REFERENCES

1. Cosse, R., Basics of Reservoir Engineering, Edition Technip, Paris, 1993 : 219
2. Heuer, G.J., Clark, G.C., and Dew, J.N., The Influence of Production Rate, Permeability Variation and Well Spacing on Solution -Gas-Drive Performance, SPE 1519-G, 1961
3. Morse, R.A. and Whiting, R.L., A Numerical Model Study of Gravitational Effects and Production Rate on Solution Gas Drive Performance of Oil Reservoirs, SPE 2696, 1970
4. Savage, W.K., Thachuk, A.R., Beykpour, H., and Lohrenz, J.H., MER : Ultimate Recover and Production Rate, SPE 4933, 1974
5. Satter, A.; Brugman, R.J.; Yard, M.B., and Mims, D.S., The Role of Simulators in Reservoir Management, SPE 25605, 1993
6. Lefevre, Didier; Pellissier, Gerard, and Sabather, J-C., A New Reservoir Simulation System for a Better Reservoir Management, SPE 25604, 1993
7. Salerl, N. G., Reservoir Performance Forecasting Acceleration by Parallel Planning, SPE 25151, 1993
8. El Hamalawy, F.A.; Elsayed, G.A.; Swedan, N.E.M. and Barden, I.R., A Conventional Reservoir Engineering Approach for Managing a Difficult Field, SPE 26405, 1993
9. Bourdet, D., Ayoub, J.A., and Pirard, Y.M., Use of Pressure Derivative in Well-Test Interpretation, SPE Formation Evaluation, June 1989 : 293-302

10. Clark, D.G. and Van Golf-Racht, T.D., Pressure-Derivative Approach to Transient Test Analysis: A High-Permeability North Sea Reservoir Example, Journal of Petroleum Engineering, November 1985 : 2023-2039

11. Ayeni, B.J., and Pilat, R., Crude Oil Reserve Estimation : An Application of the Autoregressive Integrated Moving Average (ARIMA) Model, Journal of Petroleum Science and Engineering 8, 1992 : 13-28

12. Lo, K.K., and Holden, C.W., Use of Well Management Schemes for Rate Forecasts, SPE 24071, 1992

13. Lo, K.K.; Stanley, G.P., and Holden, C.W., Application of Linear Programming to Reservoir Development Evaluations, SPE 26637, 1993

14. Box, G.E.P., and Jenkins, G.M., Time Series Analysis: Forecasting and Control, Revised Edition, Holden-Day, California, 1976

15. Balchen, J.G., and Mumme', J.I., Process Control Structure and Applications, Van Nostrand Reinhold, New York, 1988

16. Smith, T.J., Petroleum Reservoir Engineering, Document presented at the Petroleum Reservoir Fundamental, Bangkok, Thailand, 17 - 28 March 1997

17. Bladley, H.B., Petroleum Engineering Handbook, SPE, Texas, 1987 : 22-9, 22-10, 22-15

18. Hagroot, J., Fundamentals of Gas Reservoir Engineering, Elsevier, Amsterdam, 1988

19. Dake, L.P., Fundamentals of Reservoir Engineering, Elsevier, Amsterdam, 1983

APPENDIX

CORRELATIONS FOR OIL AND GAS PROPERTIES

The correlations used for determining properties of oil and gas for the simulation study in this work are included in this appendix. The following is the detail of those correlation. It includes the development of each correlation and limitation to each correlation is included if available.

Bubble point pressure correlation

Standing's correlation[17] for estimating bubble point pressure of oil is used in this work. His correlation was based on 105 oil samples from California. The average error of the correlation to the actual data from the samples was 4.8% and 106 psi. The correlation is as follows.

$$p_b = 18(R_{sb} / \gamma_g)^{0.83} \times 10^{yg}$$

where

yg = mole fraction gas

$= 0.00091 (T_R) - 0.0125\, \gamma_{API}$

p_b = bubble point pressure, psia,

R_{sb} = solution gas oil ratio at $p \geq p_b$, SCF/STB,

γ_g = gas gravity (air = 1.0),

T_R = reservoir temperature, °F,

γ_{API} = stock-tank oil gravity, °API

Solution gas oil ratio for saturated oil

For the pressure point below initial bubble point pressure of oil in the reservoir, the correlation of Standing[17] as follows is used.

$$R_s = \gamma_g \left(p / 18 \times 10^{y_g} \right)^{1.24}$$

where

R_s = solution gas oil ratio, SCF/STB,

y_g = $0.00091(T) - 0.0125\,\gamma_{API}$,

p = pressure, psia,

γ_g = gas gravity,

γ_{API} = oil gravity, °API

T = Temperature, °F

Oil Formation Volume Factor

The correlation of Standing[17] is used for determining oil formation volume factor in this work. He used the same oil systems used for developing a correlation for determining bubble point pressure correlation. The correlation is of the following form.

$$B_o = 0.972 + 0.000147\,F^{1.175}$$

where

$F = R_s (\gamma_g / \gamma_o)^{0.5} + 1.25T$

B_O = oil formation volume factor, RB/STB

R_s = solution gas oil ratio, SCF/STB

γ_g = gas gravity, air = 1.0

γ_o = oil specific gravity = $141.5/(131.5+\gamma_{API})$

T = Temperature, °F

Oil Viscosity

Correlation of Beggs and Robinson[17] is used for determining oil viscosity. The correlation was developed in 1975. More than 2,000 measured data points from 600 oil systems were used for developing the correlation. The equation developed reproduced the measured data with an average error of -1.83% and a standard deviation of 27%. The equation for dead-oil viscosity is

$$\mu_{od} = 10^x - 1.0$$

where

$$x = T^{-1.163} \exp(6.9824 - 0.04658\gamma_{API})$$

μ_{od} = dead - oil viscosity, cp

T = Temperature, °F

γ_{API} = Stock tank oil gravity, °API

To correct for the effect of dissolved gas, the following equation is used.

$$\mu_O = A\mu_{od}^B$$

where

μ_o = saturated-oil viscosity, cp

μ_{od} = dead-oil viscosity, cp

$$A = 10.715\,(R_s + 100)^{-0.515}$$

$$B = 5.44(R_s + 150)^{-0.338}$$

R_s = solution gas oil ratio, SCF/STB

Gas Viscosity

Lee, Gonzalez, and Eakin[18] proposed the correlation for predicting gas viscosity as the following form.

$$\mu_g = K \exp (X \rho^Y)$$

where

$K = (9.4+0.02\ M)T^{1.5} / (209 + 19M + T)$

$X = 3.5 + 986/T + 0.01M$

$Y = 2.4 - 0.2\ X$

μ_g = gas viscosity, micropoise

T = absolute temperature, °R

M = molegular mass,

ρ = gas density, g / cm^3

VITAE

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