further mask these effects because of the vessel volume and fluid flow control.

B) Reservoir Management

The ability to know how much oil, gas, and water a particular well is producing on a continual basis can be extremely beneficial in maximizing its life and cumulative hydrocarbon production. By observing not just pressures and temperatures but actual flow rates as well, one can spot trends, perform analyses, and take steps that otherwise would never have been possible.

C) Allocation of Production

One of the most common applications where information on flow rates from individual wells is required is in the allocation of hydrocarbons that have been commingled. The allocation is based on whatever source of information is at hand during periodic flow metering, multiphase flow meters, single phase meters, or any other means. Based on these data, the production that has been accumulated over a given period, measured at a point of relatively high accuracy, is allocated back to the production facilities, leases, units, and wells from which it was produced.

D) Other Allocation

In addition to allocating the hydrocarbon production from the contributing wells, there are often other allocations that are required in practice. For example, when by-products of the process have a negative economic impact on the individual producers, these costs must be allocated in an equitable fashion. Two examples of this are produced water disposal and the taxation of flare gas in some jurisdictions.

V. Benefits of Multiphase Flow Metering

Multi-phase measurement solutions enable real-time measurements, which allow real-time control of the production process. Production optimization applications rely on real time inputs to ensure that contractual obligations are met. In addition, increased production adds incremental contracts from the same assets. Greater return on production assets is critical due to the high capital employed in leasing, exploring, and producing from upstream oil & gas assets.

Multi-phase measurement combined with optimization solutions provides enormous benefits. Providing real-time measurements allows maximum return from optimization. Production deviations as well as production opportunities are discovered and acted upon to provide maximum value from field operations. Well Field SCADA systems increase completions by dramatically reducing the implementation time for new wells.

Multiphase metering also minimizes the field maintenance and these meters can be operated by remotely so it is also useful for de-manning.

VI. Conclusion

Multi-phase measurement solutions enable accurate, reliable and real-time allocation measurements using less equipment and reducing capital investments. These solutions are safer and cleaner, thus protecting people as well as the surrounding environment. Real-time measurements enable production and asset optimization.

Disclaimer: This paper does not represent any Chevron Corporation position and it is in no way related to Chevron Corporation.

References

[1]. R. J Wikens, D K Thomas, S. R Glassmeyer, "Surfactant Use for Slug Flow Pattern Suppression and NewFlow Pattern Types in a Horizontal Pipe", Journal of fluids engineering PP 164-169, Vol 128, January 2006.

[2]. API Recommended Practice for Measurement of Multiphase Flow standard, API RP 86, 2005.

[3]. The Norwegian Society for Oil and Gas Measurement, The Norwegian Society of Charted Technical and Scientific Professional , 2nd ed., Handbook of Multiphase Flow Metering, 2005

[4]. (2014) Oil online website. Available: http://www.oilonline.com/

[5]. (2014) Rexa website. [Online]. Available: http://www.rexa.com/industries/oil-and-gas.cfm

[6]. (2014) ABB website. [Online]. Available: http://www08.abb.com/global/scot/scot267.nsf/veritydisplay/1860ce14370dc1aa85257d4f00495df1/$file/FAQ_VIS_Final%20.pdf

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 2, Issue 3, March 2015

BIOGRAPHY

Mr. Saurabh Goswami did his Bachelor of Engineering in Industrial and Production Engineering form Gulbarga University, India, Master of Science in Industrial System Engineering from National University of Singapore, Singapore and Master of Business Administration from Victoria University, Australia. He is ISO 9001 Lead Auditor, Integrated QEHS Management System Auditor and Certified Facilitator for Shaping Accident Free Environment (SAFE). He has more than 15 years of Quality Management System experience in Oil & Gas Industry. Currently he is working with Chevron Corporation, Houston, TX, USA on technically challenging Congo River Crossing (CRX) Project as a Project Quality Manager and he has also worked with Kellogg Brown & Root, Leatherhead, UK; KBR Asia Pacific, Singapore; PT Punjlloyd Indonesia, Jakarta; Indonesia, Pratibha Pipes & Structural, Mumbai, India; American Bureau of Shipping, Mumbai, India and Dolphin Offshore, Mumbai, India. Saurabh has received Maximizing Valued Performance (MVP), a prestigious award from KBR Asia Pacific, Singapore for his Leadership and Extraordinary Contribution for Effective Quality Management System. He is Senior Member of American Society for Quality and he has written many Papers and Articles on “Multiphase Pumps” and “Quality Management System”.