

Reducing Hydrocarbon in Place Uncertainty in Akasia Bagus Structure as Potential Field and Redevelopment Review

(Pengurangan Ketidakpastian Hidrokarbon di Tempat dalam Struktur Akasia Bagus sebagai Lapangan Berpotensi dan Tinjauan Pengembangan Kembali)

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Abstract

The success of the discovery of new structure Akasia Bagus with potential L layer in 2009 at PT Pertamina EP's Jatibarang Field was followed up by the drilling infill wells with Plan of Development (POD) mechanism which is currently in the process of drilling the last well. The basis of the L layer hydrocarbon calculation in place on the POD is a static analysis. The wells currently produced are still able to flow with natural flow and enough production data since 2009 this structure was found. This study will present an analysis of production in the L layer of Akasia Bagus structure for Original Oil In Place (OOIP) updates using the conventional material balance method and then carry out the best development strategy to optimize oil production. Economic analysis is also carried out for reference in making decision on which scenario to choose. The conventional material balance method gets an OOIP value of 17.36 MMSTB, with the drive energy ratio being 5:3:2 for water influx : fluid expansion : gas cap expansion. Three (3) production optimization scenarios were analyzed, the results showed that the addition of 2 infill wells reached Recovery Factor (RF) of oil up to 23% of OOIP, minimal water production and attractive economic results.

Keywords: OOIP, OGIP, production analysis, L Layer of Akasia Bagus structure, Economic

Sari

Keberhasilan penemuan struktur baru Akasia Bagus dengan lapisan potensial L pada tahun 2009 di Lapangan Jatibarang PT Pertamina EP ditindaklanjuti dengan pemboran sumur-sumur infill dengan mekanisme Rencana Pengembangan Lapangan (POD) yang sampai sekarang sedang dalam proses pemboran sumur terakhir. Dasar dari perhitungan hidrokarbon di tempat Lapisan L pada POD adalah analisa statik. Sumur-sumur yang sekarang diproduksi masih dapat mengalir secara sembur alam dan mempunyai data produksi sejak tahun 2009 struktur ini ditemukan. Penelitian ini akan menyajikan analisa produksi pada lapisan L struktur Akasia Bagus untuk update Awal Isi Minyak di Tempat (OOIP) dengan menggunakan metode material balance konvensional kemudian melakukan strategi pengembangan terbaik untuk mengoptimalkan produksi minyak. Analisis ekonomi juga dilakukan untuk acuan dalam membuat keputusan skenario yang akan dipilih. Metode material balans konvensional mendapatkan nilai OOIP 17,36 MMSTB, dengan rasio energi pendorong adalah 5:3:2 untuk water influx : fluid expansion : gas cap expansion. Tiga (3) skenario optimasi produksi telah dianalisis, hasilnya menunjukkan bahwa penambahan 2 sumur infill akan mencapai perolehan minyak sebesar 23% dari OOIP, produksi air minimal, dan hasil ekonomi yang menarik.

Kata kunci: OOIP, OGIP, analisa produksi, Lapisan L struktur Akasia Bagus, Keekonomian

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I. INTRODUCTION

Akasia Bagus Structure is in Jatibarang Field which is an onshore field of PT. PERTAMINA EP and located in Indramayu Regency, West Java Province. There are 6 wells produced in this field using Plan of Development mechanism, the ABG-01 (2009), ABG-02 (2014), ABG-03 (2016), ABG-04 (2018), ABG-05 (2018), and ABG-06 (2019), as well as ABG-07 wells which are in the process of drilling. All six of these wells have been successfully proven hydrocarbon potential in 9 prospective zones in the Upper Cibulakan Formation [3].

Akasia Bagus structure has been approved is the development of the Put On Production (POP) mechanism, which was previously 3 production wells then developed with 4 infill wells, 3 Workover and subsurface facilities upgrades. From this development mechanism the cumulative production up to April 2019 was 522.41 Mbbl, 8,540.95 MMscf, with the last average production rate of 450 bopd, and for associate gas of 1.01 MMscfd. All gas production is channeled through the pipeline to the SP Tugu Barat while condensate production is sent to the Cemara SPU via the existing trunkline.

The production zone is currently at layer L with OOIP and Original Gas In Place (OGIP) calculations based on static models of POD were 0.9 of P1 + 0.5 of P2: 16.77 MMSTB and 235 BSCF [3]. This layer has been produced since 2009 with natural flow conditions. Before the end of the current POD mechanism, the L layer of Akasia Bagus structure needs production analysis which covers several analyzes such as: well modeling analysis, material balance analysis, and economic analysis to update reservoir conditions and field development scenarios.

II. METHOD

The procedure of the research is depicted in Figure 1. The research applied three methods namely production decline analysis, well performance modeling, and material balance analysis.

In this research well testing interpretation was conducted to get important reservoir parameter such as Initial reservoir pressure, permeability, skin factor and also possible reservoir boundary. The result of well-testing interpretation then become input data to build well performance model.

Production analysis is used to analyze transient rate and pressure. The outputs to estimate OOIP. All of these outputs will be used to validate OOIP value from static model in the previous study and for a reservoir simulation for history-matching and then forecasting production for the following years to know the reservoir behavior and prepare a development strategy. The scope of work used in this research are [4]:

- Data Acquisition and Selection

Collect daily wellhead pressure and production rate data from the beginning of production, as well as static data like initial reservoir pressure and temperature, rock properties, hydrocarbon properties, open-hole logs, and well completion diagram.

- Data Validation

Make sure all the dynamic data is valid. For example, if wellhead pressure increases, the production rate should decrease. This step often takes the longest time and involves much detective work to chase down the reason for step-changes and other anomalies. It is critical because "rubbish in equals rubbish out".

- Well Modeling

First of all, conduct well-testing analysis to get reservoir pressure initial, reservoir parameter of tested well such as permeability, skin and possible reservoir boundary. The result then uses as input for gas deliverability analysis to get the Inflow Performance Relationship (IPR) curve and the Absolute Open Flow Potential (AOFPP).

- Material Balance Analysis

The production data and limited static reservoir

pressure data will be analyzed using material balance analysis to get OOIP and OGIP of the reservoir.

- Forecast Production Profile

Reservoir simulation generates several forecast scenario and development plan will be prepared to ensure oil and gas deliverability matches the production data.

- Economic Evaluation

The economic evaluation will be run to guide in making a decision which about scenario will be selected.

III. RESULTS AND DISCUSSION

A. Production Decline Analysis

The next step after the data collection and validation is complete then analyze production decline. There are five wells which are producing layer L. However only ABG-02 well has sufficient data and can represent Layer L in Akasia Bagus structure. Figure 2 shows ABG-02 well history and production profile.

ABG-02 well began producing on April 12, 2018. During production from the beginning, the choke size changed several times to increase production until April 2018. After that, the ABG-02 well produced naturally without adjustment choke until June 2019. It was also seen that from April 2018 already a noticeable decline in production. While the other wells ABG-03, ABG-04, ABG-05, and ABG-06 have not seen a decline in production, history and production profile can be seen in Appendix B.

On the decline analysis will be made 3 types of decline is exponential, harmonics, and hyperbolic. The third decline will be compared and selected one of decline that may occur in the layer L reservoir with high Gas Oil Ratio (GOR) and there is a gas cap [2].

- Exponential Decline

Figure 3 is an exponential decline with the axis is the number of days versus the ordinate is the production of oil (in bopd) on a logarithmic scale. Table 1 shows the calculation result of exponential decline of ABG-02 Well. The exponential line equation is

$$q_o = 4.979177E+02e^{-3.342060E-03 t}$$

where q_o is production rate of oil (bopd) and t is time(day).

- Harmonic Decline

Figure 4 is a harmonic decline with the axis is cumulative oil production Mbbl versus the ordinate is the production of oil (in bopd) on a logarithmic scale. Table 2 shows calculation result of harmonic decline of ABG-02 Well. The harmonic line equation is

$$q_o = 4.811704E+02e^{-1.412163E-02 t}$$

- Hyperbolic Decline

Figure 5 is a hyperbolic decline with the axis is (1

+ b Di t) versus the ordinate is the production of oil (in bopd) on a logarithmic scale. Table IV.3 shows calculation result of hyperbolic decline of ABG-02 Well. The hyperbolic line equation is

$$q_o = 9.4584467E+02e^{-7.037395E-01(1+b Di t)}$$

Of the three declines that have been made, exponential and hyperbolic decline are quite reasonable with production time around 5 years and cumulative production around 200 Mbbl. However, initial production for exponential decline more represented the condition of the wells in the Akasia Bagus field. Therefore, an exponential decline was used for the analysis of Akasia Bagus field production's decline.

B. Material Balance Analysis

As discussed in previous chapter, there are limited static reservoir data available in the Layer L reservoir. However, in this study, the material balance analysis is also conducted. For material balance analysis using M-BAL software. Input data for the M-BAL analysis are reservoir parameters, relative permeability, production analysis, PVT, and water influx as the sensitivity parameters [1].

Some of the methods that have been modeled, the F/Et versus We/Et method which gives a fairly representative curve at both points, can be seen in Figure 6. The OOIP estimation given by this method is 17.36 MMSTB.

Figure 7 shows the percentage of energy reservoir on the L layer that contributed to oil when it was produced. The figure shows that there are 3 dominant energies namely water influx, gas cap expansion, and fluid expansion. The initial energy ratio is 5: 2: 3 for water influx: gas cap expansion: fluid expansion. But over time the well-produced energy from water influx is increasing.

C. Production Forecast

This section focused on the prediction of the future field/reservoir performance. Forecast production methods used in this study is exponential decline previously discussed. To obtain the perfect scenario to optimize production of the field, a total number of 4 (four) different forecast cases were run up to the economic limit at 10 bopd [4]. The forecast cases considered were as follows:

Case 1: Base Case or No Further Action (NFA)

NFA case showed the oil recovery of 15.1 % at the end of prediction run-up to its economic limit in May 2028. In this case, the cumulative oil production was 2.56 Mbbl.

Case 2: Add 2 Infill-drilling Wells

The impact of additional two infill-wells can be seen in Figure IV.8, recovery factor of 20 % and the cumulative oil production was 3.29 Mbbl.

Case 3: Workover Acidizing ABG-04

In the history of ABG-03, acidizing was done to increase well production. After 2.5 months the well is produced, there seems to be a downward trend. This is inversely proportional to the performance of adjacent wells. After acidizing, ABG-03 production increased to 1,000 bopd.

The ABG-04 well is an identical well with ABG-03, therefore it is necessary to work on acidizing workover activities at ABG-04 well to increase well production. In this case showed the cumulative oil production was 3.08 Mbbl and oil recovery 18%, at the end of prediction run in October 2018

Case 4: Combination Scenario 2 and 3

In this case, it was combination of scenario 2 (additional 2 infill-wells) and scenario 3 (work over of ABG-04 well). This case showed the cumulative oil production was 3.91, gas recovery of 22.5 % at the end of prediction run in January 2029.

According to Table 4, its observed Case 2 and 3 not have significant differences. In terms of recovery factor Case 4 shows are slightly different from the other cases. Based on RF comparison above Case 4 is the best case. To select the best scenario economic evaluation of each scenario will be considered.

IV. CONCLUSIONS

Layer L Akasia Bagus Structure is an oil field with high GOR. Continue produced since April 2018 with current cumulative production is 522 Mbbl. From the analysis of production was concluded as follows:

1. The conventional material balance method gave OOIP 17.36 MMSTB, this method shows slightly higher with OOIP volumetric calculation of previous static reservoir model 16.77 MMSTB with discrepancy OOIP value + 3.5%.
2. There are three dominant drive energies namely water influx, gas cap expansion, and fluid expansion. The initial energy ratio is 5: 2: 3 for water influx: gas cap expansion: fluid expansion.
3. In this thesis work, 4 (four) different prediction cases were run up to limit its economic to optimize production. Case 4 is the best result with the highest RF 23% and minimal water production.

REFERENCES

1. Arcaro D. P., Bassiouni. 2012. The Technical and Economic Feasibility of Enhanced Gas Recovery in the Eugene Island Field by Use of the Coproduction Technique.
2. Gomaa E. 2009. In-House Training Course, Jakarta, Reliability & Consistency of Core Analysis PVT Data.

3. Pertamina EP Team, 2016. Plan of Development Lapangan Akasia Bagus.
4. Widiatoro P. S. and Hakim A. R. 2015. Production Data Analysis: Estimating OGIP and Forecasting Gas Production Profile from Rough Data of Over-Pressured Gas Reservoir. presented at APOGCE, Bali.
5. Engel A. A. S., Sudibjo R., and Fathaddin M. T. 2018. Peramalan Kinerja Lapangan SNP dengan Injeksi Air Menggunakan Metode Material Balance. Journal of Earth Energy Science, Engineering, and Technology, 1(3), p. 111-113.

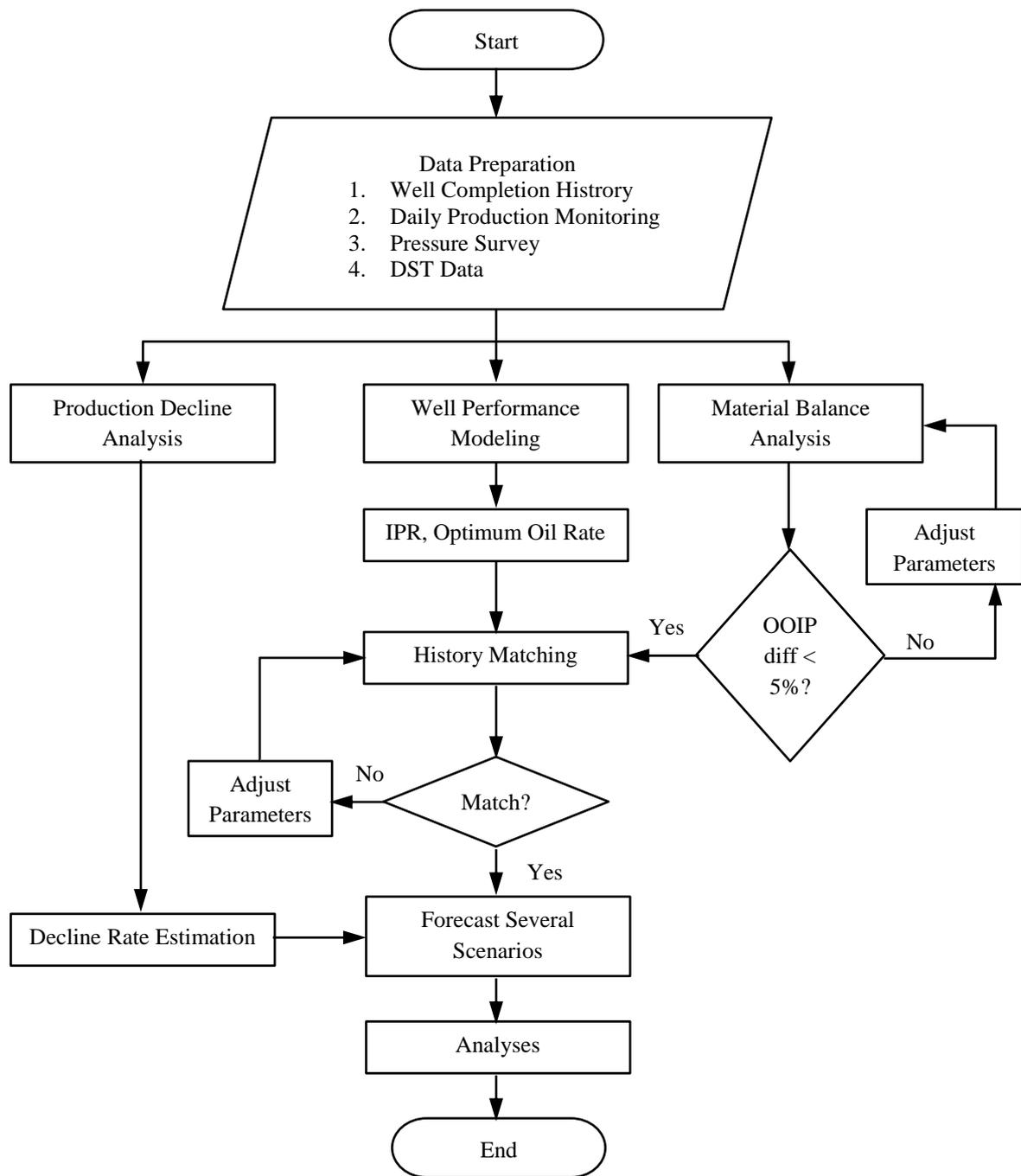


Figure 1. Research Flow Chart

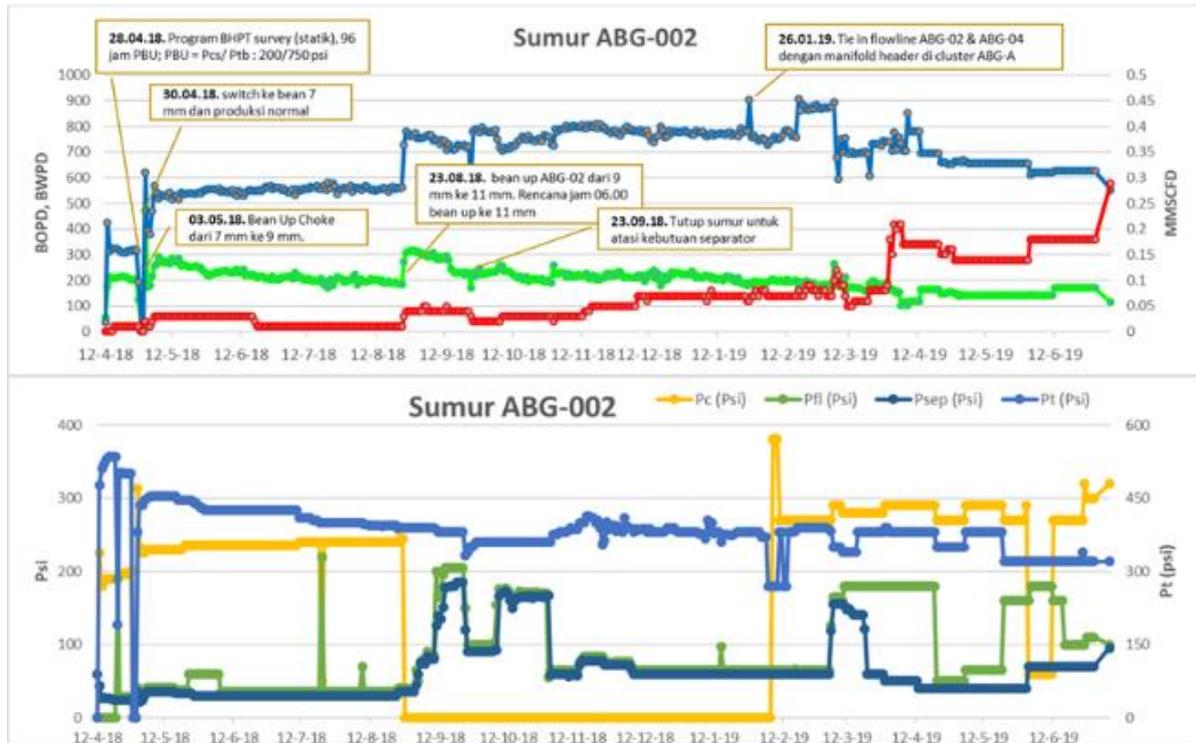


Figure 2. ABG-02 Well History and Production Profile

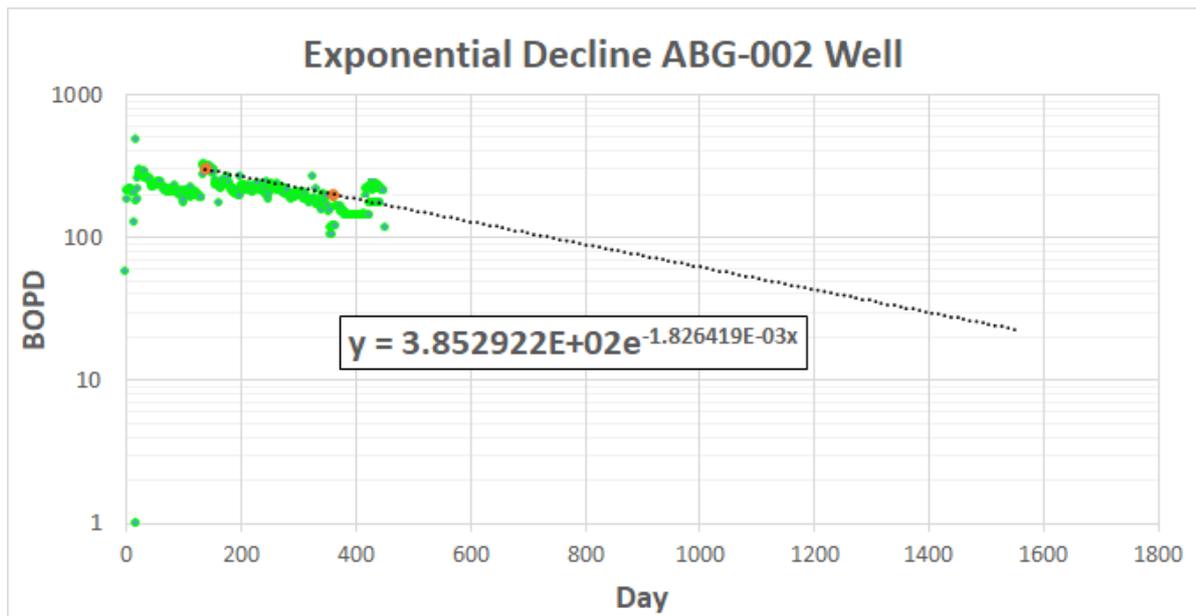


Figure 3. Exponential Decline Curve of ABG-02 Well

Table 1. Calculation Result of Exponential Decline of ABG-02 Well

Qi (bopd)	Qabd (bopd)	m	Di		t abd		Np, Mbbl
			daily	yearly	day	year	
385	10	-0.000793	0.00183	0.65763	2000	5.5	205.5

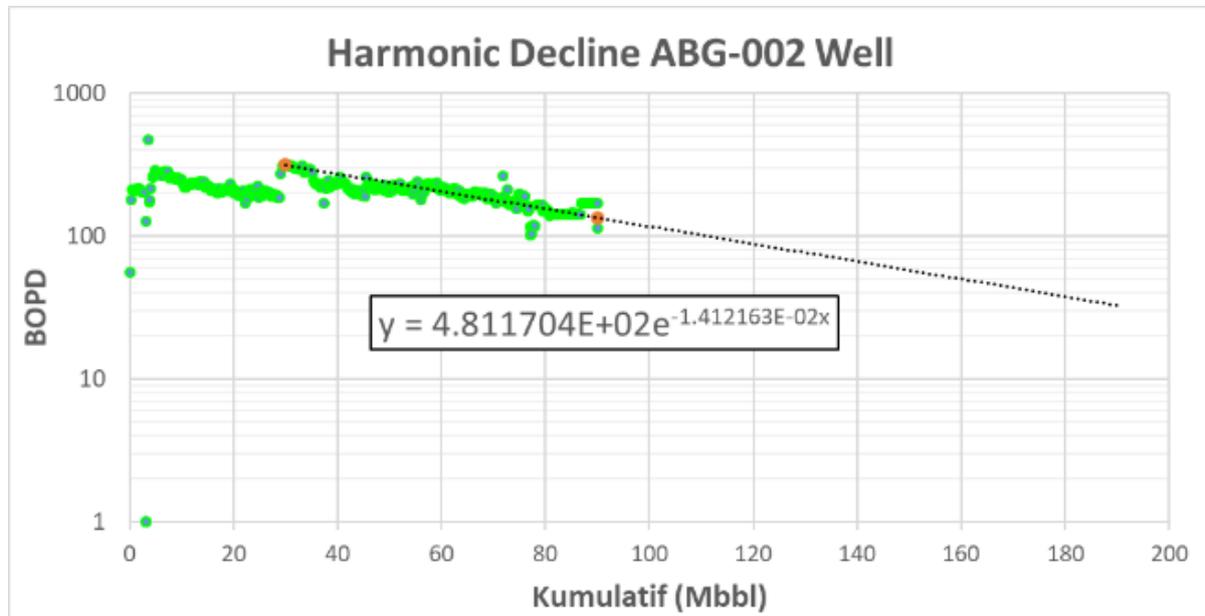


Figure 4. Harmonic Decline Curve of ABG-02 Well

Table 2. Calculation Result of Harmonic Decline of ABG-02 Well

Qi (bopd)	Qabd (bopd)	m	Di		t abd		Np, Mbbl
			daily	yearly	day	year	
481	10	-0.000006	0.00680	0.08155	6902	19.2	274.0

Table 3. Calculation Result of Hyperbolic Decline of ABG-02 Well

Qi (bopd)	Qabd (bopd)	m	Di		t abd		Np, Mbbl
			daily	yearly	day	year	
848	10	0.000127	0.00068	0.00820	2001	5.6	184.4

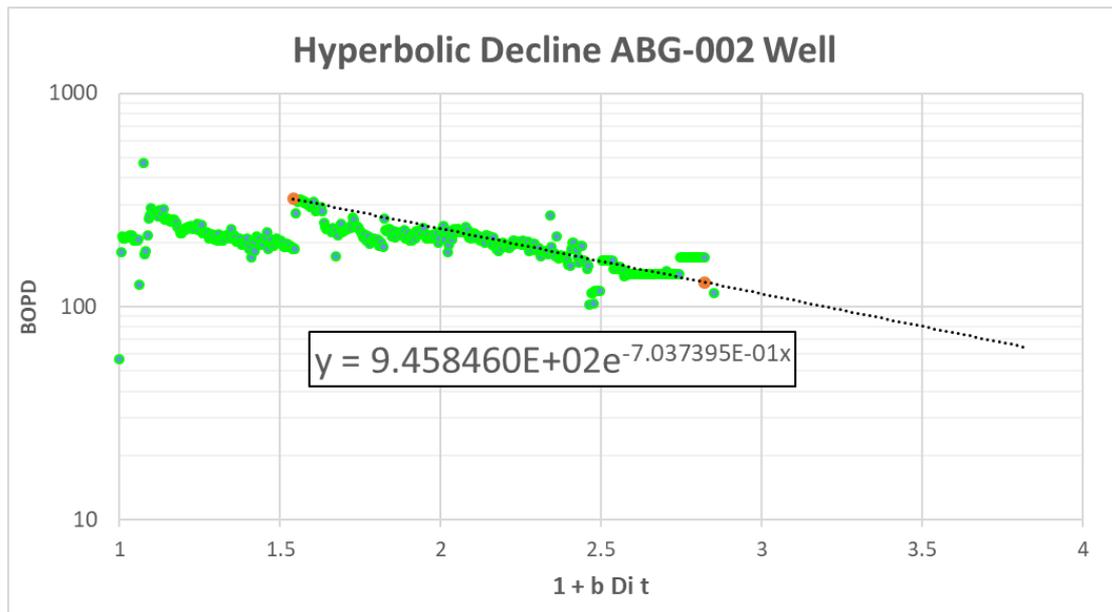


Figure 5. Hyperbolic Decline Curve ABG-02 of Well

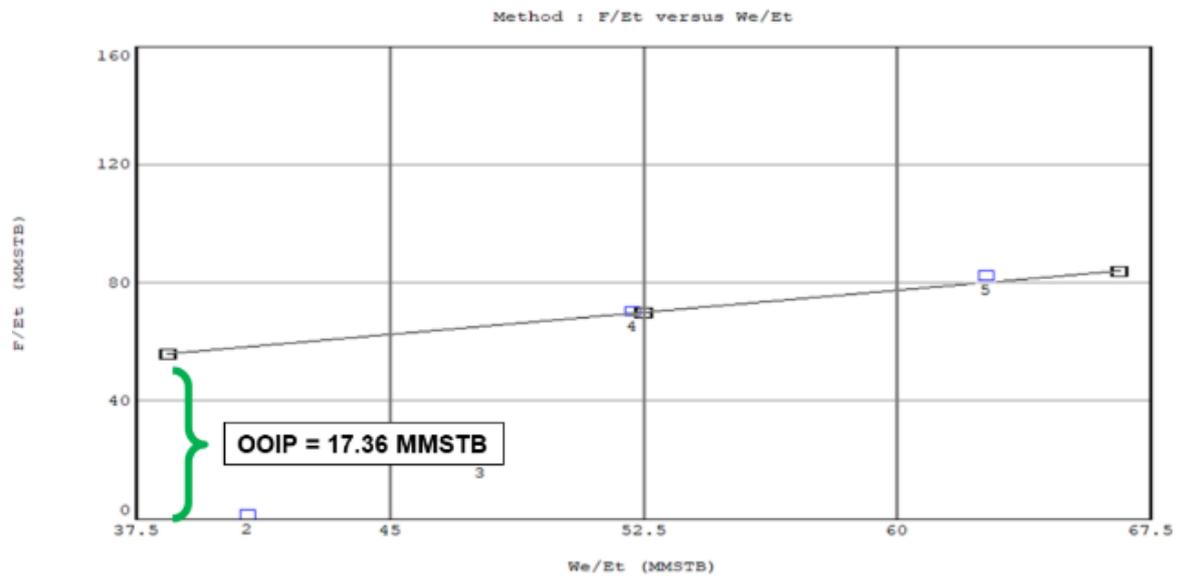


Figure 6. Material Balance F/Et vs We/Et Estimate OOIP of 17.36 MMSTB

Table 4. Performa prediction Comparison of Case 1-4

Prediction Case	Definition	OOIP (MSTB)	Cum Oil Production (Mbbbl)	RF
Case 1	No Further Action (NFA)	17.3	2.56	15%
Case 2	Additional 2 Infill Well		3.29	20%
Case 3	Workover Acidizing ABG-04		3.08	18%
Case 4	Combination scenario 2 & 3		3.91	23%

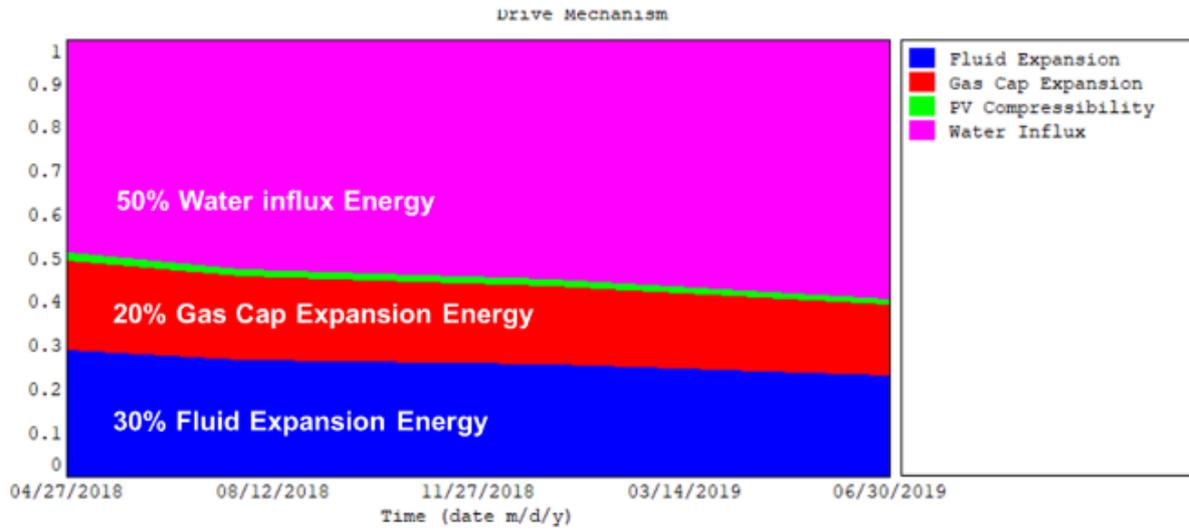


Figure 7. Reservoir Energy Plot of Layer L