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Optimizing gas production in the existing and new reservoir layer using a combination of compensated neutron log interpretation and selective perforation methods at PSU Field wells, North Sumatra.

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Abstract

PSU Field is one of the areas that are included in PT. Pertamina Hulu Rokan in North Sumatera. It produces gas and has continued to contribute to fulfill the gas demand for the local consumers, especially the industrial market. Based on the information on the decree issued by the Power and Mineral Resources Ministry of Indonesia, the local industries need 81 mmscfd of gas supply until 2024. Out of the total demand, PSU Field of PT Pertamina Hulu Rokan is allowed to supply 7 BBTUD (5,8 mmscfd). Therefore, in order to accomplish the desired gas volume, so PT. Pertamina Hulu Rokan has established some working fields to produce gas: ARB Field and GBG Field.
Producing gas in each of the fields has its own challenges. ARB is challenging because of the increasing gas water contact in the subsurface layer that potentially could have contained hydrocarbons. This condition might have been caused by the incorrect production method which is to produce the well using the commingle layer that could intensify the water production and decrease the oil production. At the same time, GBG field's challenge is the amount of reservoir layers which are thick and have been depleted (maximum recovery factor and decreased pressure). To overcome this challenge, prospecting was needed on the thin reservoir layers. Used methods to minimize the situation is by using a combination method of compensated neutron log interpretation and selective perforation. This method was applied both in ARB-01 and GBG-55 even though each has its different cases.
Case 1 (ARB-01 field) used the combined method of compensated neutron log interpretation and selective perforation and produced low-pressured gas and cumulatively 112.91 mmscf of gas (February 2020-June 2021). In the meantime, Case 2 (GBG-55 field) has produced gas in the new layers cumulatively 51.52 mmscf by using the same method (April-June 2021).
The total revenue from both of the productions is USD 657,720 which is equal to IDR 9,295,556,760. This achievement has also increased the gas well intervention success ratio on the PSU Field workplan by 100% (PPJ-38, PPJ-54, GBG-55, PPJ-60 and ARB-01).
By combining both methods, the problems related to contact fluid change and depleted reservoirs can be prevented in order to optimize the gas production and increase the company's revenue in the midst of the instability of oil price.

Keywords: gas production, gas water contact, commingle layer,depleted reservoir, compensated neutron log, selective perforation, revenue.

Introduction

Location of ARB and GBG fields each has total area and is geographically different.
ARB field is the gas and oil field which is located about 25 km northwest from Pangkalan Brandan. This field is an old field managed by PT. Pertamina from 1975. The wells in this fields counted as many as 113 and has produced gas and oil massively ever since.
As for GBG field is located in the district of Langkat, North Sumatera. The location of the field is ± 95 km northwest of Medan and ± 12 km northeast of Pangkalan Brandan. The total area of this field is about 68.7 km^2. As for the amount of wells inside this field is 60 wells.
Both of these fields were first known as oil producing fields from the deep zones. However, as the time goes by, eventually they were also recognized as oil producing fields from the shallow zones.

Geologically, both of these fields were put to production through Keutapang Formation in which this formation was deposited at the shallow marine depositional environment (foreshore, shoreface, tidal influence). The challenge in searching for the layers that potentially would contain hydrocarbon in Keutapang Formation is the existence of of thin layers that are spread tightly. Therefore a detailed mapping was indispensable. In addition to that, geology structural control of strike slip fault progression has caused the compartment in between reservoirs and directly resulted in varied production performances.

ARB field has reservoir layers that contain oil. The total of OOIP (Original Oil In Place) of ARB fields is 2.2 MMSTB, This amount were calculated from the Keutapang Formation on the sandstone layer at the 480BB, 480OB, 460, 535, 580BB. The drive mechanism of the mentioned sone was the combination of solution gas and water drive mechanism and has produced a recovery factor of 27% and cumulatively has reached 524 MSTB until the year of 2020, leaving a total of 4 MSTB of oil reserve. This achievement has also formed secondary gas cap at the formation. From the obtained oil production and gas solution, the GOR has reached 2265 scf/stb.

Contrarily, GBG field has reservoir layers which contained oil and gas (non-associated), The total of OOIP on the field is 35.7 MMSTB which comes from the summation of OOIP of Keutapang formation at the sandstone zone of 900, 1000A, 00B, 1030A. The total of IGIP (Initial Gas In Place) reached to 198.9 BSCF. This number came from the summation of IGIP from the Keutapang formation on the sandstone zone of 860, 900, 950, 1000B, 1030B, dan 1100.

Among the sandstone layers from both of these fields, there were some interesting layers that were found to be used in production: 480BB layer (ARB field) dan 850 layer (GBG field). Through the combination of the methods and technique of compensated neutron log interpretation and selective perforation, there was layer perforation interval that has produced hydrocarbon gas that could evidently increase the company revenue with the transaction process with the local consumer.

Data and Method

The method applied in this study is to map the reservoirs of thin layers so that the pattern of distribution of sandstone reservoirs can be known. Then the interpretation in detail of the results of the CNL running cased hole log is compared to the interpretation of open hole log data. Through data obtained from CNL overlays and open hole logs, the selection of the right perforation interval on the layer to be produced is carried out.

ARB-01 and GBG-55 are two well candidates for the selection of potential gas-containing layers. In the year of 2020 and 2021, well intervention job is carried out on both of these wells. In the previous year, the reservoir layer produced in the ARB-01 well was in the 400OB zone and in the GBG-55 well was in zone 950 of the Keutapang Formation. The characteristics of these two reservoir layers are almost the same: the reservoir fluid is a gas, of which the gas from zone 400OB is the associated gas and the gas from zone 950 is a non-associated gas. In both of these zones, GWC (gas water contact) has reached the top level of its reservoir layer, so that when these two zones are produced, the gas produced is very small and dominated by water production. This is because the draining of hydrocarbons in both zones is large enough to be obtained from the surrounding wells, resulting in GWC levels rising and eventually the reservoir will be dominated by water. In practice, if in the gas reservoir there is already water dominance, then water with greater mobility than gas will make the gas will not be produced properly. In Figure 1 can be seen the current level of GWC which is a reference for the determination of the candidate layer or the next zone to be produced.

From the isopach map zone 850 in Figure 1, it can also be concluded that the thickness in the GBG-55 well tends to be smaller than the thickness of other wells that are on the contour flank, but the advantage is the position of the GBG-55 well is on the top contour of the compartment.

In Figure 2, it can be observed that wells that are more downdip than GBG-55 wells produce water in zone 850, so gbg-55 wells become very interesting to produce because of the good reservoir quality that can be seen from gamma ray values, resistivity, and neutron-density in existing open hole logs. Likewise in the ARB-01 zone 480BB well, structurally this zone was once produced in the PPJ field which is located to the northwest of the ARB field, but in the ARB field this zone includes the virgin zone, and the ARB-01 well is in the second most updip position and has good reservoir quality when viewed from the open hole log in the well itself.

Result and Discussion

Case GBG-55

GBG-55 well has been perforated in the Z-850 layer where the layer is a thin layer (net pay is about 1.5 m). Below the Z-850 (+-5 meter) layer is a thick main gas reservoir (Z-860 series) where the main gas layer is depleted reservoir and has an already high GWC depth. The Z-850 layer is interpreted as a tidal flat deposition environment. The shale break between Z-860 and Z-850 is good in trapping hydrocarbons in the Z-850 layer. Before perforation, compensated neutron log (CNL) was run and interpreted by comparing it with an open hole log. The interpretation confirmed that there was an absence of significant changes of neutron value between the CNL and the neutron open hole log in Z.850 layer, thus, it can be concluded that Z.850 layer is a new potential layer and has cumulatively produced gas of 91.32 mmscf / 92,870 mmbtu (April-August 2021). By producing that amount of gas, PSU Field of PT Pertamina Hulu Rokan has obtained a total revenue of USD 371,481 (USD 4/mmbtu).

Case ARB-01

Some of the wells in ARB Field completed by commingle layer completion method produced formation water. This was possible because the layer containing formation water had a higher productivity index compared to the layer containing the hydrocarbon potential. The last well produced by commingle method and producing formation water was ARB-01. After using a single zone completion method, to confirm the hydrocarbon potential existed in the target layer, the CNL method was applied.
Perforation was applied after the result of the evaluation of CNL in the target layer had been available, then swabbing by a swab tool and static bottom hole pressure measurements were carried out to get useful data for analyzing the productivity index of the well.
By this method, ARB-01 has produced 136.66 mmscf of cumulative gas production and 138,985 mmbtu of energy value. By producing that amount of gas, PSU Field of PT Pertamina Hulu Rokan has obtained a total revenue of USD 555,941 (USD 4/mmbtu).

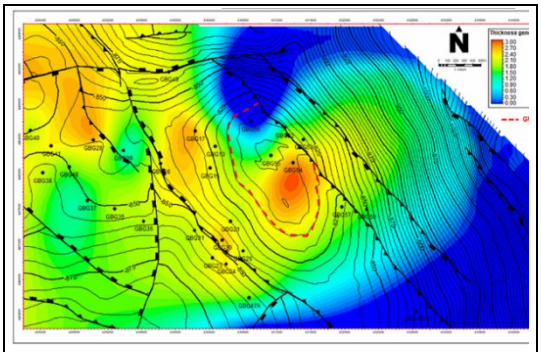

Figure 1: Z.850 GBG field isopach map with current GWC depth

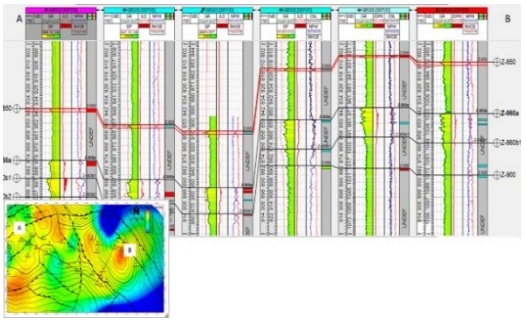

Figure 2: Well log correlation of Z.850 GBG Field

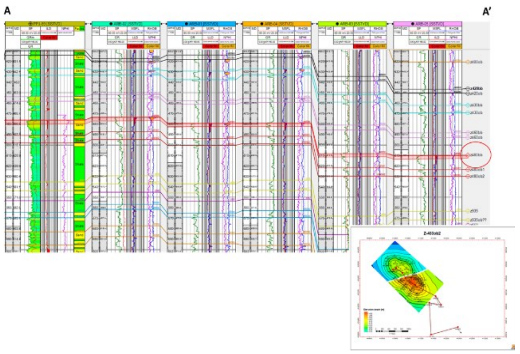

Figure 3: Well log correlation of Z.480BB ARB Field

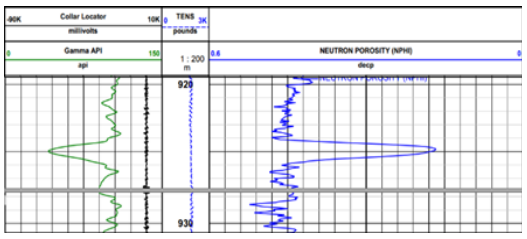

Figure 4: Current CNL (Compensated Neutron Log) of Z.850 sandstone reservoir at GBG-55

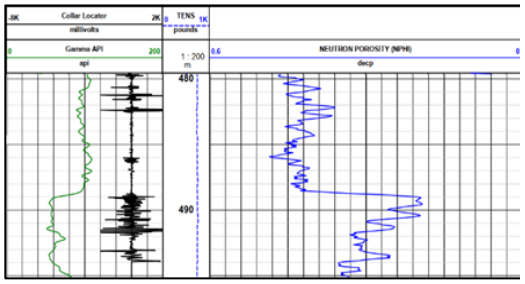

Figure 5: Current CNL (Compensated Neutron Log) of Z.480BB sandstone reservoir at ARB-01

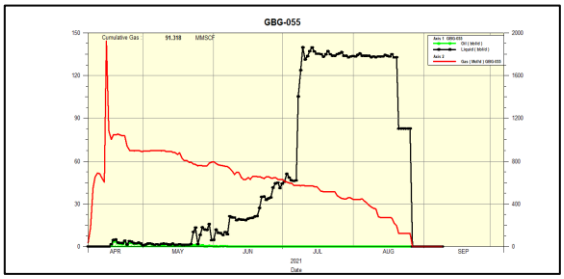

Figure 6: Production Performance of GBG-55

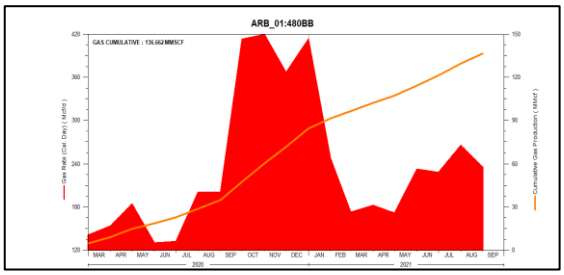

Figure 7: ARB-01 cumulative gas production vs gas rate

Conclusions

The combination of overlay CNL with open hole log and selective perforation method is proven to produce hydrocarbon potential, especially natural gas, in a thin formation layer and make it a new reserve to be developed in other wells and in general can increase the company's revenue through the sale of natural gas to consumers.

References

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