Analysis of determining deliverability test and transient pressure in the PW-02 Well of Alpha Fields by using Ecrin software

P Wijayanti*, L Said and P J Singh
Petroleum Engineering Department, Faculty of Earth Science and Energy, Universitas Trisakti, Indonesia

*puri.wijayanti@trisakti.ac.id

Abstract. Quantitative analysis of reservoir properties in a well is determined by transient pressure analysis. Transient pressure according to its type consists of Pressure Build up and Pressure Draw Down. This analysis provides an overview of the characteristics of a reservoir. This analysis includes the process of determining drainage area, shape, heterogeneity, porosity, average pressure, skin, permeability, and distance from a reservoir to boundary or flow discontinuities. This test is to determine the ability of gas production in the PW-02 Well, carried out by using the Modified Isochronal test method. This test aims to determine the productivity of a potential (Absolute Open flow). Transient pressure test on PW-02 Well using the Pressure Build up Test (Type Curve Pressure Derivative) method, it is found that the well model is Vertical well and the reservoir model is Two porosity PSS. While the boundary model obtained is Rectangle. Then, the data obtained in the form of positive skin is 1.46, the permeability is 62.5 mD and the reservoir pressure is 2529.32 psia. Based on the analysis obtained Absolute Open Flow Potential (AOFP) is 117406 mscf/D. While the deliverability test value obtained is 117413 mscf/D with n value of 0.825.

1. Introduction
PW-02 well is a well that has been produced since 2010, PW-02 well is a producer of dry gas reservoir and classified as a type of carbonate rock. The main purpose of this pressure test analysis is to determine the size of the formation characteristics of PW-02 Well based on Pressure analysis Build Up Test with the Type Curve Pressure Derivative and Horner Plot method, as well as analyzing the ability of PW-02 Well in flowing gas fluid (AOFP) based on deliverability tests with Ecrin software.

The principle of well testing is to provide a pressure equilibrium disruption to the well to be tested and this effort is carried out by closing a well with a certain time interval or by producing a well with a constant flow rate [1-3]. When testing wells there are several analytical methods that can be used such as Pressure Build Up test, Pressure Drawdown, and deliverability tests such as the Modified Isochronal Test carried out on a gas well [4-8]. The method to be used in this problem is the Type Curve Pressure Derivative Method, the Horner plot with a pseudo pressure approach (P) in the Pressure Build Up test, and the Modified Isochronal Test method on the deliverability test [9-12].

Massonet et al. presented the results of flow simulations in geological complex channelized reservoirs, well test analysis was performed by pure flow simulation and no proposed interpretation technique was presented [13]. The other methods to calculate the type curve pressure
derivative method will be carried out by using reservoir simulation especially by using petroleum software [14-16]. In this research, the software used is Ecrin software, where the process requires reservoir data, pressure data, time data, and production data as input data to be included in the Ecrin software then matching between the model curves with the actual curve. Then by using the Horner Method to plot the pseudo pressure approach manually will be done by first converting from pressure to pseudo pressure in the plot equation P curve vs pseudo pressure Ψ (P) [17-20]. This method is done with Ecrin.

The desired results from the results of this analysis are to provide a comparison of accurate results between the manual with Ecrin Software and can describe the state of the reservoir that is close to the actual condition so that information can be obtained to determine the plan for the well in the future.

2. Method
The deliverability test and transient test in this research is done by using Ecrin Software. The data needed to carry out the analysis with Ecrin software. Data on time, pressure, and production data as input material to carry out further analysis. With Ecrin software, Well Model, Reservoir Model, and Boundary Model can be determined. Figure 1. And Figure 2. Shows workflow for PBU test and deliverability test.

![Figure 1. Workflow pressure build up test with Ecrin software.](image1)

![Figure 2. Workflow deliverability test with Ecrin software.](image2)

3. Results and discussion
3.1. Data used for analysis
To determine Pressure, build up on PW-02 well, supporting reservoir data is needed to support production data with time and pressure data with time.
Table 1. Reservoir data of PW-02 well.

| Reservoir Data                  | Value   | Unit  |
|--------------------------------|---------|-------|
| Reservoir Pressure             | 2530    | psi   |
| Reservoir Temperature          | 206     | °F    |
| Specific Gravity Gas           | 0.64    | -     |
| Gas Deviation Factor (Z)       | 0.88    | -     |
| Gas Viscosity ($\mu_g$)        | 0.018   | cp    |
| Gas Volume Formation Factor (Bg) | 0.0065743 | Cuft/scf |
| Hydrogen Sulfide (H$_2$S)      | 0.18    | %     |
| Carbon Dioxide (CO$_2$)        | 1.2     | %     |
| Nitrogen (N$_2$)               | 0       | %     |

In addition to the reservoir data, other supporting data are needed such as depth data, perforation intervals etc. Table 2. is additional PW-02 well data available from petrophysical data:

Table 2. Petrophysics data of PW-02 well.

| Well Data                  | Value   | Unit  |
|----------------------------|---------|-------|
| Reservoir Thickness (h)    | 65.6    | Feet  |
| Porosity ($\Omega$)        | 20      | %     |
| Well Radius (rw)           | 0.35    | Feet  |

3.2 Ecrin software result

3.2.1 Pressure build up test analysis with Ecrin software. In conducting PW-02 well pressure test analysis, the first method used is the Type Curve Pressure Derivative and Horner Plot method using Ecrin software, where in this software requires reservoir data input, petrophysical data, production test data and pressure data. Figure 3. is the history plot results for PW-02 well?

After history plot was matched, the next stage is the derivative plot matching. Figure 4. is a picture of pressure derivative plot:

**Figure 3.** Result of history plot on PW-02 well.

**Figure 4.** Pressure derivative well curve type of PW-02 well.
Based on Figure 4, the results of the derivative curve in PW-02 well can be seen in the Table 3:

| Well Model | Vertical |
|------------|----------|
| Reservoir Model | Two Porosity PSS |
| Boundary | Rectangle |
| Pi, Psia | 2529.61 |
| Permeability (K), mD | 65.9 |
| Skin Total (S) | 1.46 |
| Omega (ω) | 0.669 |
| Lambda (λ) | 4.68 x 10^{-10} |
| re, ft | 841 |
| ΔP skin, psia | 10.38 |

Besides using the Type Curve Pressure Derivative plot, the Horner plot method can be used. In the PW-02 well, two methods of the Horner approach will be used, namely the Horner method using the pseudo pressure Ψ (P) approach. Figure 5. is a drawing of the Horner chart plot using the Horner method approach Ψ (P).
Table 4. Modified Isochronal Test Data on PW-02 Well.

| P_w, psia | P_wf, psia | Q, MSCFD | P_w^2-P_wf^2 psia |
|-----------|------------|----------|-------------------|
| 2524.07   | 2516.52    | 2836     | 38056.45          |
| 2526.58   | 2505.56    | 6432     | 105775.6          |
| 2526.26   | 2490.43    | 9838     | 179748            |
| 2524.89   | 2467.91    | 14114    | 284489.7          |
| 2524.89   | 2439.07    | 19992    | 426007            |
| 2524.89   | 2464.55    | 10019    | 301062.8          |

Figure 6. is a graph of the deliverability test analysis using the BHP Modified Isochronal equation C and n Producer using Ecrin software?

Based on Figure 6, the n value is 0.825, C when extended flow is 0.2811 (mscf / D) / (psi2 / cp) n, and AOFP is 117413 mscf / D.

The results of analysis and calculations on the Transient Pressure test with Pressure Build Up test and Deliverability test that have been carried out on PW-02 Well. The results of the analysis and calculations include the determination of Well Model, Reservoir Model, Boundary Model, and reservoir characteristic parameters such as reservoir pressure value (Pi), permeability thickness (kh), permeability (k), skin (s), pressure drop due the skin (∆Pskin), flow efficiency (FE), and drainage (re) obtained from Pressure Build Up Test, while the Deliverability Test will get a value of n, C at extended flow and AOFP for PW-02 Well. In the calculation work, both for the Pressure Build Up test and will be done with Ecrin software.

From the results obtained in the analysis of the Pressure Build Up test and Deliverability test on the PW-02 Well, it can be used as an analysis for the planning of further well development so that the well development can be carried out well and optimally so that the well can produce optimally.

4. Conclusion
Based on the analysis of deliverability test and pressure transient conducted on PW-02 well in Alpha Field, some conclusions can be drawn as follows:

- Permeability thickness values obtained based on Type Curve Pressure Derivative and Horner Plot method Ψ (P) with Ecrin software are 4320 mD.ft, 4150 mD.ft, and 4093 mD.ft, respectively, for permeability values of 65.9 mD, 62.5 mD, and 62.4 mD, for skin (s) values respectively 1.46 and 1.56.
• Based on the analysis of the Type Curve Pressure Derivative with Ecrin software, the well model for PW-02 Well is vertical well with the reservoir model Two porosity PSS and the boundary Rectangle model with a reservoir pressure value of 2529.32 psia.
• The reservoir pressure value obtained based on the Type Curve Pressure Derivative with Ecrin and Horner software the method plot (P) is 2925.61 psia.
• Based on the results of Deliverability test with Ecrin software, then the C extended flow value is 0.28115 (mscf / D) / (psi2 / cp) n, for the n value of 0.80521, and the absolute open flow potential (AOFP) for PW-02 Well is 117413 mscf / D. With the value of n obtained 0.80521, then the value indicates if the flow in the PW-02 Well is turbulent flow.

References
[1] D L Katz 1959 Handbook of Natural Gas Engineering (New York City: McGraw-Hill Publishing Co.).
[2] J Lee 1992 Well Testing (Society of Petroleum Engineering of AIME. New York: Dallas)
[3] Z Heinemann 2003 Well Testing (Leoben: University of Leoben) 4.
[4] A U Chaudry 2003 Gas Well Testing Handbook (Advanced TWPSOM Petroleum Systems. Inc. Houston: Texas).
[5] J Lee 1996 Gas Reservoir Engineering (Richmond: TX).
[6] A Tarek 2000 Reservoir Engineering Handbook 2nd Revised Edition (Houston: Texas).
[7] F Kuchuk, M Onur and F Hollaender 2010 Pressure Transient Formation and Well Testing: Convolution, Deconvolution and Nonlinear Estimation (Elsevier: New York).
[8] D Tiab 1995 Analysis of pressure and pressure derivative without type-curve matching: 1-Skin and wellbore storage J. Pet. Sci. Eng. 12 171.
[9] C U Ikoku 1984 Natural Gas Reservoir Engineering The Pennslyvania State University (JohnWiley & Sons Inc. New York: USA).
[10] D Bourdet 2002 Well Test Analysis: The Use of Advanced Interpretation Models (Amsterdam: Elsevier Science B.V.).
[11] M M Kamal 2009 Transient Well Testing (Richardson, TX : Society of Petroleum Engineers) 23.
[12] F H Escobar, Y A Hernandez and C M Hernandez 2007 Pressure Transient Analysis for long Homogeneous Reservoirs using TDS Technique (Colombia : Elsevier Science B.V.).
[13] G J Massonet, R J Norris and J C Chalmette 1993 Well test interpretation in geologically complex channelized reservoirs Paper SPE 26464 68th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers held in Houston: TX.
[14] T Ertekin, J-H Abou-Kassem and G R King 2011 Basic Applied Reservoir Simulation (Society of Petroleum Engineers Inc. Texas).
[15] M M Kamal, Y Pan, J L Landa and O O Thomas 2005 Numerical Well Testing-AMethod To Use Transient Testing Results in Reservoir Simulation paper SPE 95905 presented at the 2005 SPE Annual Technical Conference and Exhibition (Dallas: TX).
[16] I S Nashawi, F H Qasim and R Gharbi 2003 Transient Pressure Analysis of Gas Well Producing at Constant Pressure (Qwaut : Elsevier Science B.V.).
[17] R N Horne 1995 Modern Well Test Analysis: A Computer-Aided Ap- proac (Petroway. Palo Alto. California).
[18] D Abdassah 2005 Production Well Test and Pressure Analysis (Bandung: Yayasan IATMI).
[19] A U Chaudhry 2004 Oil Well Testing Handbook (USA : Elsevier Inc.).
[20] D Rukmana, 2011 Teknik Reservoir Teori Dan Aplikasi Universitas Pembangunan Nasional Veteran Yogyakarta.