EVALUATION THE CALCULATION OF WATERSATURATION WITH SIMANDOUX AND INDONESIA METHOD IN THE P LAYER R FIELD

Puri Wijayanti1, Ratnayu Sitaresmi2, Guntur Herlambang Wijanarko3

1Petroleum Engineering Department, Trisakti University, Jakarta, Indonesia.
2Petroleum Engineering Department, Trisakti University, Jakarta, Indonesia.
3Petroleum Engineering Department, Trisakti University, Jakarta, Indonesia.
Email of Corresponding Author: puri.wijayanti@trisakti.ac.id

ABSTRACT

Logging Interpretation aims to determine petrophysical parameters such as volume shale, porosity, formation water resistivity used to calculate water saturation values. In this study the wells analyzed were four exploration wells. Log analysis carried out in this well is in the form of qualitative analysis and quantitative analysis. The average shale volume in KML-1, KML-2, KML-3 and KML-4 wells is respectively 0.172, 0.132, 0.167 and 0.115. The average effective porosity of KML-1, KML-2, KML-3 and KML-4 wells is 0.236, 0.268, 0.219 and 0.225 respectively. The values of a, m and n follow the lithology of the well, namely limestone (carbonate) with a value of 1, 2 and 2. The value of Rw is obtained from the Pickett Plot Method that is equal to 1.52 Ωm on KML-1, 1.52 Ωm on KML-2, 1.52 Ωm on KML-3 and 0.5 Ωm on KML-4. The average water saturation with the Simandoux Method in KML-1, KML-2, KML-3 and KML-4 wells is 0.336, 0.434, 0.670 and 0.397. While the average water saturation value with the Indonesian Method in KML-1, KML-2, KML-3 and KML-4 wells is 0.439, 0.488, 0.723 and 0.440 respectively. From the comparison with Sw Core, the Simandoux method is better used in calculating water saturation because the result is closer to the value of Sw Core.

Keywords: Logging Interpretation, Water Saturation, Simandoux Equation, Indonesia Equation

I. INTRODUCTION

The P layer is one of the layers that have been proven to produce petroleum in R Field. In this "P" layer there are a total of 26 production wells that are still active. The purpose of this evaluation was to interpret 4 exploration wells namely KML-1, KML-2, KML-3 and KML-4 to calculate shale volumes, porosity, and water saturation and determine the water saturation calculation method suitable for use in the P Layer R Field.

The background of this evaluation is to find out the value of water saturation in the P layer, which can be used as a reference for further field development. Also, determining the appropriate method for calculating water saturation can be used as a reference in subsequent calculations in the R field. The method used in this evaluation is to use Simandoux and Indonesia, calculations which can be calculated manually using Microsoft Excel software.

II. METHODOLOGY

The research procedure begins with collecting data needed in this study such as LAS data and formation data. LAS data used in wells are data from Microsoft Excel. It can then be interpreted and converted into curves manually (Kennedy, 2015). Known formation data in the P layer are can be seen at Table 1:

| Parameter | Value | Unit |
|-----------|-------|------|
| a         | 1     | -    |
| m         | 2     | -    |
| n         | 2     | -    |
| $\rho$ fluid | 1 | gr/cc |
| T gradient | 4 | °F/100 ft |
| T surface | 89 | °F |

The research procedure flowchart can be seen at Figure 1:
III. RESULT AND DISCUSSION

In determining the water saturation value in Y Field, petrophysical parameters such as shale volume, porosity, and formation water resistivity are needed in four exploration wells, namely KML-1, KML-2, KML-3 and KML-4. The data is obtained from logging analysis qualitatively and quantitatively (Hongqi, 2017). This paper aims to determine the parameters used to determine water saturation values and the proper method of calculating water saturation in the P Layer R Field.

The first thing to do is to do a qualitative analysis to determine the permeable layer, fluid content and OWC (Oil Water Contact) limits. After qualitative analysis, quantitative analysis is performed to determine the volume shale value, effective porosity and formation water resistivity used in determining the saturation value of water (Doveton, 2012). Qualitative interpretation is done by a quick look or by looking at the log curves both singly and in combination without being counted (Asri & Sumantri, 2014).

Quick look of qualitative interpretation can be reached by triple combo log. Triple combo of KML-

Figure 1. Flowchart $S_w$ Calculation

Figure 2. Triple Combo KML-1 Well

Figure 3. Triple Combo KML-2 Well
Based on triple combo log of KML-1, KML-2, KML-3 and KML-4 well, the qualitative analysis of the four wells there were intervals of 1163-1238 ft in the KML-1 well, 1207-1283 ft in the KML-2 well, 1225-1293 ft in the KML-3 well and 1268-1309 ft in the KML-4 well in the P Layer is based on deflection analysis of gamma ray logs which shows a small value. The lithology type in P Layer is dominated by limestone which can be determined by crossing the neutron log and log density shown in Figure 6 (Schlumberger, 2009).

After determining the permeable layer then determine the contents of the fluid content (fluid content) in the layer. Through qualitative analysis, it can be seen that the fluid contained therein is only in the form of oil and water at the bottom. This is indicated by the crossing and coinciding NPHI and RHOB curves accompanied by high resistivity values in the hydrocarbon zone and smaller in the water zone. After interpreting the log qualitatively, the quantitative log interpretation is then carried out to determine the value of shale volume, porosity and water saturation in the four wells. The existence of a thin shale value in the formation makes it necessary to do a calculation to get the volume shale value that affects the calculation of the Simandoux Method water saturation and the Indonesian Method (Shedid & Saad A, 2017).

The first thing to do in calculating shale volume is to determine the value of GR clean and GR shale. The results obtained from KML-1 wells are GR clean of 34ºAPI and GR shale of 145ºAPI, in KML-2 wells GR net is 40ºAPI and GR shale is 182ºAPI, in KML-3 wells GR clean is 45ºAPI and GR shale is 185ºAPI and in KML-4 wells obtained a GR clean of 51ºAPI and GR shale of 184ºAPI.

Figure 4. Triple Combo KML-3 Well

Figure 5. Triple Combo KML-4 Well

Figure 6. Cross Plot NPHI/RHOB KML-1 Well
Calculation of shale volume using the log GR curve because the GR log is considered capable of distinguishing radioactive (shale) elements and non-radioactive elements (formation rocks) (Sitaresmi & Arifin, 2018). By using the GR log, the average shale volume in KML-1 wells is 0.172, KML-2 wells is 0.132, KML-3 wells is 0.167 and KML-4 wells are 0.115. The next thing to do is to determine the effective porosity value. In determining effective porosity the combination of porosity logs is used, namely neutron-density log. It is expected that the accuracy obtained will be higher than calculating porosity using only one log curve (Kobrynich, 2015).

In KML-1 wells, the effective porosity value of 0.236 is obtained, for KML-2 wells the effective porosity value is 0.268, for KML-3 wells the effective porosity value is 0.219 and for KML-4 wells the effective porosity value is 0.225. This shows that the porosity at the P Layer R Field has a very good value. After determining the porosity of the analysis to determine the resistivity of formation water. Before determining the resistivity of formation water first determine the temperature in the formation under study (Liu, 2017). This formation temperature is used to correlate formation water resistivity obtained from the Pickett Plot Method of KML-1 well as shown in figure 7.

The resistivity value obtained for the KML-1 well was 1.52 Ωm at a temperature of 137.02°F, the KML-2 well was 1.52 Ωm at a temperature of 138.80°F, the KML-3 well was 1.52 Ωm at a temperature of 139 36°F and KML-4 wells at 0.5 Ωm at 140.54°F. From the results of water resistivity of 1.5 Ωm at a temperature of 138.83°F obtained a salinity value of 2100 ppm. Before determining the Sw value, data such as tortuosity (a), cementation factor (m) and saturation exponent (n) are needed (Crain, 2010). This data is usually obtained from SCAL data (Special Core Analysis). Values a, m and n obtained from SCAL are worth 1, 2 and 2. After getting the data, we can start calculating the Sw value with the Simandoux Method and the Indonesian Method at each depth point analyzed and then averaged (Crain, 2010).

From the results of this water saturation average the value of Sw calculation using the Simandoux Method in KML-01 wells is 0.336, KML-02 is 0.434, KML-3 is 0.670 and KML-4 is 0.397. While the results of the calculation of water saturation by the Indonesian Method on KML-1 wells are 0.439, KML-2 is 0.488, KML-3 is 0.723 and KML-4 is 0.440, and Indonesian Method with Sw Core value. The known Sw Core values are the Sw Core in KML-1 wells shown in figure 8.

Comparative analysis can be done by charting the trendline in Microsoft Excel by entering both data, namely Sw Core and Sw from the method we want to compare as shown in figures 9 and 10.
After a comparison, the Simandoux Sw value is closer to the Sw Core value because the value is still close to the trendline with R² value of 0.865 which is closer to one while the Indonesian Sw value is farther than the trendline and R² value of 0.848 which is less than one.

IV. CONCLUSIONS

From the research that has been done, the conclusions that can be drawn are as follows:

1. Formation in the P Layer R Field in the form of limestone with temperatures ranging from 135-140ºF. The zones analyzed in KML-1, KML-2, KML-3 and KML-4 wells were 1163-1238 ft, 1207-1283 ft, 1225-1293 ft and 1268-1309 ft, respectively.

2. From the results of gamma ray log calculations, the average Vshale obtained in wells KML-1, KML-2, KML-3 and KML-4 were 0.172, 0.132, 0.167 and 0.115.

3. The effective porosity value is obtained by using the Neutron-Density log method, namely in wells KML-1, KML-2, KML-3 and KML-04 respectively 0.236, 0.268, 0.219 and 0.225.

4. Water saturation (Sw) in the P layer by Simandoux Method on KML-1 wells on average by 0.336, KML-2 on average by 0.434, KML-3 on average by 0.670, KML-4 on average amounted to 0.397.

5. Water saturation (Sw) in the X layer by the Indonesian Method in KML-1 wells is an average of 0.439, KML-2 is an average of 0.488, KML-3 is an average of 0.723, KML-4 is an average amounting to 0.440.

6. From the results of the analysis of the calculation of water saturation, it can be seen that the best method of determining water saturation in the P layer is the Simandoux method because it has results that are closer to the Sw Core data.

REFERENCES

Asri, N., & Sumantri, R. (2014). Penilaian Formasi I. Jakarta: Universitas Trisakti.

Crain, R. (2010). Petrophysical Handbook. Alberta: Spectrum 2000.

Doveton, J. H. (2012). Principles of Mathematical Petrophysics. New York: Oxford University.

Hongqi, L. (2017). Principles and Applications of Well Logging. Berlin: Springer-Verlag.

Kennedy, M. (2015). Practical Petrophysics. Amsterdam: Elsevier.

Kobrynich, J. (2015). Absolute and Effective Porosity of Petroleum Reservoirs: The Barnes Fluid Saturation Technique and Helium Porosimetry of Sandstones. Pennsylvania.

Liu, R. (2017). Theory of Electromagnetic Well Logging. Amsterdam.

Schlumberger. (2009). Log Interpretation Charts. Texas: Schlumberger.

Shedid, A., & Saad A, M. (2017). Analysis and Field Applications of Water Saturation Models in Shaly Reservoirs. Cairo.

Sitaresmi, R., & Arifin, P. (2018). Effect of Conductive Minerals in the Determination of Water Saturation in “Y” Field. Jakarta.

Sitaresmi Ratnayu, Wijanarko Herlambang Guntur, Wijayanti Puri, Kusumawardhani Danaparamita. 2019. Determining of Formation Water Saturation to Estimate Remaining Hydrocarbon Saturation in The X Layer Y Field.; Petro, Vol 8 No 3: September.