the development system to achieve maximum performance for each of the layers. [4]. The project presents an algorithm for optimizing the production of a field, discusses development options, taking into account the limitations imposed by a single collection system.

As a result of the calculations, an optimal variant of joint reservoir development was obtained, which takes into account the characteristics of the production system, collection and preparation of products in justifying production levels.

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THE APPLICABILITY OF ESTABLISHED RULES OF THUMB IN THE MODERN PARADIGM OF INTERPRETATION WELL TESTING

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Rules of thumb evolve in every civilization and culture as humans experience and observe cause and effect relationships. Rules that don't work are discarded; rules that do work become part of the culture, tradition, practice, or science.

The rules can be both general and quite specific. Although these rules can assure us of false security or even make a fatal mistake.

These rules, whether general or more specific, are empirical and can be based simply on common sense, even if the physical, economic, social or other principles underlying them are not well understood. They allow us to reduce the time to make a decision, but at the same time, they can lead us to a costly mistake. As experience increases, we can independently derive and adopt new rules of thumb. It is very important that we periodically, or at least at the beginning, check these rules for compliance in each new situation.

Various rules of thumb apply in well testing. This paper presents some rules of thumb used by practitioners in well testing, examines their validity and limits, and in some cases, develops their theoretical basis.

The rule of the «1½ logarithmic cycles». The rule of 1½ logarithmic cycles was first introduced by Wattenbarger.

It was found, that pressure build up and pressure decline curve form the search straight area in semi-log coordinates of about 1½ logarithmic cycle, after the graph of the dependence ΔP on log Δt deviates from the straight line with a slope of 45˚. However, for wells with low values of the CDe2s parameter characterizing the condition of the bottomhole zone, a straight line in semi-log coordinates could be watched after 1 logarithmic cycle and for wells with a high parameter CDe2s this interval grew to 2 or more logarithmic cycles. We consider a well researched model of the formation with one impenetrable rift as to illustrate this principle. The figure 1 explains how to apply the rule 1½ logarithmic cycles. The impact of the borehole volume ends at $\Delta t = 0.1$, moving along the time line by 1½ logarithmic cycle, we'll have $\Delta t \approx 3$. The result is consistent with the beginning of stabilization of the curve derivative, which defines the radial inflow.

If the bottem-hole/formation system has not yet reached the radial regime of inflow, errors may occur in definition the «straight area» after 1½ logarithmic cycles.

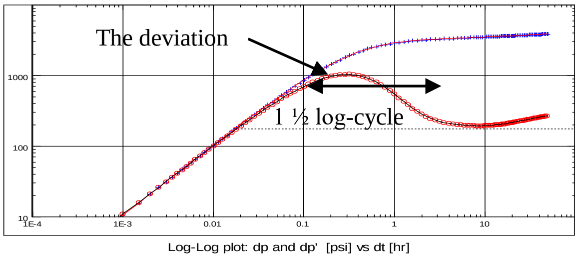

Fig. 1 Pressure build up in well with the skin effect/effect of the wellbore storage with an impermeable boundary

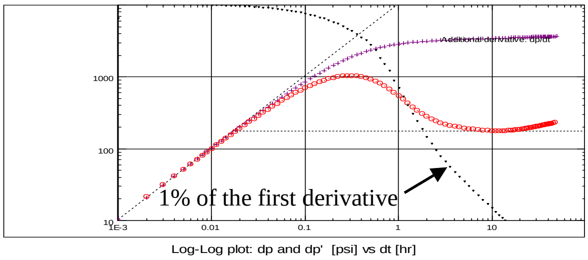

Fig.2 The Rule of 1% of the first derivative

The rule of the «1% first derivative». This is one way of an evaluation the time of finishing of the wellbore storage effect. Matthews and Russell suggested that the after-operation inflow (the wellbore storage effect) be insignificant when the volume of fluid flow to the well decline to 10% of the initial flow.

They proposed to measure the slope of the curve reflecting the dependence of the difference bottom-hole and wellhead pressure on time. When this slope is reduces to 10% of its original value, we can say, that the effect of the wellbore storage has become negligible. Using the speed of change of oil-water interface as a rate of the volume of inflow to the well implies that if the speed of change of oil-water interface in time (by definition Mattar – the first derivative) will decline to 1% of the initial value of the first derivative the effect of the wellbore of the becomes negligible and inconsequential. The application of this principle is illustrated in Figure 2.

The rule of the «less ½ cycle». The principle states: "the Transition period of the derivative limited by the time interval less than ½ of the log cycle is not the result of the influence of the collector". Transition period – a change in one supply mode to another. If the transition period is less than ½ of the logarithmic cycle, this effect can be ignored and the tripling rule can be applied. We cannot offer any formal justification for this rule and are based only on observations and modeling. The limiting limit of ½ logarithmic cycle effectively eliminates various noise effects, although it can be even smaller. It was noticed that the transition from one flow regime to another, caused by the properties of the reservoir, requires about 1 logarithmic cycle time. During modeling of limited formation with an impenetrable fault, the time interval from the beginning of the transition period to the doubling of the slope in the late time interval (LTR) takes about 1 ½ logarithmic cycles. In Figure 1, you cannot see the fully 1 ½ logarithmic transition cycle, because the well was not closed for quite a long time so that the doubling of the slope could be distinguished.

Law of substances. When reviewing the diagnostic graph, the engineers noticed that the typical "bend", which characterizes the skin – volume effect of the well effect, is followed by the stabilization of the derivative, and then there is a straight section of the curve with a slope of ½. the engineers concluded that this should be a well model with an infinite conductivity crack. This decision was not confirmed by real data, and the correct model is the well model with the skin – volume effect of the well effect in the linear reservoir. Geology confirmed the validity of the new model. Figure 3 shows the diagnostic graph corresponding to the case described. Figure 4 shows a similar derivative, but a characteristic section of a straight line with a slope of ½ meets until the derivative stabilizes. The effect of "½ tilt" is tied to the well. This is a model of a well with hydraulic fracturing with a skin effect on the fracture surface. Note that the 1½ Δt rule of logarithmic cycles is applied in Figure 3 and was not used in Figure 4. If you carefully watch Figure 4, you can determine that the end of a straight line segment with a single slope is $\Delta t = 0.001$. Adding 1 ½ logarithmic cycles, we get $\Delta t \approx 0.03$ h, or 1.8 minutes. However, reaching the boundary of the reservoir in 1.8 minutes is unrealistic for studies at a late time interval.

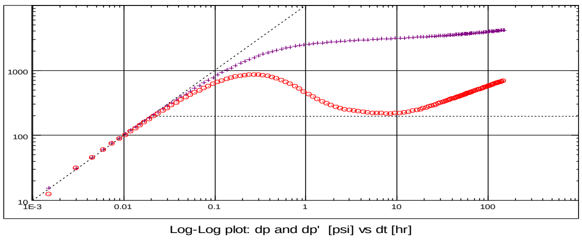

Fig.3 Well with skin effect / borehole effect in a linear formation

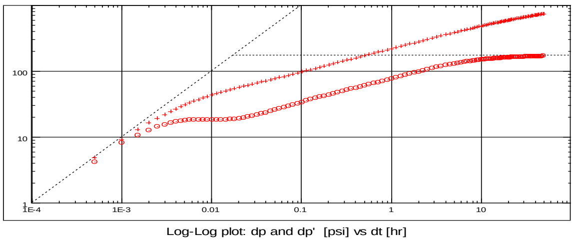

Fig.4 Well with fracturing and skin on the surface of the crack

Emission of derivatives. Interpretation of hydrodynamic studies has such phenomenon as the emission of a derivative. It can be seen on the diagnostic graph, when during the action of the volume effect of the influence of the borehole, the derivative curve passes above the curve. This phenomenon is most often encountered when conducting a formation test or other tests with short inflow periods, such as studies with instant depression or a pulse test.

Universal value r_w^2. Sometimes it is necessary to have at hand the value of r_w, when performing interpretation of well testing. If you delve into the search for the desired value, you can see that there are many choices.

This method unifies this value. The value r_w always appears in the form r_w^2. And it is found in the equation for determining the skin and when calculating dimensionless time. For a wide range of drill bit sizes and casing strings, which are commonly used in production zones $r_w^2 \approx 0.1$ ft^2 ($r_w \approx 0.3$ ft When converted to SI units, after rounding, we get 0.01 m^2 ($r_w \approx 0.1$m).

As for the error: if the approximation error is 25%, then the error in calculating the skin will be approximately 0.15. Such error will change the skin from 3.0 to 3.15, which is not essential for future geological and technical measures. More important is the error in calculating the dimensionless time.

For the analysis of well testing, the principle «the simplest solution is most often the best» applies. In accordance with this principle, it is possible to define the procedure for carrying out the interpretation of well testing - one should start with a simple model and complicate the model only as needed. A complex model contains a lot of parameters, so it is always very easy to fit to real data and often looks quite attractive, although in fact the model may be completely inappropriate. Good compliance of the model with real data does not necessarily mean that you can perform a good interpretation of well testing.

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STUDING THE PRESSURE INFLUENCE ON THE PROCESS OF DIESEL FUEL CATALYTIC DEWAXING

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For Russia, due to the peculiarities of climatic conditions and geographical location, the production of winter and Arctic grades of diesel fuel with appropriate low-temperature and environmental characteristics is of particular importance [2]. In addition, the share of processing of heavy and high-sulfur oils is increasing annually.

One of the processes of winter and Arctic diesel fuels production is catalytic dewaxing. It is important to improve the process of catalytic dewaxing using the method of mathematical modeling to regulate the technological conditions of the process of dewaxing of diesel fractions, which will ensure the achievement of optimal product yield and compliance with standards for low-temperature characteristics when changing the hydrocarbon composition of raw materials [1].

The aim of this work was to study the influence of pressure on the process of catalytic dewaxing of diesel fuel.

For calculations the computer modeling system of catalytic dewaxing process [3], created on the basis of mathematical model of this process, was used.

Two types of raw materials with different content of n-paraffins were chosen for the study. Data on the component composition are presented in Table 1.

Table 1

The composition of the raw materials of the catalytic dewaxing process

Component	Raw materials-1	Raw materials-2
N-paraffins C_{10}-C_{27}	15,50	22,50
N-paraffins C_5-C_9	0,60	0,69
Olefins	1,98	1,09
Naphthenes	37,75	31,44
Isoparaffins	24,23	24,23
Monoaromatic hydrocarbons	18,82	18,82
Polyaromatic hydrocarbons	1,12	1,23

For each type of raw material, the influence of temperature on the content of n-paraffins, the output of the diesel fraction and the limit temperature of filterability was studied. The results are presented in the following graphs:

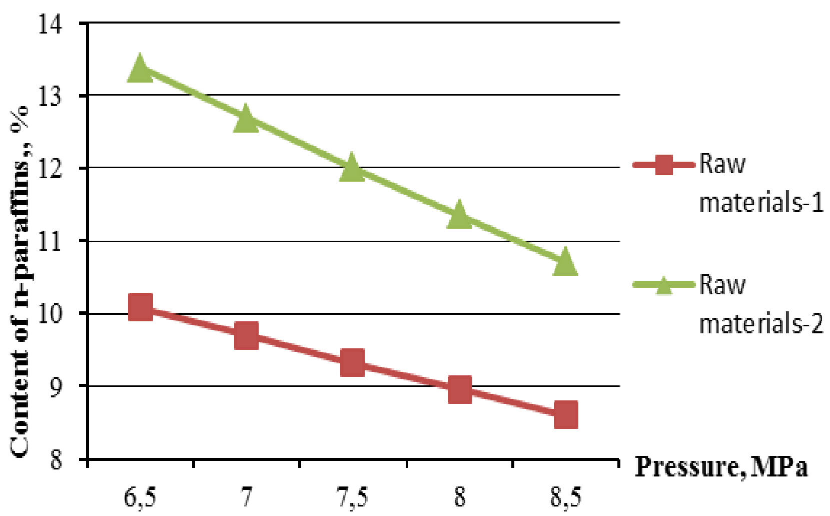

Fig. 1 The dependence of the content of n-paraffins C10–27 on the pressure