Performance verification of multiphase flow meters in allocation measurement in the Oil & Gas wells

Luiz Octavio Vieira Pereira [1,2], **Alcir de Faro Orlando**[1]

[1] Postgraduate Program in Metrology of Pontifical Catholic University in Rio de Janeiro, Brazil;

[2] Research and Development in fluid measurement, Petrobras S.A., Rio de Janeiro, Brazil

E-mail: luizoctavio@petrobras.com.br

Abstract: In October 2015, the Brazilian Agency for Petroleum, Natural Gas and Biofuels (ANP) published Ordinance number 44 with specific regulations for the application of multiphase flow meters (MM) in the allocation measurement in Brazil. It is believed that with this regulation the use of MM in Brazil will increase considerably. This ordinance requires the Oil & Gas companies has a MM performance verification plan that will inform the periodicity and how the meter verification methodology will be performed. This work presents the main performance verification methodologies of MM for the oil and gas industry.

Keywords: multiphase flow meter; MPFM; allocation; performance verification; Oil & Gas.

1. INTRODUCTION

With the beginning of the oil and gas exploration in Brazil, the process of regulatory process of the volumes produced was started together. The establishment in Brazil of the technical regulation for measuring oil and natural gas (RTM), by joint ordinance of the National Petroleum, Gas and Biofuels Agency (ANP) / INMETRO nº 1, at June 2013, established the metrological and the requirements to carry out the measurement for allocation. Allocation measurement is allocation of production to each reservoir, field and well periodically. Oil & Gas companies commonly use test separators in field for allocation measurement. They are vessels capable of separating the fluids, and then measure the volumes through single-phase oil, water and gas flow measurement devices [1] as can be seen in figure 1.

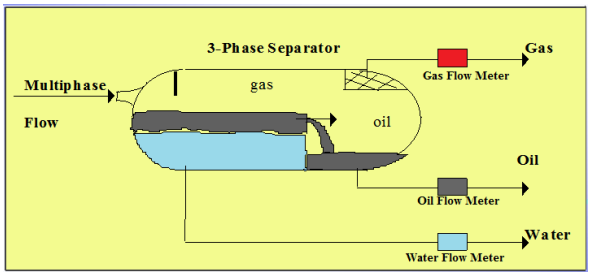

Figure 1 – Design of a conventional three-phase separator.

The application of multiphase flow meters (MM) is an option to the use of conventional test separators in the execution of well tests with objective of allocation measurement. MMs are widely used in the world by oil and gas operators reaching approximately 3000 meters installed [2]. The application of MM has been small in Brazil until now.

1 Marquês de São Vicente Street , 225, Gávea - Rio de Janeiro, RJ – Brazil

2 Horácio Macedo Avenue, 950 – Ilha do Fundão – Rio de Janeiro , RJ - Brazil

In October of 2015 the ANP published regulation number 44 with specific regulation for the application of MM in the allocation measurement in Brazil [3]. Therefore it is expected that application of this technology will increase in this country.

This regulation requires that Oil & Gas companies have a performance verification plan for MM that will inform the periodicity and methodology of this plan. The regulation doesn't specify how to make this verification. The operators have to define these requirements and to submit for ANP.

The objective of this article is to present the main methodologies of performance verification of MM for the oil and gas industry.

2. SEPARATORS X MM

The test separators are heavy systems, require considerable space for their installation, have high manufacturing, operation and maintenance costs and require long periods of process stabilization before starting well tests [4].

The MM are systems that measure the flow rate of each individual phase from multiphase flow. They are lighter and smaller than the separators. Space and weight are critical resources in maritime platforms. They can perform continuous monitoring of well production. It allows a quick diagnosis of a some problem and avoids loss of production. In addition, MM interferes less in the well flow obtaining a more representative flow rate.

However, it isn't expected that the MM has the same uncertainty that test separator for all flows rate from all wells. This can occur if there is a periodic performance verification of MM in the field. The performance verification will show the necessity of maintenance and calibration of the meter [5].

3. PERFORMANCE VERIFICATION OF MULTIPHASE FLOW METER

There is an understanding that the best way to make the performance verification of MM in the field is to test against the conventional test separator since it is the reference standard we can normally find in the field [5-8]. Moreover the ANP presents this methodology in regulation 44/2015 as the most acceptable. Figure 2 shows a graphic of liquid flow rate measurement of MM against a test separator.

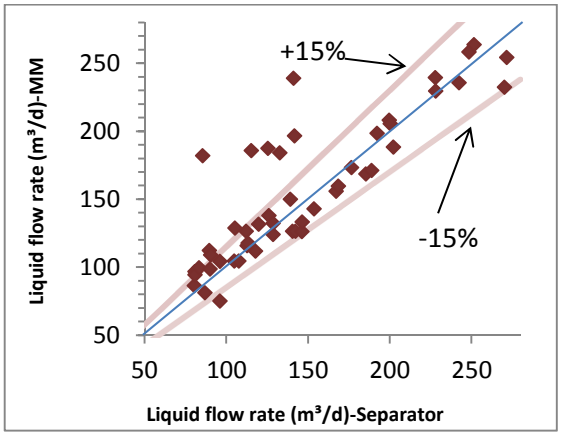

Figure 2 - Graphic of MM performance against a test separator in liquid flow rate measurement.

In the absence of the test separator or as a complementary form of performance evaluation, other methodologies will be presented to verify the correct measurement of the MM when in operation. In addition, it is important to inform that one of the advantages of using the MM is to remove the test separator and save weight and space in the installation.

Some meter models, especially for subsea installation, have sensor redundancy. The signal comparison of these sensors allows to verify their good operation [9].

The MM verification can be achieved by using a mobile test unit with a MM that can be called Master. This unit is mounted on a skid to

be transported. This method consists of testing the meter in operation against the Master meter in order to evaluate the performance of the meter in operation. In this way, the mobile unit can be calibrated regularly at a test site or with a test separator before being used to evaluate the meter in operation [7].

The multiphase meter can be evaluated through chemical tracers. This technology consists of injecting small volumes of a selective tracer into the oil, water or gas phase, i.e., substance having predominant physico-chemical affinity only in one of these phases. The tracers are injected under controlled flow rate. Multiphase flow samples are collected at points far enough from the tracer injection point to ensure complete mixing of the tracer in flow. The individual flows of each phase can be determined by measuring of tracer concentration in the sample collected.

The flow measurement of each phase by tracer technique is given by (1) [10]:

$$Q = \frac{Q_t}{C_t} \qquad (1)$$

Onde:

Q is the mass flow rate of the phase in test

Qt is the mass flow rate of the tracer injection

Ct is the mass concentration of the tracer in phase

The reconciliation factor (RF) is a means of monitoring the quality of operational data and can be a very effective method [5-8] to evaluate MM. This method consists in generating a factor by the division of the volume measured in the platform in the fiscal measurement, that is, measurement of the oil and gas after the treatment in the processing plant, by the sum of oil and gas production of the wells measured by the MM (2).

$$RF = \frac{\text{Fiscal Oil or Gas production of platform}}{\text{Sum of Oil or Gas production from each well}} \qquad (2)$$

The sum of the Oil and Gas potential production of each well is proportional to the total production of the fiscal measurement point. The better will be considered the accuracy of MM as closer as RF of 1. However, the most important feature is stability than absolute value. Monitoring the RF allows the observation of the change in the trend of the measurement and it indicates the appearance of a systematic error.

The RF analysis should be in long periods of production, usually monthly or perhaps annually basis according to figure 3. This analysis in short periods of time, for example daily, may show a factor that does not represent well the MM performance.

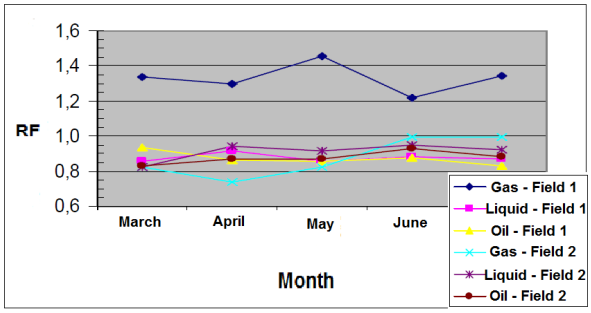

Figure 3 - RF monitoring of the MM for two Oil and Gas fields.

4. CONCLUSION

The multiphase flow meters are presented as a solution for allocation measurement with several advantages over the conventional test separator system. But, the multiphase flow measurement is a new matter in metrology, so aren't fully known errors and uncertainties sources and measuring capability of MM.

The use of test separators as reference for MM performance verification is not always possible. Although other methodologies that can be used for performance verification, they need to be

studied in order to know what is the best to be implemented in each Oil and Gas scenario.

REFERENCES

[1] Falcone G, Hewitt G, and Alimonti, C. (2009). Multiphase flow metering: principles and applications. Vol. 54. Amsterdan. Elsevier. 20-21 p.

[2] Falcone G, and Harrison B. (2011). *Oil & Gas Journal*, *109*(10), 25-34.

[3] Saad C. H. e Andrade J F. (2016). In: *Rio Oil & Gas Expo and Conference 2016*, Rio de Janeiro. Anais... Rio de Janeiro : Instituto Brasileiro de Petróleo, Gás e Biocombustíveis – IBP.

[4] Falcone G, Teodoriu C, Reinicke K M and Bello O O (2008). *SPE Projects, Facilities & Construction*, *3*(03), 1-10.

[5] Corneliussen S, Couput J P, Dahl E, Dykesteen E, Frøysa K E, Malde E, Moestue H, Mokstunes P O, Scheers L and Tunheim, H. (2005). *Norwegian Society for Oil and Gas Measurement (NFOGM)*, Revision 2, 1-113.

[6] API Publication 2566. (2004). *American Petroleum Institute API*, 1-80.

[7] API Publication chapter 20.3 (2013). *American Petroleum Institute API*, 1-90.

[8] Mehdizadeh P and Williamson J. (2004). *Alaska Oil & Gas Conservation Commission. Well Testing*, 1-15.

[9] Streeton R and Bowling I. (2016). UPM 16050 In. *Upstream Production Measurement Forum*

[10] Hirtz P N, Kunzman R J, Broaddus M L and Barbitta J A (2001).. *Geothermics*, *30*(6), 727-745.