Hydrocarbon Accounting Verification for Reasonable Assurance on EJGP Open Access Pipe System

(Verifikasi Laporan Hydrocarbon Untuk Jaminan Kewajaran Pada Sistem Pipa Akses Terbuka EJGP)

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Abstract

The East Java Gas Pipeline (EJGP) pipeline network system is an open access for transporting almost \pm 310 MMSCFD of Natural Gas from fields in East Java offshore to the onshore Power Plant consumers. The deviation between the calculated and mass balance of gas stock is called the Discrepancy in which BPHMIGAS set up a maximum value of \pm 0.85%. The objective of the study is to develop a verification methodology to support hydrocarbon accounting in the EJGP Pipeline Network System. The methodology will be assisted by Flow Quantity Assurance software. After obtaining sufficient data, a new baseline can be taken empirically which can be used as a reference for the maximum allowable discrepancy in the EJGP Pipeline Network System. The data used in this simulation are taken from September - October 2013 such as pipes dimension of the entire network piping system, flowrate, pressure, temperature, and the composition of natural gas. The results of verification are compared with the calculations carried out by Pertamina Gas as operators. The calculation of Discrepancy in the Operators with different tools is around 0.12%, meaning that operator calculations are acceptable. The maximum allowable discrepancy \pm 0.85%, can be reviewed to be reduced according to the history of the average system discrepancy in 2017-2018 (around 0.54%). The New Shipper from Sirasun Batur Field is still more economics by using the existing pipeline network even though it bears Discrepancy / Losses up to 1% compared to building new pipes to consumers. It is found that the discrepancy is getting smaller (reducing the error) if there is a gas balance, meaning that the end consumers will take the gas according to the agreed nomination.

Keywords: Hydrocarbon Accounting, Software Flow Quantity Assurance, Production Allocation, Discrepancy

Sari

Sistem Pipa East Java Gas Pipeline (EJGP) merupakan sistem pipa open access untuk menyalurkan ±310 MMSCFD Gas Bumi dari lapangan-lapangan di perairan Jawa Timur sampai ke plant gate konsumen. Selisih jumlah Gas berdasarkan perhitungan dibandingkan dengan mass balance disebut Discrepancy yang oleh BPHMIGAS dibatasi maksimum ±0.85%. Dalam penelitian ini dilakukan verifikasi dan validasi Hydrocarbon Accounting di Sistem Pipa EJGP dengan dibantu oleh perangkat software Flow Quantity Assurance. Setelah didapatkan data yang cukup maka secara empirik dapat diambil suatu baseline baru yang dapat dijadikan acuan maximum allowable discrepancy pada Sistem Pipa EJGP. Data yang digunakan dalam simulasi ini adalah data bulan September - Oktober 2013 yaitu dimensional pipa seluruh jaringan, flowrate, tekanan, temperatur serta komposisi Gas Bumi. Hasil verifikasi dibandingkan dengan hasil perhitungan yang sudah dilakukan oleh Pertamina Gas sebagai operator. Perhitungan Discrepancy Operator dengan tools berbeda sekitar 0.12% dapat diartikan bahwa perhitungan operator dapat diterima. Maximum Allowable Discrepancy ±0.85%, dapat ditinjau kembali untuk diturunkan sesuai realisasi Discrepancy sistem rata-rata di tahun 2017-2018 adalah sekitar 0.54%. Shipper Baru dari Lapangan Sirasun Batur masih lebih ekonomis menggunakan pipa existing walaupun menanggung Discrepancy/Losses sampai dengan 1% dibandingkan dengan membangun pipa baru sampai ke konsumen. Discrepancy semakin kecil apabila terdapat keseimbangan gas masuk dan keluar, artinya konsumen agar melakukan pengambilan Gas sesuai dengan nominasi yang disepakati.

Kata-kata kunci: Akuntansi Hidrokarbon, Piranti Lunak Flow Quantity Assurance, Alokasi Produksi, Discrepancy

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I. INTRODUCTION

East Java Gas Pipeline (EJGP) system is an open access pipeline system for channeling \pm 310 MMSCFD natural gas from fields operated by Kontraktor Kontak Kerja Sama (KKKS) in East Java seas which having a \pm 450 Km pipe length from source until the Power Plant gate plant, Fertilizer Plant, and Industries in Gresik area (Figure 1). The amount of natural gas sent by the shipper will be compressed in the pipe, then absorbed by consumers on land and a small portion will be an unaccounted gas including losses which calculated daily or monthly. The deviation in the amount of gas calculated compared to mass balance is called the Discrepancy which BPH Migas is limited it to a maximum of \pm 0.85%, which will be controlled by the pipe operator and charged proportionally to each Shipper (Figure 2).

In this study, verification and validation of Hydrocarbon Accounting in EJGP Pipe System was assisted by flow quantity assurance software (methods for determining accuracy and / or precision flow of material balance in processes in oil and gas industry field) which practically can be connected with measuring instruments in the field so that the pipeline system can be monitored at all times and can immediately be adjusted to operating conditions to minimize discrepancy. First, the verification is carried out on the measuring instruments at the point of natural gas entrance and then at the point of delivery. The data used in addition to pipe's dimention data is the configuration of the entire piping system network, secondary data in the form of flowrate, pressure and temperature of natural gas as a result of data gained from measuring instruments, and also data of natural gas composition from several fields. In this study, data on flow rates and gas operating conditions used in this simulation are data from September - October 2013 and the results of verification are compared with the results of calculations that have been carried out by Pertamina Gas as operators (Figure 3).

The scope of this research:

- Verification of Hydrocarbon calculations in the EJGP open access pipeline system on Sept Oct 2013.
- Introducing the use of Flow Quantity Assurance software (Methods for Determining Accuracy and / or Precision Flow of Material Balance in Processes in the Field of Oil and Gas Industry) that can be used as a system monitoring tool (Figure 4).
- Identification of the factors that caused the discrepancy.
- Simple economic calculations for new shipper from Sirasun Batur Field if they will use the EJGP open access pipeline system.

Based on those problems, this study is aimed to get solution about:

- Using tools such as Flow Quantity Assurance software (Methods for Determining Accuracy and / or Precision Flow of Material Balance in Processes in the Field of Oil and Gas Industry) to verify Hydrocarbon accounting conducted by open access operators.
- Verify measuring instruments in the EJGP pipeline system used as input meters and output / sales meters.
- Provide recommendations for continuous improvement open access pipelines for manager starting from the KKKS inlet, transporters until

the final consumers.

• Conducting verification of maximum allowable discrepancy in an open access EJGP Pipe System.

This research is expected to provide certainty for all stakeholders that the discrepancy or losses charged proportionally by the operator can fairly and truthfully be verified, agreement for the operators and related parties on the maximum allowance tolerance that should be applied and can be used as a basis for follow-up in the form of an investigation or claim / penalty, option for the government and new KKKS/shipper to utilize the existing system with absorbing discrepancy / losses and fee tolls or building new pipes to their customers as the consequences, an agreement / SOP and apply the optimum strategy for discrepancy / losses minimization, and business awareness of data and information management related to asset exploitation and production operations.

II. BASIC THEORY

Hydrocarbon accounting is the amount of hydrocarbon that is lifted and can be divided based on ownership, oil's cost category, profit oil, and on individual fractions of each type of hydrocarbon production composition. Hydrocarbon accounting and allocation can often be used reciprocally, Hydrocarbon accounting has a wider scope, utilizing the results of allocation calculations is an oil management process where ownership of Oil and Gas is divided, calculated, and traced from the point of delivery or demolition until returning to the extraction point or loading point. In this case Hydrocarbon accounting also includes stock arrangements, material balances, and practical mechanisms to trace Hydrocarbon ownership transported in the transportation systems such as pipelines to the consumers from several production facilities. The components can be Alkane Hydrocarbon, boiling point fraction, and mole fraction [1-10].

Hydrocarbon Management handles hydrocarbon calculations in all businesses which related with reports for stakeholders and in accordance with the agreement both sharing agreements and commercial agreement and ensuring the production distribution to shareholders from the field. Hydrocarbon Management must ensure that all the data and information used in all types of report are the same and from one verified source with high quality and integrity in order to prevent financial risk and reputation.

In the open access gas pipeline network operations, the difference in the results of measurement will certainly be a problem for the shipper (users of the pipeline), especially if the gas volume measurement inserted into the network is different or smaller than the measurement of gas released. Because of that, the open access pipeline network operation requires a gas management system to manage various problems, both technical and commercial.

If the amount of gas inside the pipe is smaller than the minimum linepack, the gas supply to the consumer will be disrupted, whereas if the amount of gas in the pipeline exceeds the maximum linepack, the pipe operating pressure can increase beyond the safe operating pressure limit, thus requires gas release to the air (gas venting) which results in gas loss.

III. METHOD

The method used is a literature study with similar problems and data collection on gas distribution in the EJGP pipeline system (Figure 5). Based on existing data, a model is made according to field conditions to facilitate verification calculations on formula and data processing software. Ensuring the accuracy of measurement instrument reading at the delivery point, which using Ultra Sonic Meter type and Orifice Meter type, and at the receiving point, all of which use the Orifice Meter type. Conduct a gas volume calculation in pipe based on pipe average pressure and dimensions, average temperature (Figures 6 and 7). Discrepancy or comparison between the results of mass balance calculations, namely Gas Stock (initial fill, opening stock, quantity received, quantity delivered and own use) with the linepack calculation and the calculation conducted by the operator.

FlowQount, a tool used in this research. FQ main strength is at its modeling capabilities. Model consists of fluid flow diagram and metadata parameter. It can model the process stretch from lifting point to well head, even to the reservoir (Figure 4). The modeling can be on high level or it can be detailed to any layer that suits the needs.

The modeling becomes a powerful tool to enable all of stakeholders to have the same perspective of the process flow, what information recorded at which point within the network and how the information is generated. Hence, full collaboration, analysis and reporting can be performed in efficient and effective manner. FQ integrates the perspective of multi functions toward the upstream oil and gas operating asset from reserve potential to lifting/sales actual. FQ serves as Online Transactional Processing system and also as Online Analytical Processing system. Example of data integrated within FQ such as:

- PVT data at any nodal within fluid network
- Well test data
- Production operation activity data
- Node properties e.g. well, equipment, facility, reservoir, processing plant, terminal, etc.

If connected to measuring devices / indicators system, can be used to do real-time open access system EJGP monitoring and analysis to find out a detailed trend that occur in gas distribution, where there are a lot of changes that can affect the distribution pattern. By knowing those trends comprehensive analysis of developments that occur in a short time can be carried out so that appropriate steps can be take to control the process of supply, distribution, and transportation of gas as a whole in the system. By doing modeling and simulation we can calculate the linepack, pressure, temperature, discrepancy, and analysis of the existing trand. The work steps taken to conduct modeling and simulation include:

- Making a model of EJGP pipeline system that will be conducted in this study as an open access system, and can describe the real condition of the EJGP Pipeline.
- Determining formulas (example: Panhandle B, Weymouth) which will be used in calculations (linepack, discrepancy) with some parameter inputs that can be customized, such as flow rate (mmscfd), pressure (Psig), temperature (° F), GHV (Btu / Scf), and Specific Gravity (SG), Gas Composition and others accordingly.
- Perform an iterative calculation if needed especially to calculate the pressure and temperature at the junction which there are no indication of required parameters.
- Communicate with a web base so that monitoring can be carried out and can be accessed anywhere as desired.

IV. RESULTS AND DISCUSSION

Based on the configuration of the EJGP pipeline system, several inlet and outlet points were identified used a different measuring devices, and there was a \pm 345 MMBTU Gas stock in the pipe having a length of \pm 370 km 28 inch offshore pipe, and \pm 100 km onshore pipe.

4.1. Inspection of Gas Inlet and Outlet Measuring Devices

Checking on USM meter a, l: Verify the USM meter system data using data gained from the dry calibration and wet calibraton:

- Deviation when testing with error of 0,000221%
- Series test with a reading difference of 0.122%

Check on the Orifis meter system a, l: In the annual calibration data, it can be seen that the deviations in the Diffrential Pressure Transmitter (DPT), Pressure Transmitter (PT) and Temperature Transmitter (TT) are very small, even far below the regulations set by the government (Dirjen Migas) that the maximum deviation ± 1 (one)%.

- Dimensional checks meet the requirements set out in AGA Report # 3
- Generally, the Pressure Base (P_b) data entered into the Gas Flow Computer is not in accordance with the P_b data contained in the Gas Sale and Purchase Agreement (PJBG) with a deviation (Error) around - 0.20367%.

4.2. Calculation of Linepacks in a Pipe System

The calculation of Linepack or Calculated Gas Stock used is in accordance with best practices [11]:

$$LP = C \frac{T_s}{Z_{av} T_{av} P_s} \left(P_1 + P_2 - \frac{P_1 P_2}{P_1 + P_2} \right) LD_i^2$$
(1)

where:

LP = Linepack, MMscf

 $C = 1.193 \times 10^{-5}$

- P_1 = The gas pressure enters the pipe (receipt point), psia
- P_2 = The gas pressure at delivery point, psia
- $T_s = Standard temperature, °R atau (460 + °F)$
- P_s = Standard pressure, psia
- Z_{av} = Average gas compressibility factor in a pipe
- T_{av} = Average gas temperature inside the pipe, °R or (460 + °F)

L = Pipe length, km

 $D_i = Diameter of inner pipe, inch$

Calculation of pressure in branching has also used Panhandle B's best practices:

$$P_{2} = \left[P_{1}^{2} - \left(\frac{Q}{737\left(\frac{T_{b}}{p_{b}}\right)^{1.02} D^{2.53}}\right)^{1/0.52} K\right]^{0.5}$$
(2)

where

- $K = G^{0.961}T_f LZ$
- Q = volume flow rate, standard ft3/day (SCFD)
- E = pipe efficiency, decimal value is less than 1.0
- P_b = base pressure, Psia, in this case 14.73 Psia.
- T_b = base temperature, °R (460 + °F), in this case 520 °R
- P_1 = upstream pressure, Psia
- P_2 = downstream pressure, Psia
- G = gas gravity (air = 1.00)
- T_f = average gas flow temperature, °R (460 + °F)
- L = length of pipe segment, mile
- Z = gas compressibility factor, dimensionless.
- D = pipe diameter, in.

V. CONCLUSIONS

- 1. The Discrepancy calculation difference between the Operators and the Tools differ around -0.12%. Using the same calculation concept, there are calculation differences of Pressure and Temperature in locations where there is no measurement tool.
- 2. The Maximum Allowable Tolerancy that is currently 0.85% can be reviewed to be lowered considering the realization of the average system Discrepancy in 2017 - 2018 is around 0.54% so that the Operator has more awareness and the shipper gets better certainty.
- 3. Discrepancy will be smaller if the gas supply and

withdrawal are balanced.

- 4. Different types of measuring instruments will lead to different accuracy, and if a more accurate measuring device is wanted, then all measuring instruments had to use USM so that the verification / validation can be carried out together by the stakeholders and if needed can be conducted by independent callibration agent periodically.
- 5. Stakeholders, including state auditors, can use similar tools to verify if there are hydrocarbon losses in a system.
- 6. For new Shipper from Sirasun Batur Field, it is still more economical using existing pipes with bearing the Discrepancy / Losses up to 1% as the consequence if compared to build new pipes to consumers and also on-stream schedules will be faster.

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Figure 1. EJGP pipe system



Figure 2. Discrepancy Data History (2012-2015)



DISCREPANCY FROM SEPTEMBER TO OCTOBER 2013

Figure 3. Discrepancy between the verification data and the calculations data from September - October 2013



Figure 4. FQ Modeling Feature



Figure 5. Methodology flowchart



Figure 6. Pressure calculation flowchart



Figure 7. Temperature calculation flowchart