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The Application of P/Z Methods in Evaluation of Initial Gas in Place of X Reservoir

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ABSTRACT
Reservoir X is located in West Tanjung Jabung Regency, Jambi, Indonesia, with initial pressure is 2,028 psia, and a temperature is 226°F. The reservoir has been produced from February 2018 to the present (February 2021), with cumulative gas production of 5.17 Bscf. Based on the Plan Of Development (POD) study in 2016, the initial gas in place was determined volumetrically to be 49,92 Bscf. To compare the initial gas in place, it is deemed necessary to recalculate the initial gas in place by utilizing another method.

The calculation of Initial Gas In Place (IGIP) is conducted by using the P/Z method. In this method, the Initial Gas in Place is obtained 49.01 Bscf. Based on analyzing the phase diagrams and the prevailing reservoir conditions, reservoir X indicated a dry gas reservoir. Such reservoir drive mechanism is a depletion drive, determined from the P/Z vs Gp plot, generating a straight line. Based on the assumed abandonment pressure value of 300 psia, the estimated ultimate recovery value is 41.93 Bscf, with the recovery factor value of 87.65% and the remaining reserves of 36.76 Bscf.

Keywords: Initial Gas In Place, P/Z, Estimated Ultimate Recover, Recovery Factor

INTRODUCTION

In developing a natural gas field, several important factors must be determined accurately, one of which is determining the Initial Gas in Place (IGIP). The determination of IGIP provides an important role in basic decisions for the development and operation of a reservoir.

Based on the Plan Of Development (POD) study in 2016, the initial gas in reservoir X was determined volumetrically to be 49,92 Bscf. To obtain a comparison, the initial gas in place was recalculated by utilizing another method.

Reservoir X contains 5 production wells (SA-3 SUT-1, SAD-2, SAD-3, and SAD-5). Reservoir X has been producing from February 2018 to the present, with cumulative gas production of 5.17 Bscf (February 2021). The data obtained from the 5 above wells (Production well data, Pressure well data, PVT data) is used to determine Initial Gas In place.

IGIP calculation is determined by various methods. However, in this research, the P/Z vs Gp material balance method was used. In addition to calculating IGIP, the recovery factor, estimated ultimate recovery, and recovery factor are also determined.

METHODOLOGY

In the early stages of the study, data was collected, including well pressure data, production data, and lab PVT data. Further, an analysis is conducted on the type of reservoir. Afterward, to obtain the reservoir pressure data monthly, pressure interpolation was carried out from the existing wells. The z factor for each pressure was then determined. By Gopal method Afterward, the drive mechanism and initial gas in place were determined with the results of the Pz vs Gp plot. Further, the value of the recovery factor estimated ultimate recovery, and remaining reserves are determined.

RESULTS AND DISCUSSION

Reservoir X is a gas reservoir situated in West Tanjung Jabung Regency, Jambi, Indonesia. Reservoir X has an initial pressure of 2028 psia and a temperature of 226°F. To determine the initial gas in place, the type of reservoir needs to be determined first.**Determination of Reservoir Type**

Based on the PVP data, the reservoir type is determined by analysis using PVTP software to obtain the phase diagram as depicted in Fig. 1.

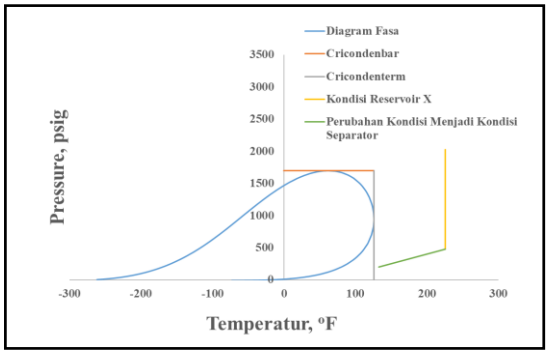

Figure 1 Reservoir Types against Reservoir X. Condition

The above Figure 1 indicates a reduction in pressure and temperature from the initial condition to the separator conditions, the path of depletion is completely outside the phase envelope. Its means that the fluid does not undergo phase changes, and therefore no liquids are formed either in the reservoir or production facilities. Based on the analysis, reservoir X was classified in the dry gas type. Thus, in determining the initial gas in place in reservoir x the p/z method could be used. Therefore, data such as pressure, production data are required to apply this method.

Pressure on Reservoir X

The pressure in Reservoir X is only available from the four wells at a certain time (table 1); thus, it is necessary to do a regression from the existing pressure data to draw a trendline. From the table, a graph of reservoir pressure against time is made and extrapolated to obtain the unknown monthly pressure from February 2018 to February 2021 (Fig 2).

Table 1 Well Pressure on Reservoir X

Date	Well	Pressure, Psia
12/02/2018	SA-2	2028,336
16/03/2018	SU-1	2017.22605
19/12/2019	SA-3	1895.524
19/11/2020	SA-5	1827.11645

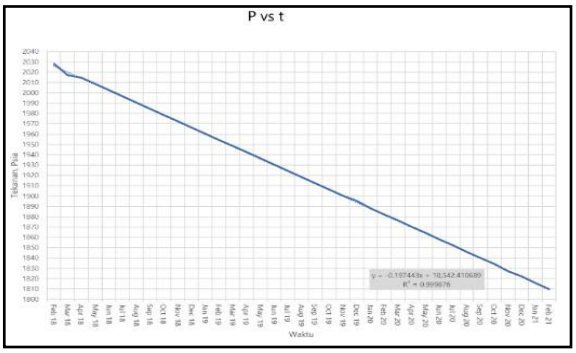

Figure 2 Reservoir Pressure vs Time

Determination of Z Factor

Determination of the Z factor is conducted by using the Gopal method. The Gopal method is used because it is easier to determine z at more data various reservoir pressures using the equation of Gopal rather than graphically (Standing and Katz).

The following is an example of determining the Z factor using the Gopal method:

in which :

T = 226 °F + 460 = 686 °R

P = 2028 psia

SG = 0.7965

Tpc = 168 + 325 g – 12.5 g2

=168 + (325 x 0.7965) – 12.5 x $(0.7965)^2$)

= 411.17 °R

Ppc = 677 + 15 g – 37.5 g2

= 677 + (15 x 0.7965) – (37.5 x (0.7965)2)

=673.38 psi

Tpr = T/Tpc

= 686/333.58 =2.05

Ppr = P/Ppc

=2028/673.38 =3.01

For the value of Tpr = 2.05 and Ppr = 2.68, it is obtained that A = 0.0211, B = 0.0527, C = 0.0127, & D = 0.9549 so that the Gopal

equation becomes as follows:Z = Ppr(0.0211Tpr - 0.0527) + 0.0127Tpr + 0.9549. By entering Tpr = 2.05 and Ppr = 3.01 then the z value is obtained below:

Z = 3.01((0.0211 x 2.05) - 0.0527) + ((0.0127 x 2.05) + 0.9549) = 0.95467

The results of the Z Factor calculation based on the Gopal method can be seen in Table 2 in Appendix.

Determination of Drive Mechanism

The drive mechanism is determined by using the material balance method P/Z Vs Gp by plotting the value of Gp on the x-axis and P/Z on the y-axis. (Table 2 at Appendix) is depicted in Fig.3

Based on the P/Z Vs Gp graph analysis (Fig 3), which shows the plot of the P/Z vs Gp is a straight line, indicating that reservoir X is the depletion drive.

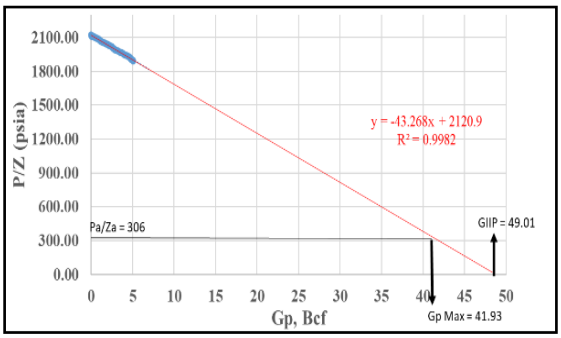

Figure 3 P/Z Vs Gp. Graph

Calculation of Initial Gas In Place

The initial gas in Place of reservoir X is calculated using the P/Z Vs Gp material balance method.

Figure 3 indicates the line equation to find the initial gas In Place value, whose equation is y = -43.268x+2120.9 and R2 = 0.9982. The initial gas in place is obtained based on the equation of the line obtained when P/Z=0. Thus, y = -43.268x+2120.9 where the y-axis is P/Z and the x-axis is Gp, in which:

y = -43.268x+2120.9

43.268 = 2120.9/ G

G = 2120.9/ 43.268

G = 49.01 Bscf

The gas initial in place is 49.01 Bscf.

Determination of Estimated Ultimate Recovery

Estimated Ultimate Recovery gas depends on abandonment pressure. Abandonment pressure conforms to company policies. and in the study conducted by the author, it was assumed that the abandonment pressure is 300 psia.

Based on assumed abandonment pressure, the calculations are carried out to obtain the value of Za. Gopal's method shows that Za is 0.97981, so Pa/Za value is 306 psig.

From substituting the equation with a Pa/Za value of 306 psig, the results obtained are EUR from Reservoir X.

y = -43.268x + 2120.9

y = 306

306 = -43.268x + 2120.9

x = 41.93 Bscf

From these calculations, it is obtained that the EUR is 41.93 Bscf.

Determination of Recovery Factor

The recovery Factor of Reservoir X is determined by the EUR value divided by Initial Gas in Place. Thus, the value of the recovery factor is obtained by:

RF = (EUR/IGIP) X 100%

= (41.93/49.01) x 100%

= 85.55%

Determining of Remaining Reserves

The remaining reserves can be determined by subtracting the Estimated Ultimate Recovery value by Gp. The cumulative gas production in reservoir X is 5.17 Bscf, thereby RR can be calculated as follows:

RR = EUR – Gp

=41.93 – 5.17

=36.76 Bscf

CONCLUSIONS

Based on the analysis and calculation of the initial gas content in place, using the P/z method at Reservoir X, the conclusions include: based on the research carried out, it indicates that Reservoir X is a dry gas type is powered by a depletion drive. The initial gas in place at Reservoir X is calculated using the P/Z Vs Gp material balance method of 49.01 Bscf. Based on abandonment pressure 300 psia, Reservoir X has an estimated ultimate recovery of around 41.93 Bscf. Reservoir X has a recovery factor value of 85.55%, and the Remaining Reserves is 36.76 Bscf.

REFERENCES

Adim, H. (2002). Basic Knowledge of Reservoir Mechanics Volume I. Trisakti University.

Ahmed, T. (2010). Reservoir Engineering Handbook Fourth Edition (Fourth Edi). Oxford, UK: Gulf Professional Publishing.

Ahmed, T. (2019). Reservoir Engineering Handbook Fifth Edition (Fifth Edi). Oxford, UK: Gulf Professional Publishing.

Ariadji, T. (2001). Reservoir Mechanics. Bandung Institute of Technology.

Cole, F. (1961). Reservoir Engineering Manual (4th ed.). Texas: Gulf Professional Publishing.

Craft, B., & Hawkins, M. (1991). Applied Petroleum Reservoir Engineering Second Edition. https://doi.org/https://doi.org/01309 8845

Dake, LP (1978). The Practice of Reservoir Engineering, Revised Edition. In Elsevier Scientific Publishing Company. New York.

Experts, P. (2010). Integrated Production Modeling. Petroleum Experts Ltd, Edinburgh, Scotland, UK

Gopal, VN (1977). Gas Z-Factor Equations Developed for Computer.

Guo, B. (2005). Natural Gas Engineering Handbook. Houston: Gulf Professional Publishing.

Ikoku, CU (1984). Natural Gas Reservoir Engineering. Pennsylvania, USA: The Pennsylvania State University.

Irwin, RW (2015). Determination of Preliminary Oil Content and Forecasting Its Production with Decline Curve Analysis in Field “R.” Proceedings of the National Seminar on Scholars.

Lee, WJ, & Wattenbarger, RA (1996). Gas Reservoir Engineering.

McChain, W. (1990). The Properties of Petroleum Fluids.

Okotie, S., & Ikporo, B. (2019). Reservoir Engineering: Fundamentals and Applications. Springer.

Rukmana, D., Kristanto, D., & Aji, VDC (2012). Reservoir Engineering: Theory and Application. Yogyakarta: The Tree of Light.

Said, L. (2011). Petrophysical. Trisakti University.

Satter, A. (2008). Practical Enhanced Reservoir Engineering Assisted With Simulation Software. Pennwell Books.

Schilthuis, RJ (1936). Active Oil and Reservoir Energy. Transactions of the AIME, 118(1), 33–52.

Sumantri, R. (1996). Reservoir Engineering. Trisakti University.

Todd, AC (2012). Reservoir Engineering. Edinburgh: Heriot-Watt.

APPENDIX

Table 2 Pressure, Z factor, P/Z, and Gp

Tanggal	P (psia)	Gp (Bscf)	Z
02/18	2028.336	0.03	0.95467
03/18	2017.2261	0.19	0.95447
04/18	2014.74	0.34	0.95442
05/18	2008.81	0.49	0.95432
06/18	2002.69	0.63	0.95420
07/18	1996.76	0.78	0.95409
08/18	1990.63	0.93	0.95398
09/18	1984.51	1.08	0.95387
10/18	1978.58	1.22	0.95376
11/18	1972.46	1.34	0.95365
12/18	1966.53	1.48	0.95354
01/19	1960.40	1.67	0.95343
02/19	1954.28	1.80	0.95332
03/19	1948.75	1.95	0.95322
04/19	1942.62	2.11	0.95310
05/19	1936.69	2.25	0.95299
06/19	1930.57	2.37	0.95288
07/19	1924.64	2.51	0.95277
08/19	1918.51	2.64	0.95266
09/19	1912.39	2.74	0.95255
10/19	1906.46	2.84	0.95244
11/19	1900.34	2.95	0.95233
12/19	1895.524	3.19	0.95224
01/20	1888.28	3.42	0.95211
02/20	1882.16	3.62	0.95500
03/20	1876.43	3.79	0.95508
04/20	1870.30	3.99	0.95516
05/20	1864.38	4.18	0.95525
06/20	1858.25	4.33	0.95533
07/20	1852.32	4.45	0.95541
08/20	1846.20	4.58	0.95550
09/20	1840.07	4.68	0.95558
10/20	1834.15	4.78	0.95566
11/20	1827.1165	4.88	0.95576
12/20	1822.09	4.98	0.95583
01/21	1815.97	5.08	0.95591
02/21	1809.84	5.17	0.95600