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Hydrodynamic studies correctness of a well equipped with a single-packer single-pump design for Multizone selective completion

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Abstract

The advance of systems of Multizone selective completion is an effective solution in the development of multilayer fields, however, there are problems with determining the correct parameters of a multilayer object.
To assess the correctness of the hydrodynamic studies results of wells revealing multilayer objects, a single-pack single-pump system of Multizone selective completion is selected, which provides direct estimates of individual parameters of jointly enter formation according to well testing results.
It was revealed that for multilayer objects, the most informative are hydrodynamic studies in wells using a packer. The conclusion is made about the correctness of the parameters obtained during the well testing (according to the interpretation of the Pressure Transient Analysis (PTA) and Production Analysis (PA)). According to the results of the well-test interpretation (WTI), it was confirmed that this arrangement provides informative hydrodynamic studies.

Keywords: Multizone selective completion, Well test, Pressure Transient Analysis (PTA), Production Analysis (PA);

1. Introduction

Hard to recover reserves, according to experts, include more than 70% of oil reserves in Russia. However, the task of increasing the rate of oil production at the fields remains relevant. In this situation, involvement in the development of multilayer fields may be one of the ways to solve this problem. In this situation, the development and implementation of Multizone selective completion is an effective solution [2].

It is important to take into account that when developing oil fields using the Multizone selective completion technologies, to ensure their effective operation, it is necessary to regularly monitor changes in the filtration parameters of the formation, to monitor the dynamics of the reservoir pressure, which provides control of the joint development of the reservoirs.

The basis of such control is well testing. The main objective of well testing is a separate assessment of the energy and filtration parameters, the characteristics of the drilling-in perfection of the jointly exploited layers opening. In this case, standard well tests determine only the integrated parameters of a multilayer system, without separation of filtration and energy properties, the characteristics of opening quality for individual layers, therefore, it is relevant to choose the optimal design of Multizone selective completion system that provides correct well-test results.

2. Methods

The study analyzed the most common layouts of dual injection and dual production in Russian oil companies, depending on the availability and informative content of these technologies when organizing the monitoring of individual parameters of reservoirs. Based on the analysis, classification of systems for simultaneous and separate operation (Table 1) is proposed based on the information content of well testing.

Table 1. Classification of Multizone selective completion based on the information content of well testing

Dual production				**Dual injection**		
Single-tube			**Double-tube**	**Single-tube**		**Double-tube**
Without formation isolation	With formation isolation	2 methods of artificial lift	Parallel / Concentric	Without formation isolation	With formation isolation	Parallel / Concentric
Information content of well testing						
low	average	average	high	low	average	high

Multizone selective completion systems with the high information content of well testing, namely, double-tube systems, presented in the table, have insufficient reliability of layout designs and are difficult to carry out repair work, therefore, this type of dual completion technology is not common in Western Siberia and has a point-to-point nature of implementation. Therefore, further, for conducting hydrodynamic studies, wells with these configurations are not considered.

Based on the results of the generalization and analysis of domestic and foreign studies and literature, it was determined that single-pump designs of the Multizone selective completion systems with packers and various formation isolation are in most cases the most preferable for conditions in Western Siberia.

When conducting well testing in wells with this layout, the packer sequentially cuts off each reservoir or interlayers, measures pressure and temperature for each of the reservoirs.

To assess the correctness of the well test, an interpretation of the Pressure Transient Analysis (PTA) and Production Analysis (PA) of well № 3026 XXX of an oil field were carried out.

PA and PTA methods share the same assumptions in terms of the use of the diffusion equation and limiting conditions. Most of the analytical and numerical models developed in PTA may be used in PA with minor adjustments, such as the ability to use the pressures as the input to simulate the rates with superposition [3].

Table 2. Comparison of methodologies PTA and PA

	Pressure Transient Analysis	**Production Analysis**
Theoretical basis	Similar equations, the superposition principle, analytical and numerical models	
Time range	Hours, days, weeks	Weeks, months, years
Data sources	Well tests data Plastist Stationary boreholes sensors	Measured production Measuring the pressure on the surface Stationary boreholes sensors
The investigated area of the formation	The volume of research achieved during the shutdown of the well	Area of drainage of a well or group of wells

Modern diagnostic graphics	Bourdet derivative, semilog plot	Semilog plot, Blasingame plot, loglog plot
Basic flow for analysis **Main results**	Infinite Acting Radial Flow kh and skin-factor	Pseudo-steady state Drainage area
Diagnostic capabilities	From high to very high	Medium to low
Long-term forecasting capabilities	Medium to low	From high to very high
Main advantages	High informative results	No need to stop the work of the well for the study - there is no loss in production
Main disadvantages	Losses in production Measuring costs Long duration of research in low-permeability reservoirs	Less accurate results The need to equip wells with stationary depth gauges or TMS

Well testing and Production Analyzes were processed using the Saphir NL software package from KAPPA Engineering based on the KAPPA-Workstation platform.

3. Comparison of the results of the PTA and PA interpretation, correctness assessment of the results.

An unsteady flow regime study can give a clear picture of what a well-formation system is at a given time. The Production Analysis covers a much wider time frame, and some initial assumptions that are true in a single study of a single well do not apply throughout the entire history of the well's operation [1].

The values of kh and skin factor obtained as a result of the analysis of production, as a rule, are somewhat inferior in accuracy to the results of classical well tests (PTA). The main reason is the low quality of the input information (low-resolution TMS, rare measurements of the flow rate, etc.).

PTA interpretation and Production Analysis was carried out for each of the productive layers of a multilayer object to evaluate the obtained parameters of a multilayer object.

The following is a comparison of the results of well test interpretation in unsteady flow regime - PTA and PA for each of the productive strata of well № 3026 by reservoir pressure (Pr) on the water surface, permeability and full skin factor obtained during the study (table 3).

Table 3. Comparison of the results of the PTA and PA interpretation.

Well №3026	**Layer JU1**			**Layer JU10**		
	Pr, atm	k, mD	full skin	Pr, atm	k, mD	full skin
PTA	127,6	0,16	-3,78	162,3	0,88	-5,39
PA	129,18	0,96	-3,01	163,35	0,75	-4,82

A comparison of PTA and PA interpretation results indicates that the use of Production Analysis is also quite reliable for determining the parameters of a well-reservoir system. In this regard, it is advisable to recommend Production Analysis as an addition to standard well testing in an unsteady flow regime.

PA has its advantages over standard well testing. The advantages of the PA are that the most informative well testing with the registration of the PTA, as a rule, are accompanied by significant financial losses due to the forced decrease in oil production caused by shutdowns of wells, and the cost of instrumental measurements.

To assess the correctness of the results obtained with PTA and PA interpretation, a comparison was made of energy parameters, namely, reservoir pressure, neighboring wells №3028,3015, 3016 and well №3026, layers JU1 and JU10.

To compare the reservoir pressure values for neighboring wells №3028,3015, 3016, the results of PTA interpretation the pressure recovery curve with a high degree of reliability were selected, therefore, the results of the comparison will be quite correct for assessing the reliability of the energy parameters obtained during the interpretation of the PTA and PA.

Table 4. Comparison of interpretation results with parameters for neighboring wells

Well №	**Reservoir pressure based on well test interpretation, atm**			
	Layer JU1		**Layer JU10**	
	PTA	**PA**	**PTA**	**PA**
3026	127,6	129,18	162,3	163,35
3028	127,05			
3015			162,89	
3016			163,68	

For layer JU1, the values of reservoir pressure for well №3028 are closest to the results of interpreting the PTA than to reservoir pressure from Production Analysis obtained during the adaptation process.

For layer JU10, the opposite situation is observed, the value of the reservoir pressure obtained during the adaptation in the Production Analysis is closer to the value of the reservoir pressure in the neighboring well.

However, the error is less than 20%, which is an indicator of the correctness of the obtained reservoir pressure values.

Thus, as a result of comparing the obtained values of the reservoir pressure in the layers JU1 and JU10, we can conclude the correctness of the results obtained as a result of the PTA and PA interpretation.

4. Conclusion

As a result, it was determined that for the conditions of Western Siberia, single-pump designs of the Multizone selective completion with packers and various formation isolation are in most cases the most preferred. Thus, for research, well №3026 with a single-packer single-pump layout for Multizone selective completion was selected for the interpretation of PTA and PA.

The filtration and energy characteristics of the reservoirs, obtained by interpreting the PTA and PA conducted in well №3026, were compared with each other and with the parameters for the wells of the immediate environment.

Based on the comparison results, we can conclude that the obtained parameters are correct, therefore, a single-packer single-pump layout provides good informational content of hydrodynamic studies for each reservoir.

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