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Pressure Transient Analysis for Sandstone Reservoir by Using Saphir

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

This work is discussed how to differentiate between two tricky models for sand stone formation by using the pressure transient analysis PTA for three Wells which are distributed in south, middle and north of X field. In the derivative curve these two models have the same sequence of flow regime which are by hump, first radial flow regime, transition hump and then late radial flow regime. The parameter Kappa (K) played the most important key to select the type of reservoir model and differentiate between the two models in PTA. In the middle and south of the field, this parameter has a value close to one at well no. Rt-16 & Rt-18, which means that the system behaves as dual porosity. On the other hand, Kappa has a value of around (0.74) in Rt-17 to represent a double permeability system but without cross flow between two layers due to the small value of Lamda.

Keywords: Dual porosity; double permeability; PTA; analytical model.

1. INTRODUCTION

X Field is a large oil field located in the west of Basra city at the south of Iraq. It has three major reservoirs that produced oil, two of them are carbonate and one is sand stone formation. Where, during the last few years ago, several appraisal Wells were drilled.

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A build test is carried out for thee well in this field to investigate Well productivity, permeability, skin factor, boundary limits, and distance to faults [1-3].

Layered reservoirs or double permeability are usually divided into two parts 1) layered formation with cross-flow*,* where layers communicate at contact planes throughout the reservoir 2) layered reservoir without cross-flow (commingled system) where layers communicate only through well-bore [4-6]. The two layers formation consists of two layers of different permeability. Cross-flow between the layers is proportional to the pressure difference between them [7].

Fig. 1 shows the double porosity system in reservoir, where the rocks consist from fissures and matrix, the last one is stored the fluid with low permeability wile fissures have high permeability and connected directly to the well-bore to contribute the production in wells.

As the well is open to flow, a pressure difference is carried out between the fissures and matrix because the pressure inside fissures declined as soon as the Well is open, this phenomena is called transition flow. And after a time the pressure in both fissures and matrix is balanced and the system is participate the production. Tis stage is called “the total system flow regime” [8].

This paper presents the analytical simulation by using Saphir V3.02 software to predict the formation properties such as average permeability, skin factor, average pressure, and shows the heterogeneity of sand stone reservoir for the current oil field.

2. Well TEST DESIGN AND SIMULATION

A well test carried out for three vertical wells, producing from sand stone reservoir and surrounds by many wells produced from the same formation Fig. 2.

The buildup test of the active wells R-16, R-17 & R-18 consists of a drawdown to open the Wells to a two phase separator to calculate the flow rate and gas oil ratio this takes around 8 hrs, then the drawdown is followed by around 60 hrs surface shut-in while pressure sensor is still in the bottom hole to measure the reservoir pressure as shown in Fig. 3.

These data is collected and fed to Saphir software V3.02 for analysis to obtain critical reservoir data including formation flow capacity, well-bore skin, current reservoir pressure, reservoir model and identification of any reservoir boundaries [9-10].

The simulation procedure followed in this work is represented by the flow chart in Fig. 4.

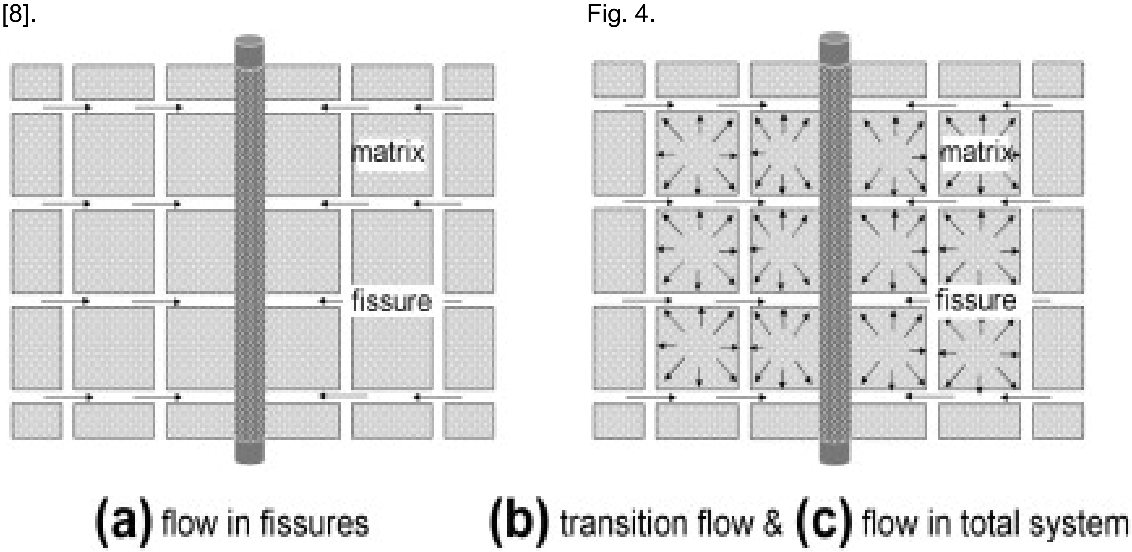


Fig. 1. Double porosity system

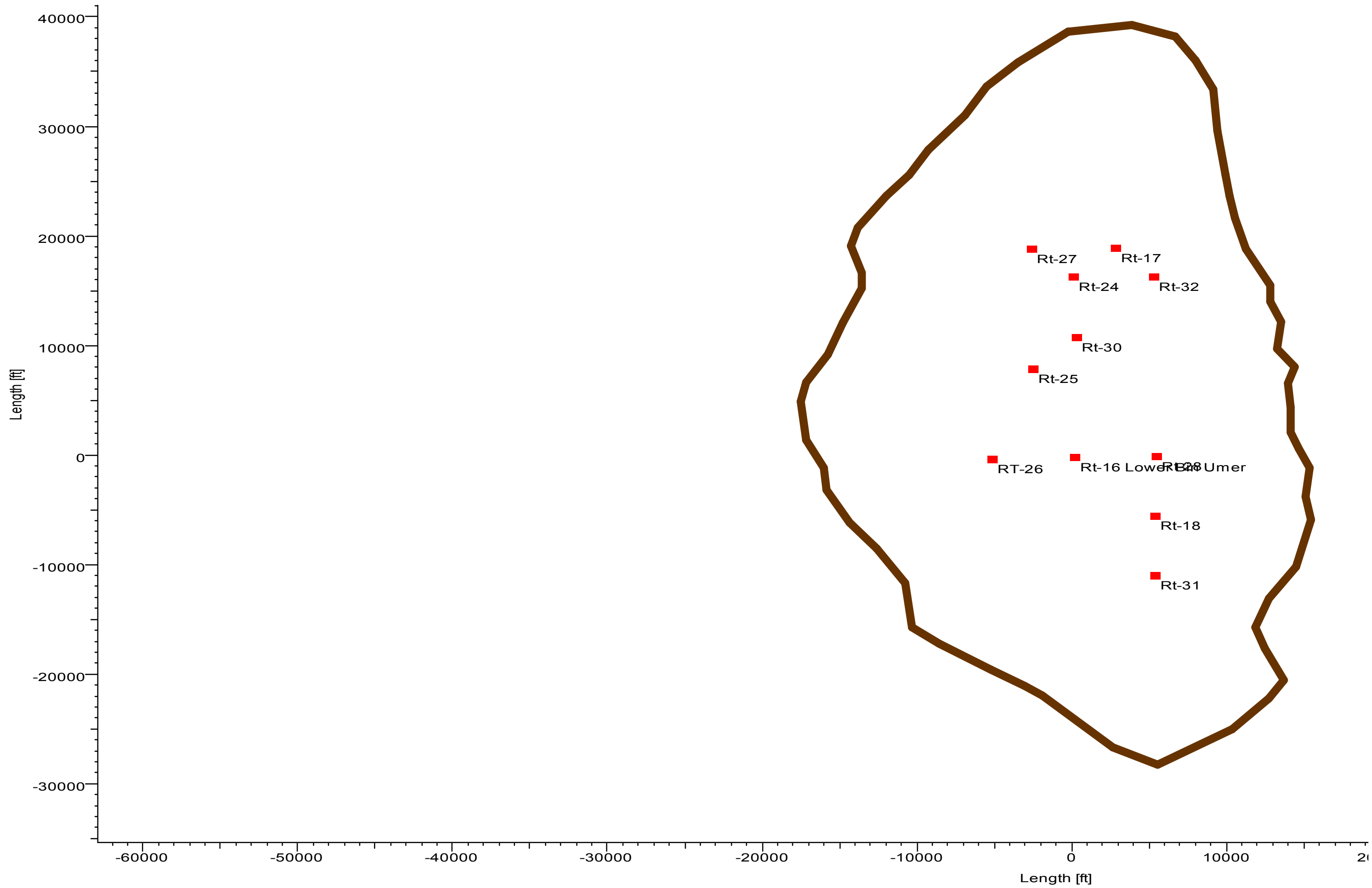


Fig. 2. Location of wells in the X field

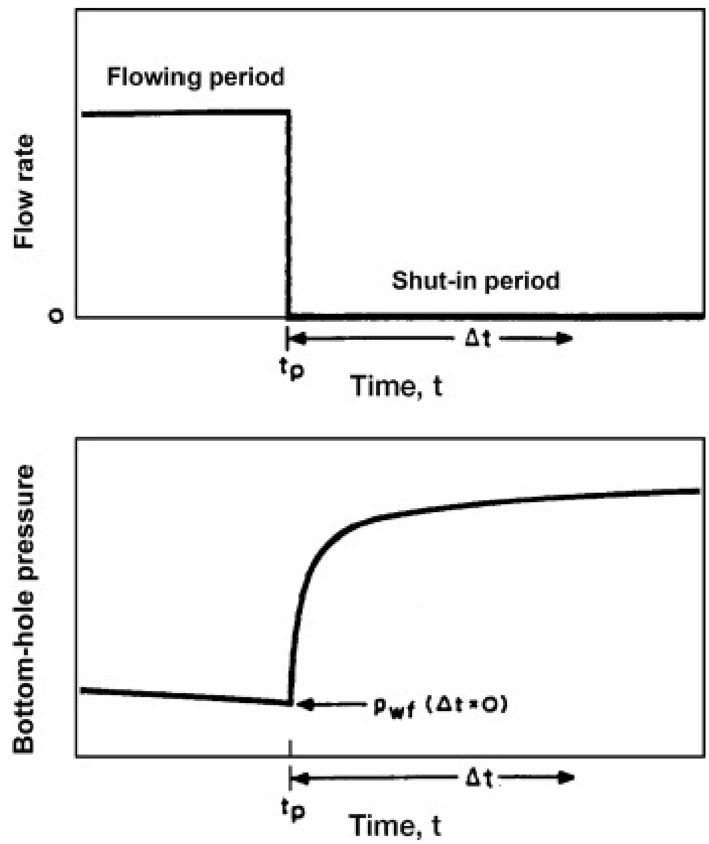


Fig. 3. Idealized pressure buildup test

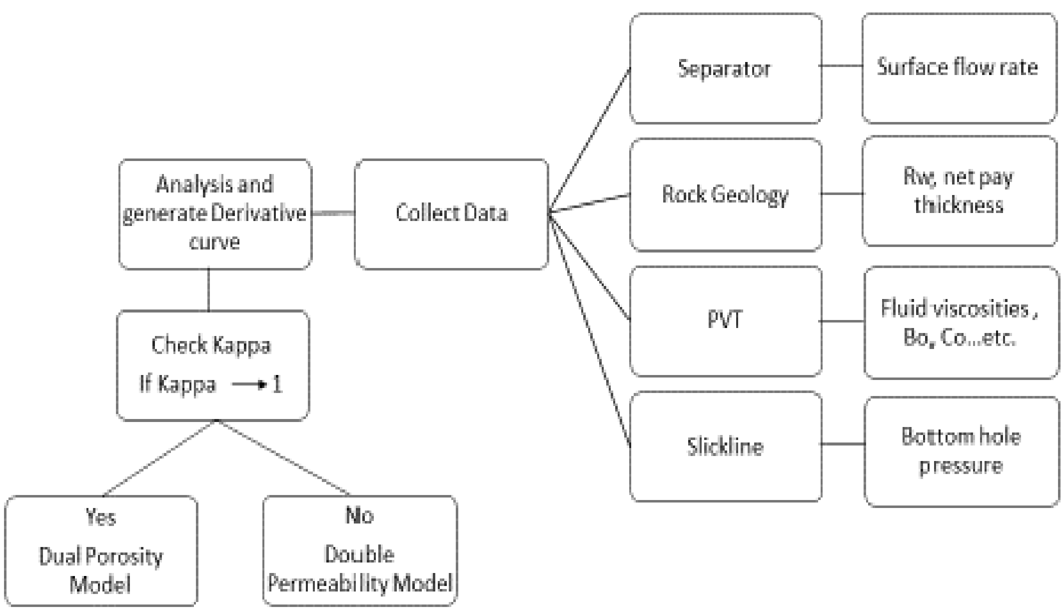


Fig. 4. Flow chart of simulation procedure by Saphire

3. RESULTS AND DISCUSSION

3.1 Input

Many information are required for the pressure transient analysis for the build test for the three active wells such as rates, pressures, PVT & petro physical information [11] that are listed in Table 1 and Table 2 shows the productivity for the surrounding wells that calculated by PLT.

3.2 Analytical Pressure Transient Analysis

After shut off the Wells in buildup test, the well-bore storage resists the flow of formation from instantaneously following the surface flow-rate [7], for that the Derivative curve starts by hump and then followed by first stabilization as shown in Fig. 5. This stable line in derivative curve represents the homogeneous behavior of radial flow where only fissures participate in the production from formation to well-bore.

On the other hand, the first radial flow in the two layers system can be seen after the well is opened where there is no pressure difference between the two layers of different permeability and the system behave as two homogeneous layers without cross-flow. The transition dip carried out when the matrix blocks start to transfer fluid to fissures in dual porosity system while in the second system this transition is carried out because the fluid transfer from the less permeable layer to the most permeable layer which is participate the production to the well-bore. In both systems a second radial flow regime is seen because the pressure is equalize between the two layers in double permeability system and between the matrix blocks and fissures in dual porosity system [3,12-14].

Fig. 5 show a late dip in the end of derivative curve, this is because the factor Lamda or the ability of flow between the layers or between fissures and matrix to reach the transition regime is very low as shown in Table 3.

The software generate the derivative curve for three wells that under study and two reservoir models are selected at the beginning of analysis the first is dual porosity model and the second is double permeability model where Table 3 is shown the results of these models.

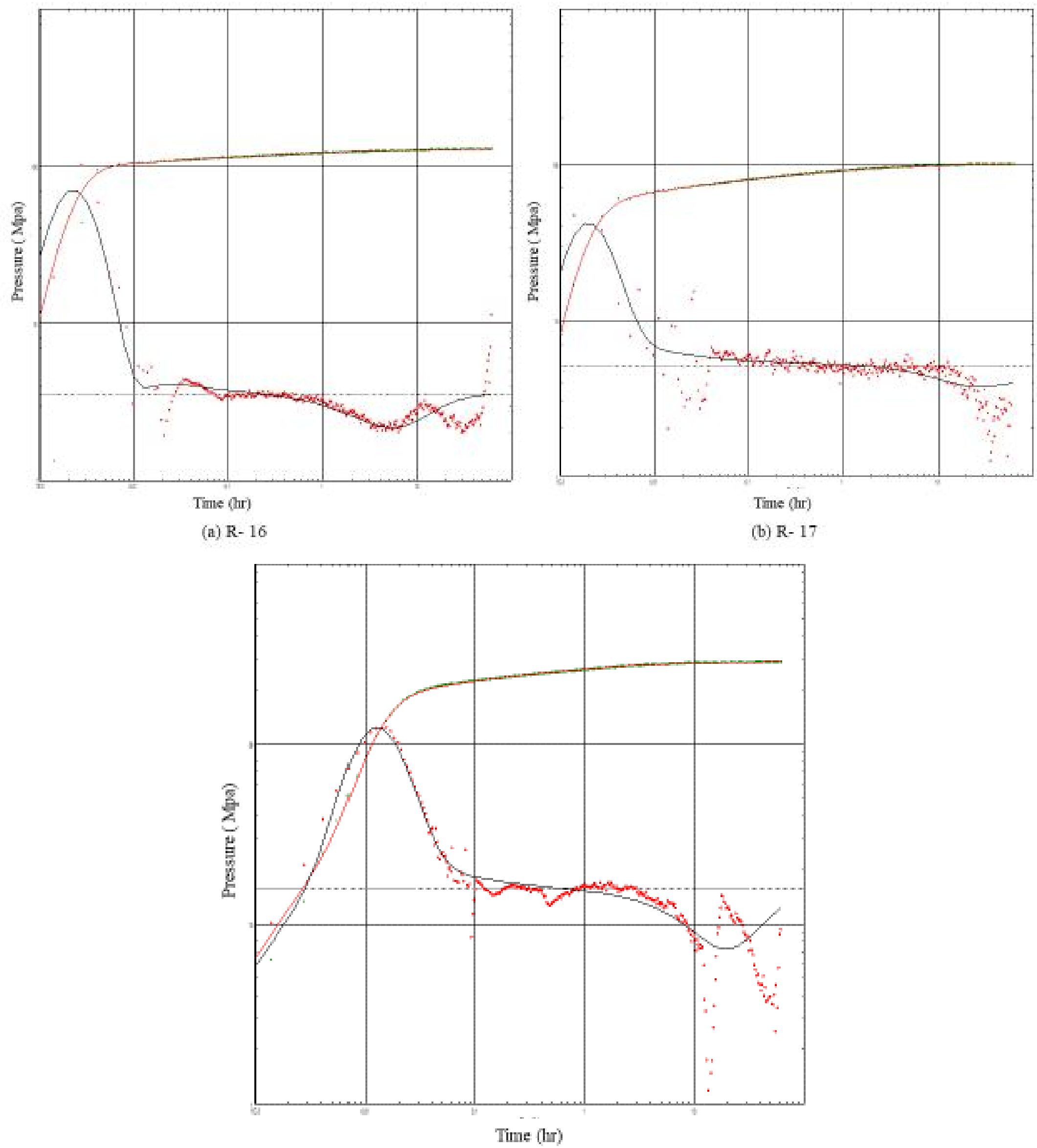
To differentiate between these two models, the factor Kappa listed in Table 3 is the most factor that use for this purpose which is define as the ratio of the permeability-thickness product of the most permeable layer to the total of both in the double permeability system or it is the ratio of the permeability-thickness for fissures divided by the total of fissures and matrix.

Table 1. The input data required for analysis

Well No.	R-16	R-17	R-18
Flow rate , bbl/day	4430.00	4340.00	3581.00
Porosity %	20.6	18	22
Well Radius (ft)	0.3	0.3	0.3
Pay Zone (ft)	46.4895	85.3018	68.8976
Volume Factor , STB/STB	1.08	1.1029	1.072
Viscosity , Cp	6.7	6.7527	7.87338
Total Compressibility (Psi^{-1})	7.95734E-6	1.2944E-5	1.1906E-6

Table 2. The production of the surrounding wells

No.	Well No.	Production (bbl/day)
1.	24	5500.00
2.	25	3966.00
3.	26	4704.00
4.	27	6923.00
5.	28	5148.00
6.	30	3910.00
7.	31	3421.00
8.	32	4674.00



(c) R- 16

Fig. 5. Log-Log plot for the analytical model

As shown the results in Table (3) the main results of analytical analysis of build test for the three wells it is clear to see that Kappa (K) for the wells R-16 & R-18 is close to one and the best model for these two wells is the dual porosity model.

Although, R-16 & R-18 have the same formation system of dual porosity, but the permeability of the first well is around doubled the value in R-18, that is because the inter porosity of R-18 is too small as compare with the second well which leads to reduce the permeability in the south of the field.

On the other hand, R-17 which is located in the north of field has kappa around 0.74 where the best model that should be selected is two layers model for this case [15].

Table 3. The output results of the analytical analysis

Well No.	R-16		R-17		R-18	
	Double K	**Dual Ø**	**Double K**	**Dual Ø**	**Double K**	**Dual Ø**
C , bbl/psi	3.88 E-4	1 E-5	0.00122	0.00202	0.00347	0.0035
Total Skin	9.61	9.7	1.94	1.21	0.655	0.954
Kh , md.ft	6.18 E+5	6.18 E+5	4.13E+5	4.13E+5	1.55E+5	1.55E+5
K , md	4350	4350	4840	4840	2250	2250
Pi , Psia	4300.78	4300.78	4313.34	4313.34	4309.39	4309.39
Skin 1	9.91	-	3.21	-	0.648	-
Skin 2	0.7	-	-1.74	-	6.02	-
Omega	0.307	0.41	0.977	0.316	0.166	0.282
Lamda	1.063E-7	1.03E-7	3.51E-9	8.91E-9	3.8E-8	8E-8
Kappa	0.99	-	0.743	-	0.999	-

4. CONCLUSION

Kappa is the most important factor that differentiate between the dual porosity and double permeability system where it is not used for dual porosity model. Out of three Wells, R-17 is the only Well that used the double permeability model as kappa is equal to 0.74 as shown in Table 3, this mean the formation for this Well is consist of two layers with different permeability and no cross-flow between them as the interporosity factor, Lamda, is very small value which is 3.51E-9.

As seen from the results the permeability of formation is enhanced toward the north of the field where it is increased in north by around twice the value of the south.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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