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Full Length Research Paper

Pressure derivative analysis with type curves for reservoir parameters estimation of Kailastila gas field

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Modern type curve analysis involves matching the pressures and their semi log derivative on a set of dimensionless type curves, and selecting a match point. Using this point and a specified matching curve, reservoir parameters such as permeability, skin factor, wellbore storage, areal extent etc. can be calculated. This paper shows that the same parameters can be obtained by using derivative analysis and type curve analysis. There are many graphical techniques that can be used to analyze well test data. These techniques include Cartesian, semi-log, and log-log plots of pressure and pressure drop functions. The particular analysis technique to be used depends uniquely on the reservoir flow model. In this paper first, semi-log plot of pressure versus the logarithm of some time function is used. Log-log plots are used, as a diagnostic tool to determine the reservoir model and to identify analogous data trends. In fact only the semi log derivative of the data is needed on log-log coordinates. Finally, pressure derivative and type curve values are used to construct a vertical model of the reservoir. In addition to the semi log derivative data, it is advisable to superimpose a plot of PPD (primary pressure derivative). This enables the analyst to differentiate between reservoir and wellbore effects.

Keywords: Pressure derivative, type curve analysis, skin factor and wellbore storage, primary pressure derivative.

INTRODUCTION

Gas well test analysis is a branch of petroleum engineering. Information derived from flow and pressure transient tests about in-situ reservoir conditions is important in many phases of petroleum engineering. The reservoir engineer must have sufficient information about the reservoir/well conditions and characteristics to adequately analyze reservoir performance and forecast future production under various modes of operation. Pressures are most valuable and useful data in reservoir engineering. Directly or indirectly, they enter into all phases of reservoir engineering calculations. Therefore accurate determination of reservoir parameters is very important.

Type Curve Analysis

A type curve is a graphic representation of the theoretical response during a test of an interpretation model that represents the reservoir being tested. For a constant pressure test, the response is the change in production rate; for a constant rate test, the response is the change in pressure at the bottom of the well. Other types of response are also used, such as the time derivative of the bottom hole pressure. Type curves are derived from solutions to the flow equations under specific initial and boundary conditions. For the sake of the generality, type curves are usually presented in dimensionless terms, such as dimensionless pressure vs. a dimensionless time. A given interpretation model may yield a single type curves, depending on the complexity of the model. Type curves are very useful in well-test analysis, particularly when used with semi log analysis techniques. Type curves can help identify the appropriate reservoir model, identify the appropriate flow regimes for analysis, and estimate reservoir properties. They are especially helpful for analyzing gas-well tests when the data are distorted by wellbore storage.

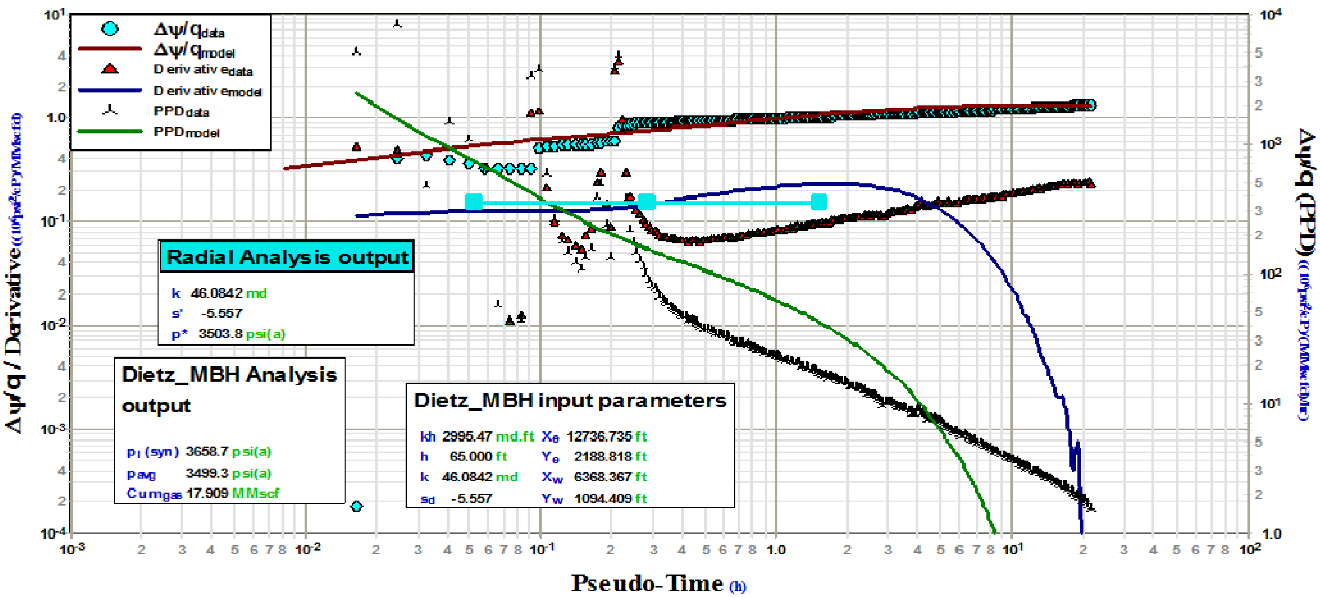

Figure 1. Pressure derivative, PPD, type curve, Dietz_MBH during build up test.

Derivative Analysis

This new method of analysis has it basis in the published literature, and is rooted in the recognition and behavior of various flow regimes. Recently, the quality of well test interpretations has improved considerably because of the availability of accurate pressure data and the development of new software for computer- aided analysis. The interpretation method based on the analysis of the derivative of pressure with respect to appropriate time function. Use of the derivative of pressure vs. time is mathematically satisfying because the derivative is directly represented in one term of the diffusivity equation, which is the governing equation for the models of transient-pressure behavior used in well-test analysis (Figure 1).

Primary pressure derivative

When analyzing data, it is imperative that the data represent reservoir transient and not wellbore transient. Reservoir effects cannot cause an increase in PPD. Therefore an increase in PPD indicates a non-reservoir effect. The PPD curve is usually plotted along with the derivative (Figure 2), to identify portions of the data that are wellbore dynamics but are often mistaken to be reservoir effects.

Objectives

The objectives of this study are to analyze the well test data to estimate the following parameters and finally these estimated parameters are matched by vertical modeling.

I. The formation permeability
II. The skin effect
III. Average reservoir pressure
IV. Wellbore storage effects
V. Reservoir areal extend

METHODOLOGY AND STUDY PROCEDURE

There are several methods may be used to estimate reservoir parameters. The pressure build-up test, type curve analysis, Dietz_MBH method, vertical modeling and flow after flow test are used to complete this study. Permeability and skin due to damage are estimated by build-up test of radial analysis by developing semi log and derivative type curves. The values of permeability, skin, and average pressure are estimated from the Dietz_MBH method. These values are used as an input for vertical modeling.

RESULTS AND DISCUSSIONS

The results presented here are obtained from pressure semi log plot, pressure derivative type curves and Dietz_MBH analysis of buildup test. The outputs of diagnostic analysis are used as input for Dietz_MBH analysis to estimate average reservoir pressure. The results from all analysis means semi log and derivative type curves are obtained similar. This section presents the discussion on parameters obtained from analytical (conventional) analysis, vertical model analysis.

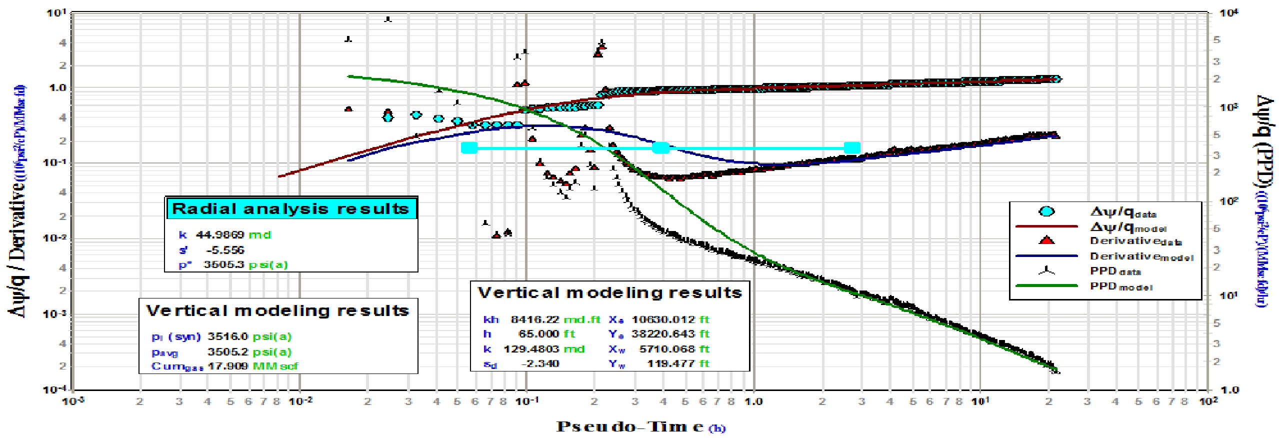

Figure 2. Pressure derivative, PPD, type curve during build up and vertical model.

Table 1. (Results from diagnostic and model analysis).

Studied reservoir		
Well	Vertical	
Reservoir	Homogeneous	
Boundary	Elongated rectangular reservoir	
Reservoir parameters	**Value**	**Remarks**
K(md)	46.0842	Average permeability
Kh(md.ft)	2995.47	Total permeability-thickness product
P_i(psia)	-5.557	Initial reservoir pressure
P^*(psia)	3503.8	Extrapolated pressure
$P_{(avg.)}$(psia)	3499.3	Average reservoir pressure
$P_{(syn)}$(psia)	3658.7	Synthetic pressure
X_e(ft)	12736.735	Reservoir length
Y_e(ft)	2188.818	Reservoir width
X_w(ft)	6368.367	Well location in X-direction measured from boundary
Y_w(ft)	1094.409	Well location in Y-direction measured from boundary
Selected model		
Well	Vertical	
Reservoir	Homogeneous	
Boundary	Elongated rectangular reservoir	
Main Model Parameters	**Value**	**Remarks**
K(md)	129.480	Average permeability
Kh(md.ft)	8416.22	Total permeability-thickness product
C_D	678444.583	Dimensionless storage coefficient
S_d	-2.300	Skin due to damage
P_i(psia)	3515	Initial reservoir pressure
P^*(psia)	3505.3	Extrapolated pressure
$P_{(avg.)}$(psia)	3505.2	Average reservoir pressure
$P_{(syn)}$(psia)	3516	Synthetic pressure
Well and Wellbore storage parameters	**Value**	**Remarks**
C_D	678444.583	Dimensionless storage coefficient
S_d	-2.334	Skin due to damage

From Table 1, it is obtained that the total skin effect ($\acute{S}$) are negative. But it is tough to conclude that the wells are stimulated as all the skin components have not been analyzed here.

The average reservoir pressure, Pavg (3499.3psia) from Dietz_MBH analysis is closer to initial reservoir pressure indicates that the reservoir is at its early stage of production. The areal extents indicate the reservoir is rectangular in shape which is consistent with assumption. The results are tabulated here from pressure semi log plots, pressure derivative type curve and dimensionless type curve. The resultant values of a specific parameter obtained from all analysis methods are same. For this reason, the specific method has not been mentioned in table containing results.

Though, all the estimated parameters are well matched with actual reservoir pressure provided by gas fields company but from the Table1 (Comparison among diagnostic analysis parameters and vertical model parameters) it is obtained that, the estimated pressure response and reservoir extends of radial analysis do not fit the vertical model. It is general case for most of the time, because all the models are developed based on the theoretical background. Therefore, the vertical model can no longer be used to extract the reservoir parameters in the conventional manner. Other perturbing influences that may cause measured pressure data to deviate significantly from the basic theory include well stimulation, formation damage, perforations, fractures and a host of other formation and fluid heterogeneities. Another reason is that, some PVT properties were not available in collected PVT data table from field. For this reason the PVT data are assumed here.

CONCLUSION

Derivative analysis can be used for drawdown or build up data in the same manner, provided the appropriate time functions are used. The derivative approach improves the definition of the analysis plots and therefore the quality of the interpretation. The differentiation of actual data has to be conducted with care to remove noise without affecting the signal. The derivative approach does not produce errors or noise but only reveals them. Type curve describe the entire behavior of the interpretation model corresponding to the well and the reservoir and include various flow regimes that successively dominate during the test. As a result, type curve analysis provides the entire well and reservoir parameters that can be obtained from well testing With the help of dimensionless type curve the estimated parameters are matched with diagnostic analysis. Type curve is a old way to estimate and pressure derivative is a new way to estimate the reservoir parameters. With the help of this two procedure the estimated parameters were validated.

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REFERENCES

Abbasi M Ajmal (1989). Mari Gas Co. Ltd. “Pressure Transient Test Design for Gas Reservoir Producing Under Water-Drive Conditions”.

Chase WR, Alkandari Hassan (1993). “Prediction of Gas Well Deliverability from Just a Pressure Buildup or Drawdown Test”.

Cobb WM, Smith JT, Denson AH (1976). “Determination of Well Drainage Pore Volume and Porosity from Pressure Buildup Tests,” SPEJ (August) 209-216.

Craft BC, Hawkins MF (1959). Applied Petroleum Reservoir Engineering, PrenticeHall, Inc., Englewood Cliffs.

Dake LP (1978). “Fundamentals of Reservoir Engineering”(1978). Elsevier, Amsterdam-London-New York-Tokyo.

Economides J Michael, Hill Daniel A, Ehlig-Economides Christine (1994). “Petroleum Production Systems”. Prentice Hall PTR, Upper Saddle River, New Jersey 07458.

El-Khatib NAF (1985). “A New Approach to Well Test Analysis”.

Gringarten AC. “practical use of well test deconvolution”.

Horne N Ronald (1990). “Modern Well Test Analysis” A Computer-Aided Approach, Forth printing.

Horner DR (1951). “Pressure Build-Up in Wells,” Proc., Third World Pet. Congress, Sec II 503.

Katz DL, Cornel D, Kobayashi R, Poettmann FH, Vary JA, Elenbass JR, ad Weinaug CF (1959). Handbook of Natural Gas Engineering, McGraw-Hill Book Co., Inc NewYork448.

Kuchuk Fikri J, Goode Peter A, Sherrard Bradley W, Thambynayagam, RK Michael (1988). ”Pressure-Transient Analysis for Horizontal Wells”, SPE 18300, 1988 SPE Annual Technical Conference and Exhibition, Houston, Oct 2-5.

Kuchuk Fikri J, Goode Peter A, Wilkinson DJ, Thambynayagam Michael RK (1991). ”Pressure-Transient Behavior of Horizontal Wells with and Without Gas Cap or Aquifer”, SPE 17413, SPE Formation Evaluation, March.

Lee John, Wattenbarger AR (1996). “Gas Reservoir Engineering”, SPE Textbook Series, Vol. 5 (Dallas, TX: Society of Petroleum Engineers).

Lee John (1982). “Well Testing”, Society of Petroleum Engineers of AIME, New York Dallas.

Muskat M (1949). Physical Principles of Oil Production, McGraw-Hill Book Co., Inc., New York, pp. 126.

Onur M, Serra KV, Reynolds AC (1991). “Analysis of Pressure-Buildup Data from a Well in a Multiwell System,” SPEFE (March) 101-110.

Osman ME (1991). U. of United Arab Emirates; “Well Test Analysis for a Well in a Rectangle with Constant or Mixed Bountaries--Part 1: Drawdown Testing”.

Appendix

Parameters	Value
Well radius (inches)	3.5
Net drained thickness (ft)	40
Effective porosity (%)	0.16
Gas gravity	0.586
Primary separator pressure (Psia)	1000
Primary separator temperature (^{0}F)	70
Dew point	N/A
CO_2 component (mol %)	0.139
H_2S component (mol %)	Nil
N_2 component	N/A
Water Salinity (ppm)	10000
Initial Reservoir Pressure (Psia)	3221
Initial Reservoir Temp ('F)	145.11
Rock Compressibility (psi-1)	N/A
GOR bbl/MMscf	Varying
WGR bbl/MMscf	Varying
Connate water saturation (%)	15