

ANALISIS UJI *DELIVERABILITY* PADA SUMUR GAS YA-01

DELIVERABILITY TEST ANALYSIS ON GAS WELL YA-01

Arinda Ristawati ^{(1,a)*}, Mulia Ginting⁽¹⁾, Jasmine Ghina Kaynes ⁽¹⁾, Onnie Ridaliani Prapansya ⁽¹⁾, Hari Karyadi Oetomo ⁽¹⁾, dan Michael Sultan Matheus Sahuleka ⁽¹⁾

⁽¹⁾ *Petroleum Engineering, Universitas Trisakti, Jakarta, Indonesia, 1140*
Email : ^(a*) arinda@trisakti.ac.id

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Abstract. Deliverability tests are used to evaluate a well's production capability by estimating the Absolute Open Flow Potential (AOFP) and maximum flow rate. The three main methods applied are the Flow-after-flow Test, Isochronal Test, and Modified Isochronal Test. For the YA-01 gas well, the Flow-after-flow Test was used, which involves steps such as data compilation, plotting, calculation of the inverse slope (n), and determination of the AOFP and maximum flow rate (Q_{max}). Software analysis results indicated an inverse slope (n) of 1.19226, a C value of $4,18 \times 10^{-7}$ MSCFD/psia², an AOFP of 12,930 MSCFD, and a Q_{gmax} of 3,879 MSCFD. For verification, a manual analysis using the Rawlins-Schellhardt and Horner methods with a pseudo-pressure approach was conducted, yielding an AOFP value of 12,850 MSCFD. The combination of software and manual results provides a comprehensive and accurate understanding of the well conditions, supporting production optimization decisions and evaluating the effectiveness of the acidizing process.

Keywords: Deliverability Test, Absolute Open Flow Potential (AOFP), Flow-after-flow Test, Permeability and Skin Factor, Flow Efficiency.

Abstrak. Metode deliverability test digunakan untuk mengevaluasi kemampuan produksi sumur dengan memperkirakan nilai Absolute Open Flow Potential (AOFP) dan laju alir maksimum. Tiga metode utama yang diterapkan adalah Flow-after-flow Test, Isochronal Test, dan Modified Isochronal Test. Pada sumur gas YA-01, Flow-after-flow Test digunakan, dengan langkah-langkah meliputi penyusunan data, plotting, perhitungan inverse slope (n), dan penentuan nilai AOFP dan laju alir maksimum (Q_{max}). Hasil analisis perangkat lunak menunjukkan nilai inverse slope (n) sebesar 1,19226, nilai C sebesar $4,18 \times 10^{-7}$ MSCFD/psia², AOFP sebesar 12,930 MSCFD, dan Q_{gmax} sebesar 3,879 MSCFD. Untuk verifikasi, analisis manual menggunakan metode Rawlins-Schellhardt dan Horner dengan pendekatan Pseudo-Pressure dilakukan, menghasilkan nilai AOFP sebesar 12,850 MSCFD. Kombinasi hasil dari perangkat lunak dan manual memberikan pemahaman yang komprehensif dan akurat mengenai kondisi sumur, mendukung keputusan optimisasi produksi dan evaluasi efektivitas proses acidizing.

Kata kunci: Deliverability Test, Absolute Open Flow Potential (AOFP), Flow-after-flow Test, Permeability and Skin Factor, Flow Efficiency.

INTRODUCTION

The deliverability test method is used to assess the production capability of a well by estimating the AOF (Absolute Open Flow Potential) value and maximum flow rate [1]. There are three main methods in this test: Flow-after-flow Test, Isochronal Test, and Modified Isochronal Test. In the Flow-after-flow Test, different back pressures are applied by shutting the well down to stable pressure (P_r), then producing the well at a flow rate of until stable pressure is reached [2]. This process is repeated four times without having to shut the well down each time a change in production rate is made. This method is effective if the reservoir has high permeability which allows stable conditions to be achieved quickly [3] [4].

Isochronal Test is often used for wells with low permeability, where a long time is needed to reach a stable state. The test is carried out with the same flow time (t), by shutting the well down to stable pressure and recording the reservoir static pressure (P_r) [1]. The well is then produced at a flow rate of q_{sc1} for a certain time (Δt) without waiting for stable pressure, and shut back in until the pressure reaches P_r . This method is designed to provide an estimate of well deliverability with the same time each time the flow is performed [5] [6].

Modified Isochronal Test was developed to overcome the weakness of Isochronal Test which requires a long time. This test is carried out with the same flow time and well shut-in time [7]. In this method, the well is shut in until the pressure is stable and recorded as reservoir static pressure (P_r), then produced without waiting for the pressure to stabilize [6]. Thus, this method shortens the testing time and is more efficient than Isochronal Test, making it more practical to use in field conditions that require fast response time [8]

RESEARCH METHODS

In the YA-01 gas well, the method used for deliverability testing is the Flow-after-flow Test. The steps taken to obtain the AOF (Absolute Open Flow Potential) value include several stages. First, compile data related to the pressure and flow rate of the well. After that, the results of the $P_r^2 - P_{wf}^2$ calculations are mapped against the flow rate (q) to obtain the slope using the y equation from the trendline on the graph [9]. The YA-01 gas well is located in a mature gas field with moderate permeability and significant production history. The field's geological structure consists of sandstone reservoirs with varying levels of porosity and permeability. Before the acidizing process, the well exhibited moderate skin effects, which hindered optimal gas flow. The primary objective of the acidizing process was to enhance permeability and reduce skin to achieve better deliverability. Reservoir pressures were measured to be stable, allowing for efficient application of the Flow-after-flow Test to evaluate well performance post-acidizing. The first step is to determine the value of n using equation 1.

$$n = \frac{\log q_{sc2} - \log q_{sc1}}{\log(P_r^2 - P_{wf}^2)_1 - \log(P_r^2 - P_{wf}^2)_2} \quad (1)$$

Once the value of n is obtained, the value of C can then be determined using equation 2.

$$n = \frac{\log q_{sc2} - \log q_{sc1}}{\log(P_r^2 - P_{wf}^2)_1 - \log(P_r^2 - P_{wf}^2)_2} \quad (2)$$

To find out the flow rate value, equation 3 is used.

$$q_{sc} = C(P_r^2 - P_{wf}^2)^n \quad (3)$$

Next, the AOFP value can be determined using equation 4.

$$AOFP = C(P_r^2 - 14.7)^n \quad (4)$$

Finally, to determine the maximum flow rate value (Q_{max}), this value can be calculated as 30% of the AOFP result, using equation 5.

$$AOFP = C(P_r^2 - 14.7)^n \quad (5)$$

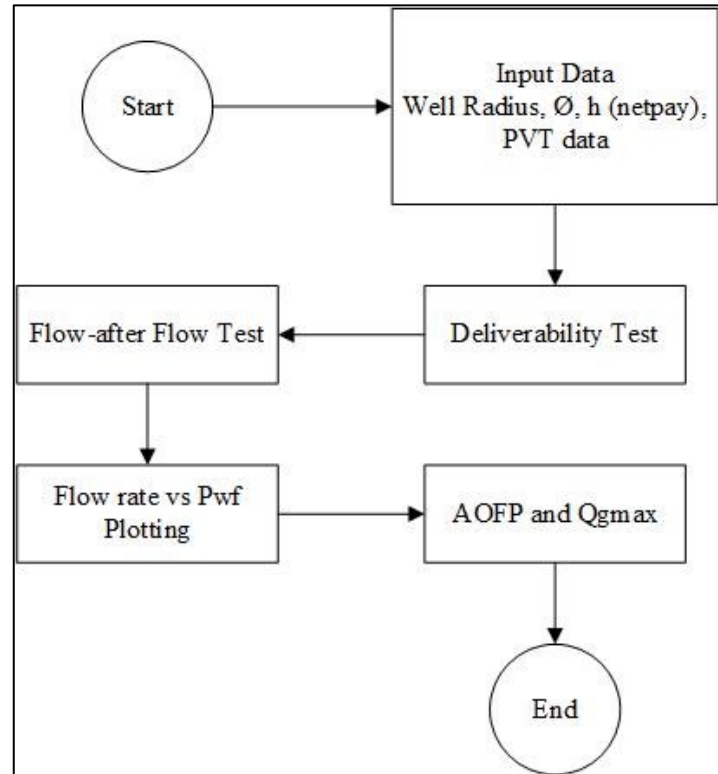


Figure 1. Work Flow on Well YA-01

RESULTS AND DISCUSSION

From the deliverability analysis using software after the acidizing process, important parameters for gas wells were obtained. The inverse slope (n) value obtained was 1.19226, while the C value was recorded at $4,18 \times 10^{-7}$ MSCFD/psia². With this data, the Absolute Open Flow Potential (AOFP) value produced was 12,930 MSCFD. From this AOFP value, the maximum flow rate (Q_{gmax}) that can be achieved by the well is 3,879 MSCFD. The

acidizing process has proven effective in increasing gas flow capacity by improving reservoir permeability and reducing skin effects. Therefore, the well deliverability after acidizing has changed significantly compared to before the intervention. In the future, this data is valid to be used as a reference as long as there are no significant changes in reservoir conditions, such as drastic pressure drops or additional formation damage. However, periodic re-evaluation is still needed to ensure consistency of well performance and to consider potential changes in reservoir conditions that can affect deliverability parameters.

Table 1. Flow-after Flow Test Data for Gas Well YA-01

P_{wf}	q_{sc}	$\bar{P}^2 - P_{wf}^2$	$\psi(\bar{P}) - \psi(P_{wf})$
Psia	MSCFD	psia ²	psia ² /cp
1810,41	7892,26	6.732.428,079	388.149.816,07
2445,36	3636,22	4.030.226,918	215.179.657,84
1645,11	8294,5	7.303.625,535	430.534.455,19
1453,32	8753,67	7.897.873,425	478.341.679,98
2028,93	5398,52	5.893.455,502	330.441.568,53
14,7	0	10.009.796,36	790.033.664,63

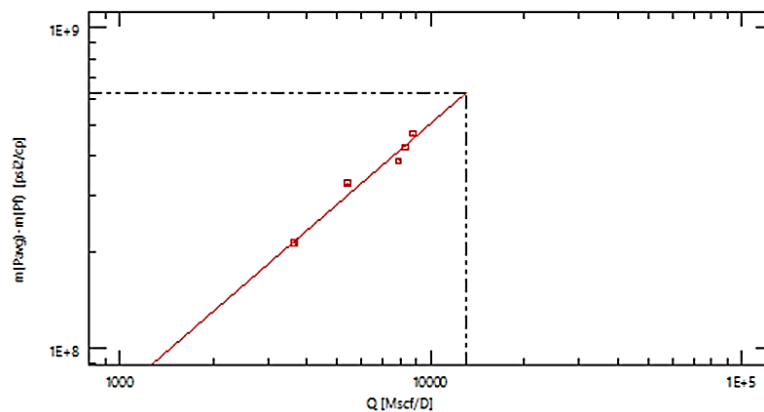


Figure 2. Flow-after Flow Test Analysis After Acidizing

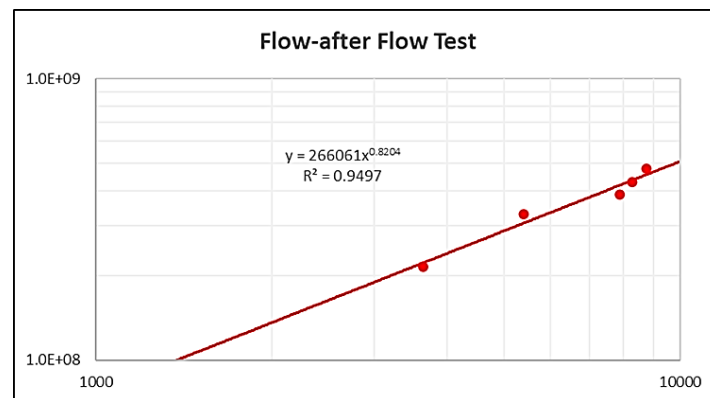


Figure 3. Flow-after Flow Chart After Manual Acidizing

After obtaining the results from the software analysis, a manual analysis was carried out using the Rawlins-Schellhardt calculation method to verify the results obtained from the software. This manual method aims to compare and ensure the accuracy of the deliverability test results previously performed. Figure 3 shows the Flow-after-flow Test graph generated from the manual analysis. This approach allows for cross-validation between the software and manual methods, providing more confidence in the accuracy of the parameters and deliverability test results from the YA-01 gas well after the acidizing process. Through this process, both the software and manual approaches can be viewed and analyzed simultaneously, providing a comprehensive picture of the performance and production potential of the well [10].

CONCLUSION

The results of the deliverability analysis after acidizing with the help of software showed an inverse slope (n) value of 1.19226, a C value of $4,18 \times 10^{-7}$ MSCFD/psia², and an AOFP of 12,930 MSCFD with a Qgmax of 3,879 MSCFD while manual analysis using the Rawlins-Schellhardt method showed an inverse slope (n) value of 1.218901705, a C value of 2.23×10^{-7} MSCFD/psia², and an AOFP of 15,620 MSCFD with a Qgmax of 3,879 MSCFD. Manual analysis using the Rawlins-Schellhardt method provided comparable results and ensured the accuracy of the parameters obtained from the software. This comparison between the software and manual results provides a comprehensive understanding of the well conditions.

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