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Research article

ANALYSING AND MODELING PRESSURE BUILDUP DATA OF KAILASTILLA GAS FIELD

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ABSTRACT

The vertical model simulates the pressure response in a vertical well within a rectangular shaped reservoir with homogeneous characteristics. The main objectives of this work were to estimate the reservoir parameters and construct a classical configuration for a dynamic reservoir system by history matching with a vertical model. For this study a homogeneous, single phase, rectangular shaped gas reservoir with vertical well is selected. At first the pressure transient data is analyzed and reservoir parameters-permeability, skin factor, average pressure, wellbore storage coefficient, reservoir drainage extent are estimated. To estimate these parameters, the deliverability test and buildup test (MBH) are used based on pressure transient data and production data. Then, the estimated parameters are matched by vertical modeling. Finally, type curves are used to validate these parameters.

Key words: Pressure transient test, Vertical modeling, Type curve, Skin factor and wellbore storage, Reservoir configuration.

1. INTRODUCTION

Modeling is the process of history matching pressure transient data based on a mathematical model. In order to optimize a development strategy for an oil or gas field, it is assumed a reservoir model is capable of predicting the dynamic behavior of the field in terms of production rate and fluid recovery. Such a model is constructed using geological, geophysical and well data. The necessary parameters are obtained from direct measurements (cores, cuttings, formation fluid samples, etc.) and from interpreted data (surface seismic, well logs, well tests, PVT analysis, etc.). While seismic data and well logs provide a static description of the reservoir, only well test data reflects information on dynamic reservoir response. The well test data is therefore a key element in the reservoir model construction [1].

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Interpretation of these data leads to individual "models" (what the geophysicist, the petro-physicist and well analyst think the reservoir looks like). A brief understanding of the fundamental aspects of well test analysis is necessary in order to incorporate dynamic well test data into the reservoir model and it is the job of the reservoir engineer to incorporate these individual models into a cohesive reservoir model. In the initial phase of well tests, pressure measurements are dominated by wellbore storage effects [6].
In this paper, a simple model is developed that can explain the measured well test data. The model gives a rather simplified and idealistic view of the reservoir, characterized by:

- Isotropic and homogenous reservoir volume,
- Constant porosity, - absolute permeability, - viscosity and - reservoir height (reservoir thickness)
- Test production with relative small pressure gradients
- Horizontal radial flow paths (no cross flow) and
- Constant flow rate
- Darcy flow

Even though these items place tight restrictions on the reservoir itself, some important information can be extracted from the models, explaining reservoir behavior on basis of the well test data [7].

There are many different models available to match the data depending on the situation [4]. Thus, it is important to analyze the pressure transient data before modeling because it forces the analyst to think about the probable reservoir configurations and provides good estimates of reservoir parameters. Models are not unique (different model types can match the same set of data) and, as a result, it is essential that the choice of model type occur after the analysis step [2]. The values of parameter obtained during the analysis step provide a good starting point for an appropriately chosen model type. Parameters can then be optimized by automatic parameter estimation (APE). Before using the APE method, irrelevant data should be removed from the data set to for efficient matching.

2. OBJECTIVES OF THE STUDY

The objectives of this study are to analyze the well test data available for well KTL-01 and, KTL-02, to estimate the following parameters and finally these estimated parameters are matched by vertical modeling.

- The formation permeability
- The skin effect
- Average reservoir pressure
- Wellbore storage effects
- Reservoir areal extents

3. MTHODOLOGIES AND STUDY PROCEDURES

There are several methods may be used to estimate these parameters [5]. The pressure build-up test, type curve analysis, Dietz_MBH method and vertical modeling 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. These values of parameters are used as input parameters for Dietz_MBH method. After entering these parameters into “FEKETE software” the Dietz_MBH method gives the output values of reservoir areal extents and these areal extents again used as input parameters for Dietz_MBH method and finally the average reservoir pressure is estimated [8]. The estimated parameters are used as input parameters for vertical modeling. Vertical model gives the output of all parameters on the basis of extrapolated pressure those are found by conventional analysis with dimensionless wellbore storage coefficient [3].

4. RESULTS AND DISCUSSIONS

From Table 1 and Table 2, it is obtained that the total skin effect ($\acute{S}$) are negative for both well KTL-01 and well KTL-02. 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, P_{avg} (3499.3psia) from Dietz_MBH analysis for KTL-01 in Table-1 is closer to initial reservoir pressure indicates the test duration was small. But in case of KTL-02, the average reservoir pressure is greater than the initial reservoir pressure. This may be the error at the time of data recording. The areal extents indicate the reservoir is rectangular 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 mentioned in table containing results.
Extrapolated pressures were found P^*= 3503.8 psia for KTL-01 and P^*= 3223.8 psia for KTL-02 against the actual shut in pressure 3499.29 psia and 3222.37 psia respectively.

Though, all the estimated parameters are well matched with actual reservoir pressures but the quality of vertical model prediction deviates. It occurs very often as all of the models are developed theoretically. Therefore, it is better to avoid vertical model to predict the reservoir parameters. 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 assumed here due to the lacking of available PVT data.

Table-1: Comparison between conventional analysis parameters and vertical model analysis parameters of KTL-01

Parameters	Analysis Value	Model value	Remarks
K(md)	46.0842	129.480	Average permeability
Kh(md.ft)	2995.47	8416.22	Total permeability-thickness product
S^-	-5.557	Not found	Total Skin
S_d	Not found	-2.300	Skin due to damage
P^*(psia)	3503.8	3505.3	Extrapolated pressure
$P_{(avg.)}$(psia)	3499.3	3505.2	Average reservoir pressure
$P_{(syn)}$(psia)	3658.7	3516	Synthetic pressure
X_e(ft)	12736.735	10630.012	Reservoir length
Y_e(ft)	2188.818	38220.643	Reservoir width
X_w(ft)	6368.367	5710.068	Well location in X-direction
Y_w(ft)	1094.409	119.477	Well location in Y-direction

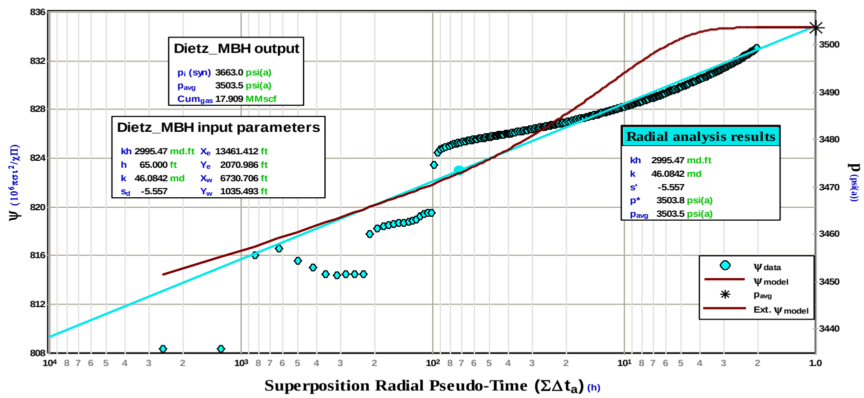

Figure 1: Dietz_MBH Semi log plot of radial flow analysis for KTL-01

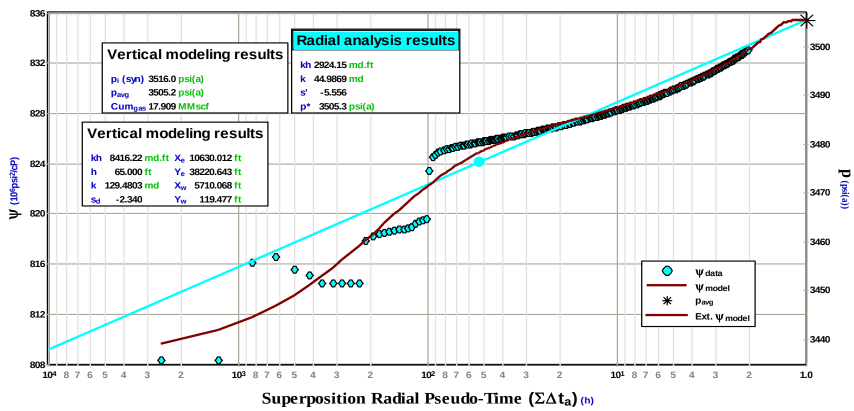

Figure 2: Semi log plot showing pressure buildup test results comparison of diagnostic analysis and vertical model analysis for KTL-01

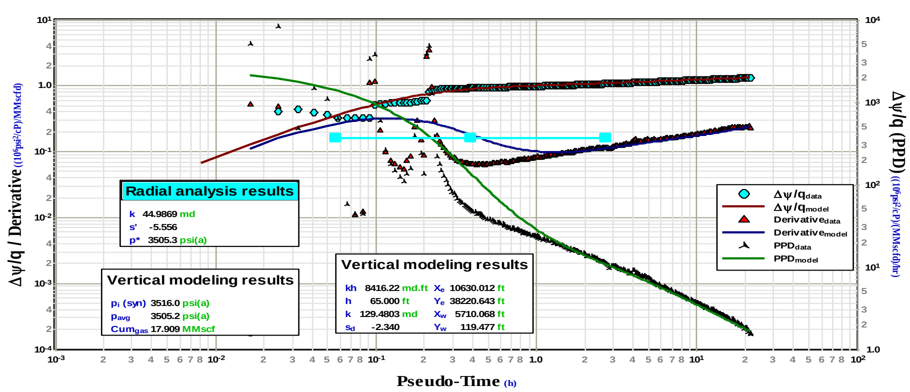

Figure 3: Type curve plot showing pressure buildup test results comparison of diagnostic analysis and vertical model analysis for KTL-01

Table 2: Comparison between conventional analysis parameters and vertical model analysis parameters of KTL-02

Parameters	Analysis Value	Model value
K(md)	699.098	899.7578
Kh(md.ft)	27963.92	35990.31
S^{-}	-0.332	Not found
S_d	Not found	0.294
P^*(psia)	3223.8	3225.2
$P_{(avg.)}$(psia)	3222.4	3219.3
$P_{(syn)}$(psia)	3373.7	3340.5
X_e(ft)	14032.289	6866.983
Y_e(ft)	1986.792	5046.971
X_w(ft)	7016.135	90.492
Y_w(ft)	993.366	4148.806

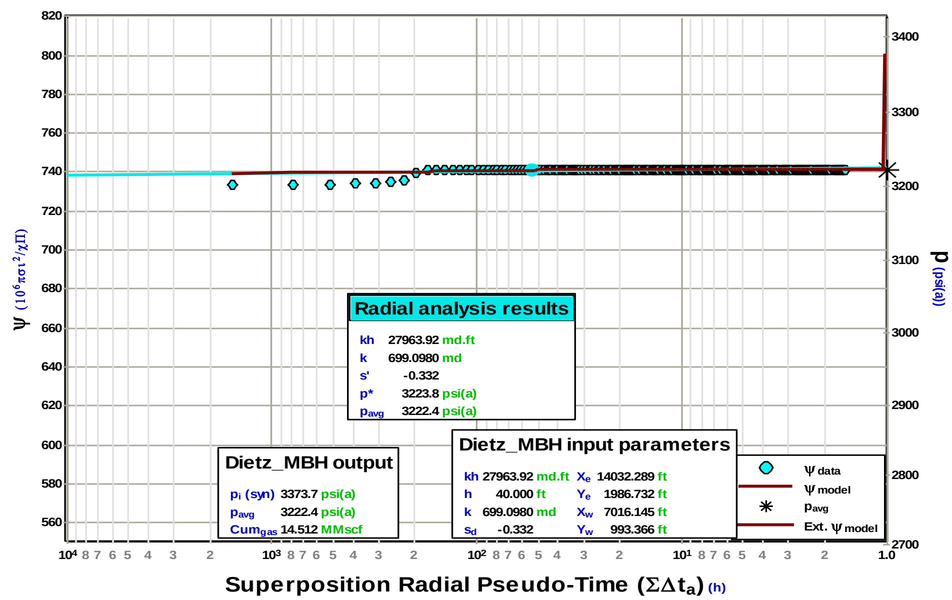

Figure 4: Dietz_MBH Semi log plot of radial flow analysis for KTL-02

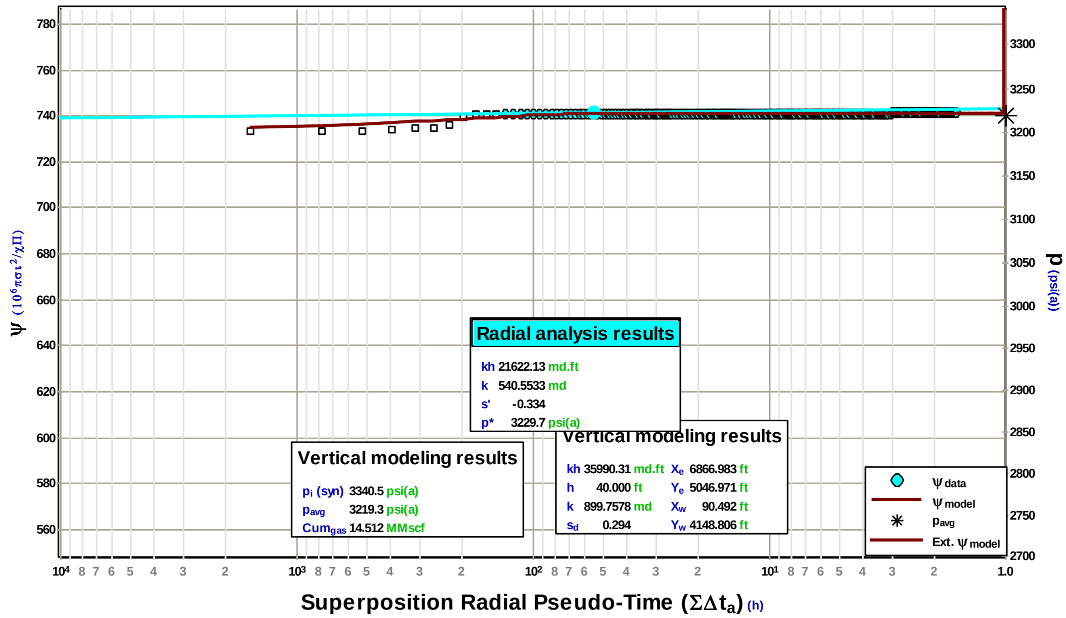

Figure 5: Semi log plot showing pressure buildup test results comparison of diagnostic analysis and vertical model analysis for KTL-01

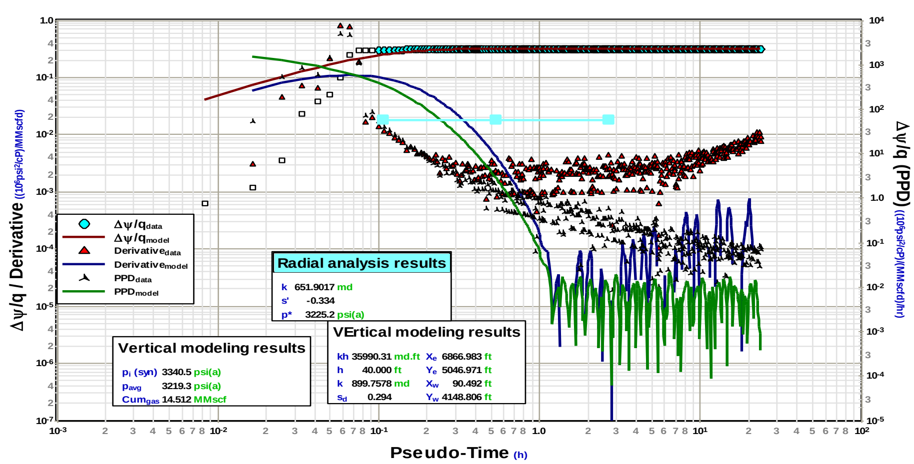

Figure 6: Type curve plot showing pressure buildup test results comparison of diagnostic analysis and vertical model analysis for KTL-01

CONCLUSION

Finally, we identify one particular realization as the reference model. This model is simulated in order to generate the "production data" used for the history matching. For purposes of the history match, we assume that each of the downhole sensors provides individual phase flow rates. For a multilateral well in which each branch is instrumented, this means that the pressure and phase flow rates in each lateral are assumed to be known. In current applications, downhole sensors do not yet provide this information directly (though flow rates can be estimated from temperature and pressure measurements), but it is reasonable to assume that future sensors will provide such data more directly and with greater degrees of accuracy. It is concluded that modeling is not a good tool for estimating or predicting the reservoir parameters for a practical field.

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