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The Application of Surveillance on Gas Wells to Prevent Shortfall in Zona 13 Donggi-Matindok Field

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Abstract.

Gas well production is governed by Gas Sales Agreement (GSA) which is consist of 3 main parts, i.e.: volume, duration, and price of the gas. If seller fail to fulfil all clause stated on the GSA, several punishments will be conducted. One of the clauses related to gas sales volume, in which if gas delivered to the buyer for 1 year is less than the amount stated in GSA, buyer need only pay for 75% gas price for the next year. Several surveillances need to be done to prevent it.

Modified Isochronal Test (MIT) is an enhancement of isochronal test. This method proven more feasible to be done because we don't need to wait for reservoir pressure reach the initial to proceed to the next choke step. We change the phase of produce-shut in wells process several times. By giving disturbance in the wells, we could see pressure change in which the data could be used to approach permeability value, skin, absolute open flow (AOF), and the estimation of reservoir boundary. All those data then used to approximate deliverability of the wells. MIT, conducted in 2019, indicated that damage value smaller than the last measurement (2018). we can see from the derivative pressure plot that boundary is not existing. Overall measurement indicated that optimistically Donggi can supply the amount of gas volume stated in GSA. This conclusion is corresponding with the production of Donggi-Matindok still stable until now. Pressure drop is also relatively small since initial production (± 300 Psi). MIT is reliable and feasible tools to see deliverability of gas wells. Meanwhile, we also need to see the condition of reservoir thoroughly. First, we need to see the movement of Gas-Water Contact (GWC). We use Reservoir Monitoring Tool (RMT) to compare the result with RMT at initial condition (during open-hole period). Second, we use Pressure Build Up (PBU) to get more information about reservoir boundary condition. PBU provide a description of reservoir condition several feet from the wellbore by interpreting pressure behavior. This test covers more range than RMT. And the last data is generated from Mobile Test Unit (MTU). This is typical test unit but conducted near the wellhead to get more accurate data than measuring in Central Processing Plant (CPP). By combining those four data, we can get an approximation of gas-rate range to be produced and get a stable gas well performance to supply buyer's demand based on GSA.

We live in a paradigm, that oil and gas industry is only focused in producing oil. We should change this paradigm because gas production also gives promising profit. Efforts to develop gas well should be done in the same pace as we develop oil well.

Keyword(s): GSA, MIT, AOF, deliverability, RMT, GWC, PBU, MTU.

1 Introduction

Donggi-Matindok Field (DMF) is an onshore field, located in Central Sulawesi. This field produce around 85 MMSCFD with main buyer is Donggi Senoro LNG (DSLNG). Gas Sales Agreement (GSA) between DMF and DSLNG started from 2016 until 2027.

There are 15 production wells and 2 injection wells in DMF. The rate of all of production wells vary between 4-11 MMSCFD. This paper will discuss about the effort to maintain Daily Contracted Quantity (DCQ) can be fulfilled by those 15 wells.

2 Data and Method

Understanding of gas wells thoroughly is the key to maintain good performance of gas wells itself. Several well surveillances need to be done to reach that purpose. In Donggi-Matindok Field, we Modified Isochronal Test (MIT) and Pressure Build Up (PBU) planned to be conducted in all the production wells. While Reservoir Monitoring Tool (RMT) planned to be conducted only at key well. Unfortunately, Donggi wells can't be entered by RMT tools and possible to be done only at several key wells in Matindok.

In this paper, we want to emphasize the measurement thoroughly in DONGGI-A because the method is similar to another well's measurement. In case of measurement in DONGGI-A, the choke variation is 18, 23, 28, and 33; all in 1/64 inch unit. Meanwhile for PBU we shut-in well for 72 hours.

DONGGI-A is a vertical well drilled in 2013 with perforation depth at (1605-1625) m, producing from Minahaki layer. This well produce 11 MMSCFD.

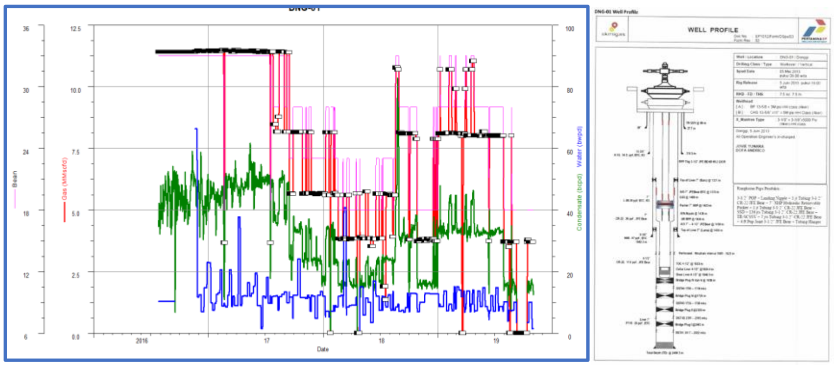

Figure 1. DONGGI-A Production History and Well Profile (DMF, 2020)

As we can see from the figure above, condensate to gas ratio at DONGGI-A about 4.2 bbl/mmscf. This led to wet gas reservoir fluid at Donggi Structure. While Matindok gives more condensate and can be categorized as retrograde gas reservoir fluid. The sequence of surveillance in Donggi is PBU then followed by MIT. RMT conducted later and only can be done in Matindok Wells, due to the ability of RMT tools enter the wellbore.

We want to highlight the condition of Matindok's reservoir. We found an interesting thing through PBU. From pressure derivative, we see an anomaly of inner-outer condition of the reservoir. We get relatively small mobility ratio. 5 out of 7 active wells in Matindok gives mobility ratio less than 1 (0.2-0.5), which is indicated that there are different fluids between inner and outer reservoir. Our main suspect is condensate banking already formed in inner reservoir that gives less mobility than outer reservoir. Next, our strategy is to apply higher gas rate to prevent liquid loading of condensate in the wellbore.

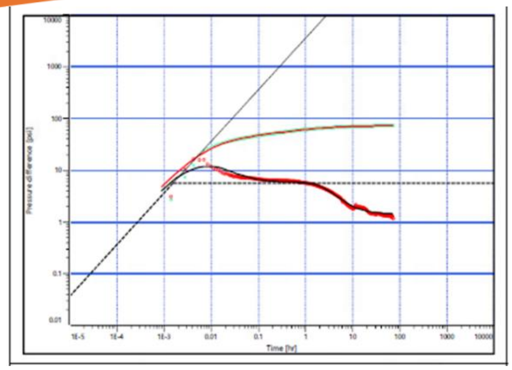

Figure 3. MATINDOK-A Pressure and Derivatives Plot (DMF, 2021)

Figure 3 is an example of pressure interpretation derives from PBU in MATINDOK-A. We can see several humps from derivative, indicate that there are two different fluids exist at inner-outer reservoir. With CGR of 13.2 bbl/mmscf, our main suspect is condensate give different mobility at inner area, which later tends to create "condensate banking" so we need to apply an optimal rate for Matindok wells.

3 Result and Discussion

Pressure data from PBU test then interpreted with software Kappa© and here are the result:

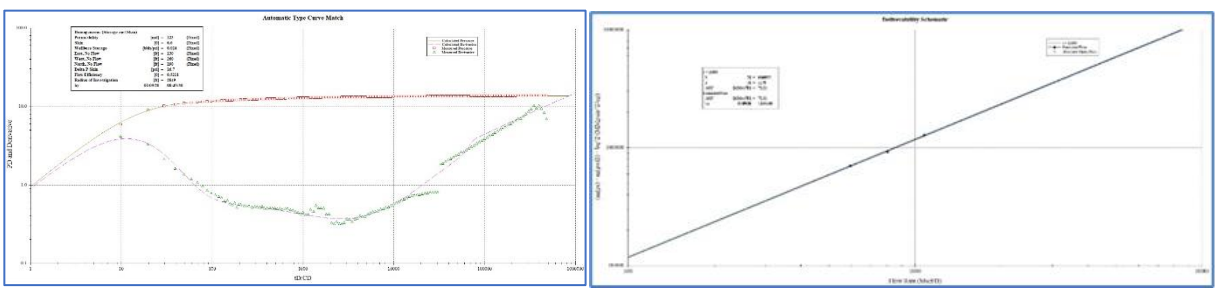

Figure 4. DONGGI-A Horner Plot and Derivatives vs ((tp+Δt)/ Δt) and deliverability (DMF, 2020)

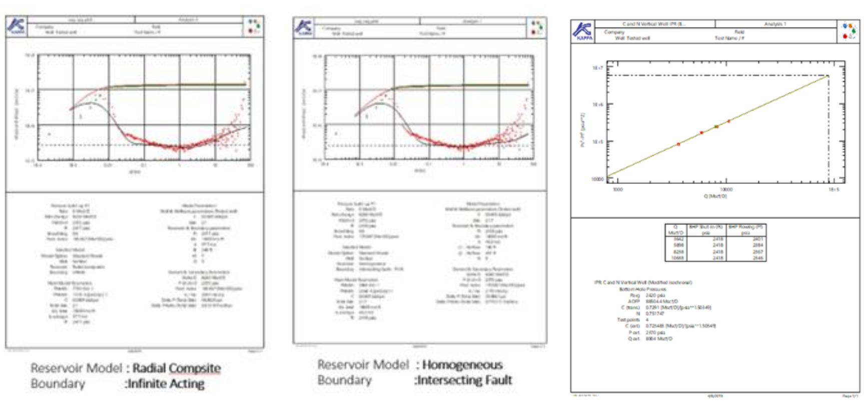

Figure 5. DONGGI-A Horner Plot and Derivatives vs ((tp+Δt)/ Δt) and deliverability (DMF, 2019)

Donggi's pressure behavior in 2020 indicates boundary, maybe fault, at the end of derivative. There is significant slop at late time period in derivatives. But later in 2021, we confirm that DONGGI-A still infinite acting reservoir, with spherical flow at first, followed by radial flow in fissure and later in rock matrix. Overall PBU data in Donggi's well indicate same things. Pressure at around 2000 Psi with AOFP range from 30-110 MMSCFD. Current production rate is 3-11 MMSCFD, so it's very safe for Donggi wells to be produced at current rate.

From those 2 data, 1 year apart, then we interpret P*, skin, and AOF. 2020's data give P* 2417 Psi, skin 6.6, and AOF 72.31 MMSCFD. While 2019's data give P* 2420 Psi, skin 83.9, and AOF 88.5 MMSCFD. We can see the AOF decrease 16 MMSCFD for 1 year production and P* decrease 3 Psi. on the other hand, the skin reduces from 83.9 to 6.6. This happens due to gas flow help to reduce debris along the way of migration from reservoir to wellbore. Overall, the surveillance test indicated that our production is very good to support current GSA. Later, this is also supported by RMT data, which is indicated that our gas-water contact (GWC) did not move from initial.

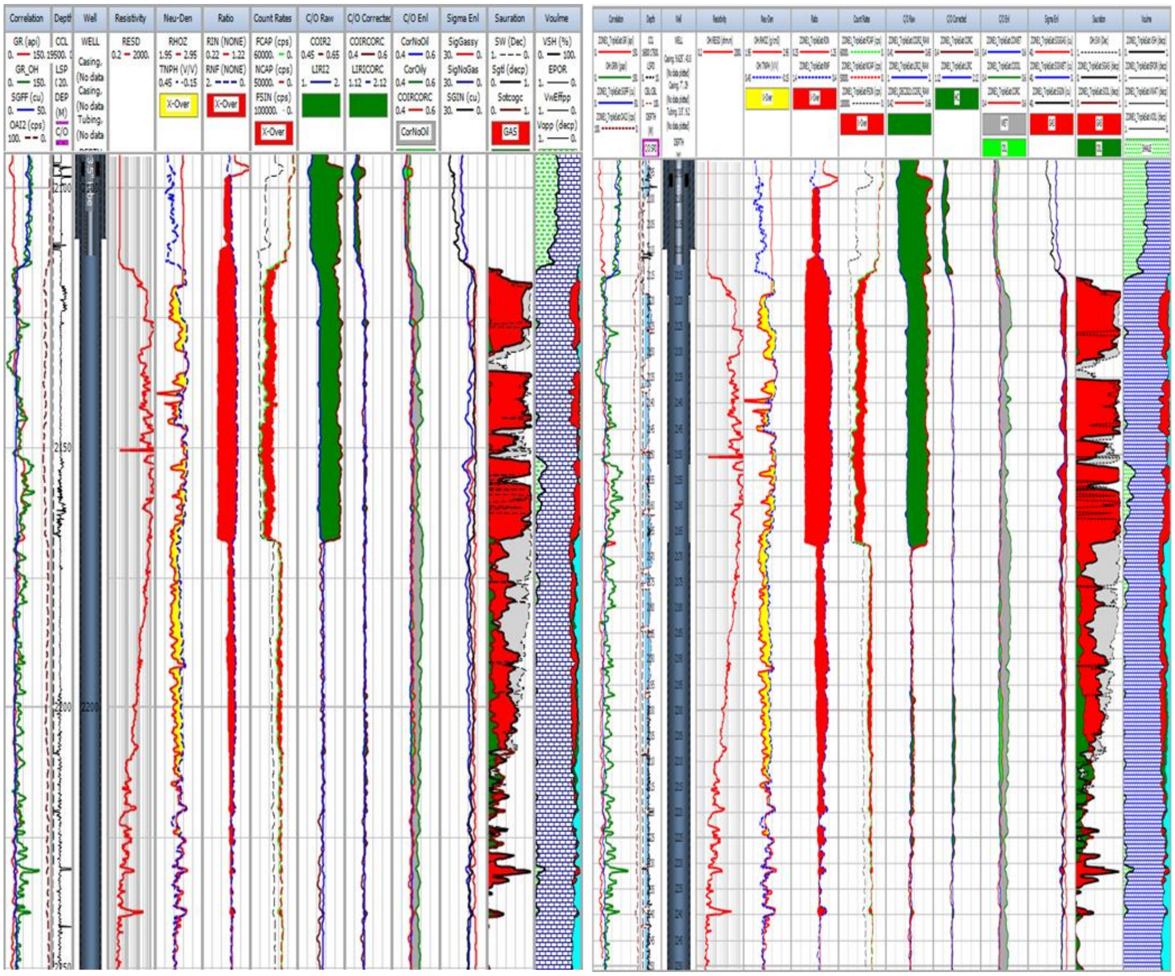

Figure 6. RMT Comparation 2021 (left) and 2022 (right) (DMF, 2021)

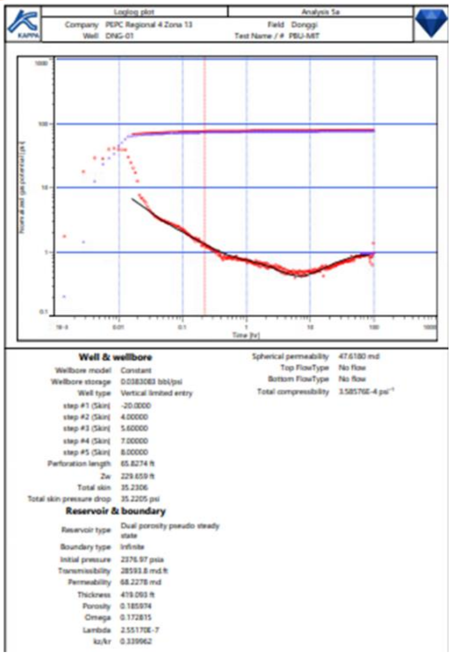

Figure 7. DONGGI-A Pressure and Derivatives (DMF, 2021)

Our main issue is Matindok Wells. There is an indication of condensate banking at the inner reservoir. We apply several conditions to determine in what rate Matindok well should be produced. First, we need to decide minimum rate to avoid liquid loading in the wellbore.

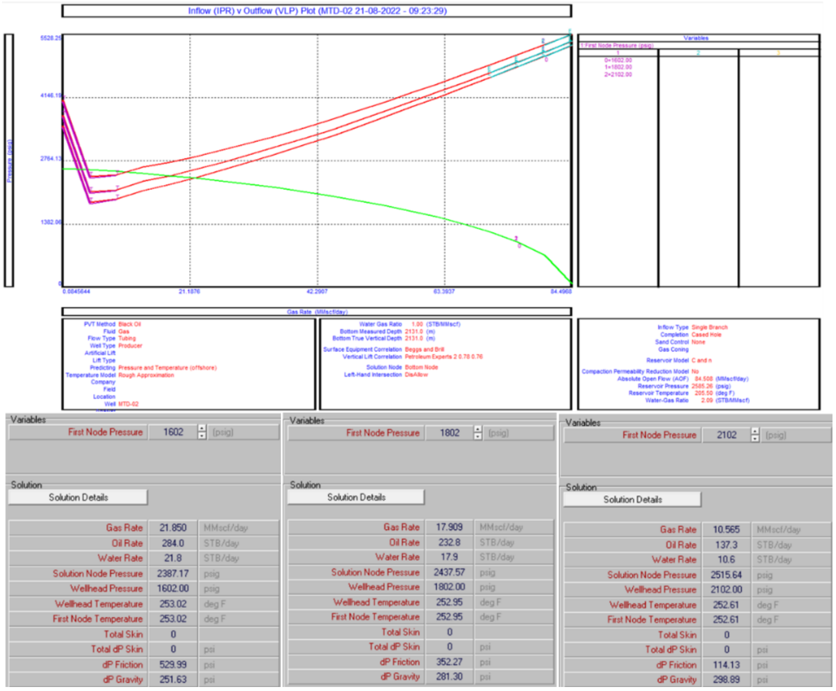

Figure 8. Inflow (IPR) and Outflow (VLP) of MATINDOK-A (DMF, 2022)

There are 2 different slopes at outflow (VLP) plot in figure 8. The transformation from negative slope (indicates gravity-dominated force) to positive slope (indicates friction-dominated force) is minimum rate to avoid condensate banking in the wellbore. Second, we need to decide maximum rate to avoid water breakthrough. We use Meyer - Gardner Equation as below:

$$q_c = \frac{1.381E\text{-}07(\rho_w - \rho_g)k(h^2 - D^2)}{B_g \mu_g \ln\left(\frac{r_e}{r_w}\right)} \quad where$$

q_c = critical rate, MscfD
ρ_w = water density, lbm/ft^3
ρ_g = gas density @ wellbore, lbm/ft^3
k = formation perm., mD
h = distance to water contact, ft
D = completion thickness, ft
μ_g = gas viscosity, cp.
B_g = gas formation volume factor, rcf/scf
r_e = drainage radius, ft
r_w = wellbore radius, ft

Figure 9. Meyer-Gardner Equation for Maximum Gas Flow Rate (1954)

By combining those data, we can determine exactly at what range our gas wells need to be produced.

4 Conclusion

1. In order to fulfil buyer's demand based on GSA, we need to have excellent understanding about reservoir condition.
2. There are 2 types of surveillances we use to get better understanding about reservoir: reservoir surveillance (Pressure Build Up, Reservoir Monitoring Tool, etc.) and well surveillance (Modified Isochronal Test, Mobile Testing Unit, etc.)
3. By combining those 2 types of surveillances, we can determine gas well rate need to be produced in order to maintain sustainability of reservoir performance.

Appendices

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References

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Acknowledgments

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