ANALYTICAL REPRESENTATION FOR CONSTANT TERMINAL PRESSURE FUNCTIONS (RESERVOIR OIL-WELL SYSTEMS)

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ABSTRACT

An analytical expression is established for the constant terminal pressure solution of the diffusivity equation, which describe the flow through porous media. This expression is based on the data reported by John Lee. The expression is prepared for dimensionless reservoir size ranged from twenty to one million and shows an excellent agreement for the estimated cumulative influx (Qt_D).

The developed expression is simple and is suitable to use in reservoir simulation and performance calculations.

INTRODUCTION

One of the main solutions of the diffusivity equation is the constant terminal pressure solution, which assumes a constant pressure at the inner boundary and calculates the cumulative influx across that boundary.

Muskat [1] presented the solution for this assumption by the application of Fourier-Bessel series-Van Everdingen and Hurst [2] presented the same solution employing Laplace transforms. The latter presented data for dimensionless reservoir size ranging from 1.5 to10.

Slider [3] presented the work of Exxon production Research Company for dimensionless reservoir size ranged from 1.5 to 3200.

Uraiet and Raghavan [4] solved the diffusivity equation numerically by the method of finite difference. Their results are presented graphically for dimensionless reservoir size ranged from 500 to 10000.

John Lee [5] presented data for dimensionless reservoir size ranged from 1.5 to one million. This range covers the range encountered for the aquifer- reservoir system (i.e. re_D=1.5 to 10) and reservoir- well system (re_D>10).

Shuker etal [6] developed an analytical representation for re_D ranged from 1.5 to 10.

In this work the data published by John Lee [5] are utilized to develop an extended expression for re_D ranged from 20 to one million.

This expression is developed with the aid of regression analysis techniques.

REGRESSION ANALYSIS

John Lee [5] presented data for constant terminal pressure for re_D ranged from 1.5 to one million. He tabulated his results as dimensionless influx (Qt_D) and dimension-less rate (qt_D) as a function of dimension-less time (t_D) for the above re_D range.

Multiple linear regression analysis is applied using the above data and the following expression is developed.

$$Qt_D = a_0 + a_1 t_D + a_2 \ln(t_D) + q_3 t_D^{1.2} + a_4 \left[\ln(t_D)\right]^{1.2} + a_5 \left[t_D \ln(t_D)\right]^{1.2}$$

Many trials are made to generate such equation, for each trial an equation is proposed in the main program.

Multiple correlation coefficient and objective were used to choose the preferable equation. In the above equation we get the highest for the former and the lowest for the later for all of the data involved in the regression, and these lead to high accurate results of Qt_D.

The regression coefficient are presented for each reservoir size in table (1).

The objective functions and multiple

correlation coefficients are listed in table (2) together with the range of dimensionless time (t_D).

CONCLUSIONS

An analyzed expression is developed for the constant terminal pressure solution of the diffusivity equation. This expression gives high accurate values of Qt_D for various values of re_D and t_D and could be utilized with confidence for petroleum reservoir simulations.

This expression is suitable for the realistic range of reservoir-well system.

REFERENCES

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Table (1), Regression coefficients

re_D	a_0	a_1	a_2	a_3	a_4	a_5
50	0.1436E03	-0.33037E00	-0.1417E05	0.376E-01	0.82628E04	-0.46883E-03
100	0.1877E05	0.17124E01	-0.13285E05	-0.43668	0.71761E06	0.14381E-01
200	0.33451E06	0.55656E00	-0.21674E06	-0.13238	0.11583E06	0.40987E-02
500	0.45251E07	-0.30916E00	-0.24545E00	0.27382E-01	0.12663E07	0.60037E-03
1000	0.22E08	0.68343E00	-0.14192E08	-0.6430E-01	0.69456E07	0.14323E-03
2000	0.33802E08	0.2991E00	-0.57225E09	-0.1666E-01	0.26976E09	0.31649E-03
10000	0.16478E10	0.2991E00	-0.57225E09	-0.1666E-01	0.26976E09	0.31649E-03
25000	0.23442E11	0.25768E000	-0.72012E12	-0.1231E-01	0.33128E10	0.2228E-03
100000	-0.1073E12	0.11239E01	0.32755E11	-0.2599E-01	-0.1504E11	0.4031E-03
250000	-0.3904E13	0.16914E01	0.1007E13	0.27843E01	-0.4474E12	0.40226E-03
1000000	0.26494E13	0.25686E00	-0.5124E12	-0.492E-03	0.21357E12	-0.2879E-05

Table 2 Statistical parameters

Re_D	Multiple Correlation. Coefficient	Objective Function
50	.9998	7.0E-07
100	.9999	7.3E-07
200	.9992	2.2E-07
500	.9997	3.1E-08
1000	.9999	2.9E-07
2000	.9990	3.7E-08
10000	.9993	1.4E-08
25000	.9992	1.1E-08
100000	.9992	2.2E-08
250000	.9991	9.1E-08
1000000	.9990	9.1E-08