Comparison of methods for calculating gas reserves in providing certainty of reserves in the oil and gas industry

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Abstract. The volumetric method is the initial method used in calculating hydrocarbon reserves obtained from the exploration stage obtained geological data from a field in the oil and gas industry. The hydrocarbon reserve calculation obtained from a volumetric method is the result of interpretation data, such as seismic and logging data that have a small range of trust. In this study estimated hydrocarbon reserves in the XY formation gas reservoir using a material balance method or P/Z method in assessing optimism or pessimism of the reserve value generated from a volumetric method. The material balance method or P/Z method was chosen as a reliable method. Because it has better accuracy data such as pressure measurement data, reservoir rock, and fluid analysis data. Cumulative production measurement data compared to interpretation data on a volumetric method. From this research can be concluded that the reserve value produced by the volumetric method is more pessimistic than the reserve value using the material balance method and P/Z method. By knowing pessimism results from the volumetric backup method for the other two methods, it will affect the amount of oil and gas industry reserves so that geological model needs to be done again after more accurate data is obtained.

1. Introduction

Determination of the value of original oil in place or original gas in place (OOIP / OGIP) is a very important initial stage and greatly affects the sustainability of an oil and gas industry. The number of methods in the current analysis of OOIP / OGIP calculations requires correction to eliminate uncertainty from each method used in carrying out the analysis [1–6]. Uncertainty in the analysis of OOIP / OGIP values depends on the data used whether the data should be analyzed first or the data can be directly used in the analysis of these calculations. The uncertainty of each data that first requires analysis before it can be used in the OOIP / OGIP. Has greater uncertainty compared to the real data generated directly from each well in the oil or gas field which can be directly used in the value determination analysis OOIP / OGIP [7-8].

In this study, data from wells in the gas reservoir is used. The data obtained are petro physical data, bulk volume data from the model geological analysis, PVP data, production data.

The comparison of the methods used in the OGIP analysis in this study aims to correct the OGIP value from the volumetric method analysis using the material balance method. So that it can be seen how much the analysis results differ from the two methods.
2. Methods

In this study, a comparative method or comparison between the two analytical methods will be used in analyzing the OGIP value of a gas reservoir field. To conduct an OGIP analysis on the gas reservoir, it is necessary to identify the type of gas produced from the reservoir by looking at the value of the contents of C1 to C7+ from the gas reservoir production results [9-10].

After knowing the type of gas to be analyzed by OGIP, then doing an OGIP analysis using two methods, namely the volumetric method and the P / Z material balance method. That will be compared how much the difference in OGIP values resulted from the two methods [11-12]. The difference between the two methods may not exceed ± 5% according to the provisions of the results of previous studies [13]. The flow of the analysis in this study can be seen in figure 1 flow chart.

![Flowchart of research work](image)

Figure 1. Flowchart of research work.

Volumetric analysis requires data such as bulk volume data from the results of geological analysis models and data from logging data analysis. These data are usually obtained from the exploration stage so that the data still needs to be analyzed first before being used directly in volumetric analysis [14-16].

In the analysis of material balance, data is needed such as reservoir rock analysis data, production data, pressure data, and PVP analysis data. These data are real data obtained from a routine recording of wells and lab analysis results from real samples from wells. So that the data can be said to have less uncertainty than the data used in volumetric analysis [17-20].

3. Results and discussion

In table 1, it can be seen that the results of the identification components of the contents about C1 to C7+ in the gas produced have a type of wet gas, so it is necessary to first calculate how much the vapor equivalent value contained in the gas. To be able to determine the value of Veq can be seen in figure 2.
Table 1. Gas composition.

| Component | Composition (%) | Exp. |
|-----------|-----------------|------|
| C1        | 87.95           | Wet gas |
| C2        | 4.14            | Dry gas |
| C3        | 2.00            | Wet gas |
| C4        | 1.22            | Wet gas |
| C5        | 0.56            | Wet gas |
| C6        | 0.30            | Wet gas |
| C7+       | 1.30            | Wet gas |

Figure 2. Vapor equivalent graphics.

After determining the type of gas from the gas composition contained, the next stage can be analyzed OGIP value in the gas reservoir using the volumetric method and material balance. The results of the analysis can be obtained using the following formula.
\[ G = \frac{43560 \times V_b \times \phi \times (1 - s_{wi})}{B_{gi}} \]

\[ G = \frac{43560 \times 1662000 \times 0.248 \times (1 - 0.048)}{0.006035} \]

\[ G = 2832 \text{ BSCF} \]

By obtaining the value of \( V_{eq} \), can be analyzed the value of the condensate contained in the gas content produced. The condensate value will be added to the value of the gas produced so that the wet gas value will be obtained which will be used in the analysis of material balance. The results of the analysis of wet gas values can be seen in table 2.

### Table 2. Wet gas production cumulative.

| Pressure (psia) | Condensate (BSCF) | Dry Gas (BSCF) | Wet Gas (BSCF) |
|-----------------|-------------------|----------------|----------------|
| 2887.81         | 0.23              | 9.05           | 9.28           |
| 2872.54         | 0.60              | 21.35          | 21.95          |
| 2853.29         | 1.08              | 39.19          | 40.27          |
| 2805.72         | 2.27              | 83.47          | 85.74          |
| 2742.72         | 4.06              | 153.60         | 157.66         |

The resulting wet gas production value can be directly used in the OGIP analysis using material balance by also using analysis PVT data from the results of laboratory fluid reservoir analysis to obtain the Z value to be used in the material balance method which can be seen in table 3. Material balance method using \( P / Z \) produces an OGIP value of 3141 which can be seen from the plot in figure 3.

### Table 3. Z Constanta.

| Pressure (psia) | Z     | ZiP   | PiZ   | \( 1-(Pzi/PiZ) \) | Gp Wet |
|-----------------|-------|-------|-------|-------------------|--------|
| 2900.49         | 0.903 | 2619.14 | 2619.14 | 0.00000          | 0.00   |
| 2887.81         | 0.903 | 2607.81 | 2618.29 | 0.00400          | 9.29   |
| 2872.54         | 0.902 | 2594.32 | 2617.24 | 0.00876          | 22.00  |
| 2853.29         | 0.902 | 2576.64 | 2615.93 | 0.01502          | 40.36  |
| 2805.72         | 0.901 | 2533.91 | 2612.61 | 0.03012          | 85.92  |
| 2742.72         | 0.899 | 2608.77 | 2608.77 | 0.04999          | 158.06 |

![Figure 3. Material balance methods.](image_url)
The results of the analysis OGIP values generated from the volumetric method are 2832 BSCF and from the material balance value are 3141.44 BSCF. The results of the two methods show a large difference in OGIP value of 9.8%. So it can be said that the OGIP value generated from the analysis using volumetric methods is more pessimistic than the OGIP value generated from the material balance method.

The material balance method is a correction value for the value produced by the volumetric method. Because the material balance method uses well data from each field that is directly used in the material balance analysis. So that the uncertainty of the data becomes smaller than the data used in the volumetric method. the data must be analyzed first before being used in volumetric methods so that it will cause considerable uncertainty.

4. Conclusion
From this study can be concluded:

- Analysis of reservoir type through reservoir fluid analysis data produces a conclusion of the type of gas reservoir in the XY Reservoir, namely the Wet Gas reservoir.
- Calculation of the initial gas count on the place of use, the Volumetric method and the Material Balance method obtained a large reserve value as follows 2832 BSCF and 3141 BSCF.
- From the results of the initial gas reserve calculation using the two methods, it can be seen that there are a number of large reserves where the reserve value from the volumetric method is more pessimistic than the reserve value from the results of the material balance method.
- the difference in the reserve value of the results of the volumetric method on the material balance method is 9.8%, so correction or re-analysis needs to be done to determine the reserve value using the volumetric method.

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