Hydrocarbon mixtures (gasoline and kerosene) under normal conditions exist in liquid state, therefore the hydrodynamic laws related to their transfer through pipelines, with polymer additives and without polymer additives, are studied well and they are typical for liquid media. Currently, liquefied natural gas (LNG) technologies are rapidly developing for its transportation in a liquid state through pipelines and in tankers. To reduce the energy costs for LNG transportation and to reduce the downtime of tankers during the loading and unloading of products, we first carried out laboratory studies of the influence of the oil-soluble polymer (polyhexene) on the flow velocity of the liquefied propane-butane mixture and calculated the magnitude of the hydrodynamic resistance reduction effect. Experiments with solutions of LNG containing different amounts of dissolved polyhexene (Fig. 2, curve 1) were carried out in the closed airtight laboratory bench at room temperature and elevated pressure. It was established (Fig. 2) that in order to achieve maximum effect, an even lower polymer concentration is required, i.e. total Copt = 100 g/m3. Thus, to intensify the transfer of liquefied natural gas, it is also possible to use drag-reduction additives based on high molecular weight petroleum-soluble polymers.

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EFFECT OF TEMPERATURE ON THE RESERVOIR PROPERTIES OF THE SHALE ROCKS DURING PYROLYSIS

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Development and application of non-traditional technologies are required to extract hydrocarbons that contain in deposits in Western Siberia of the Bazhenov suite and other geological formations. One of the innovative solution of the aim is the development of a method that based on thermal action. The method suggests an improvement in reservoir properties by increasing the void space and converting kerogen to light oil as a result of initiating the pyrolysis process.

The process conversion of kerogen to synthetic oil can be achieved by thermal dissolution, hydrogenation or pyrolysis [5]. Pyrolysis is most closely related to the natural conversion of kerogen, using the high temperatures to compensate for the geological time frame [2.7]. During pyrolysis the kerogen is heated in the absence of oxygen to produce a substance that decomposes kerogen.

High temperatures provide a fast conversion of kerogen. It has been found that shale treatment increases product quality at lower temperatures for a long time. A high pressure also improves the quality of oil, since evaporation prevents the stimulation of secondary cracking reactions. Nevertheless, a low temperature and a high pressure reduce the overall yield [8].

The aim of this work is to analyze the effect of high temperatures on the reservoir properties of shale rocks.

Laboratory experiments were carried out on crushed samples taken from the core of exploratory wells of the Southern and Southern Kinyaminskoye oil fields (Tyumen region). Experiments determine the open porosity, bulk and mineralogical density, gas permeability.

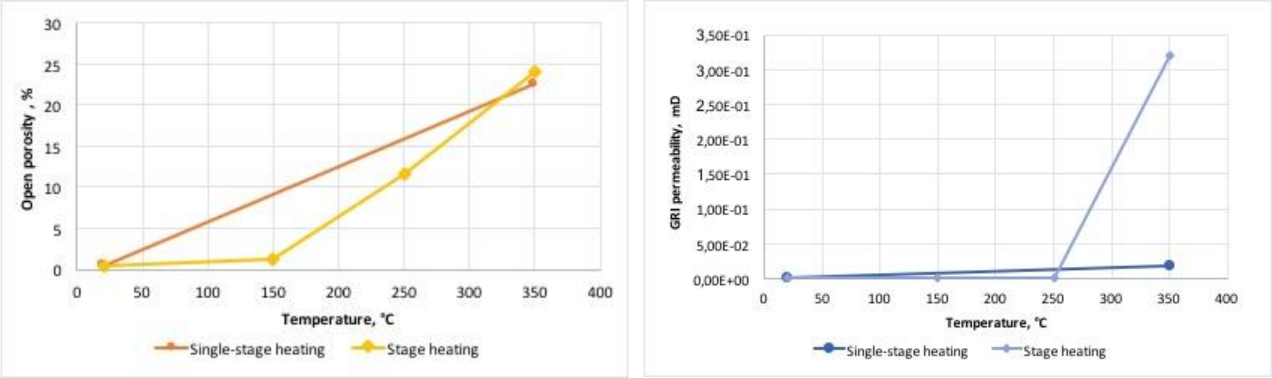
Matrix permeability of the crushed samples was carried out by the method - Gas Research Institute (GRI) in accordance with GRI-95/0496 "Development of Laboratory and Petrophysical Techniques for Evaluating Shale Reservoirs" [3,4]. The samples were heated to a certain temperature in a muffle furnace. The experiments were carried out on a matrix permeate SMP-200 on the determination of gas permeability.

The effect of heat treatment on core samples was investigated. One sample of the Southern deposit was heated to the temperature of 350 °C in one stage, and the other sample was heated to stepwise to the same temperature at an interval of 150 °C. At each stage, the permeability of the sample was measured by the GRI method. Similar processing was carried out for samples of the Southern Kinyamin deposit. As a result of the experimental work, graphs of the pressure changes were obtained with time, from which the permeability coefficient for gas was calculated.

The bulk density of the core samples of the Southern deposit increased by 28.7% to 2.648 g/cm3 when it was heated by 32.7% to 2.729 g/cm3. The values of the mineralogical density and the tendency of their change do not significantly differ from the bulk density. The overall density of the samples of the Yuzhno-Kinyamin deposit increased by 3.6% to 2.302 g/cm3 when it heated in one stage by 9.2% to 2.428 g/cm3. Mineralogical density rose by 5.5% to 2.387 g/cm3, with stepwise heating - by 10.9% to 2.51 g/cm3.

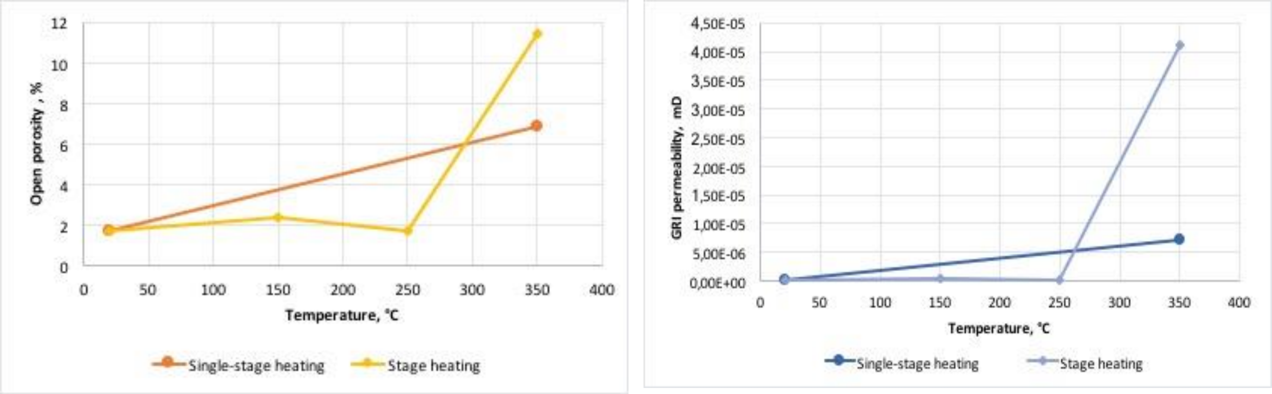
When the core sample of the Southern Deposit was heated (Fig. 1) to 350 °C, the coefficient of open porosity increased from 0.46% to 22.55%, and the gas permeability coefficient, that changed from 2.28·10-9 mD to 1.77·10-2 mD. The coefficient of open porosity and permeability reached of 24.14% and 0.32 mD with stepwise heating, consequently.

When the core sample of the Yuzhno-Kinyaminskoye deposit was stepped (Figure 2), the coefficient of open porosity grew from 1.75% to 11.42%, and the gas permeability coefficient changed from 2.65·10-7 mD to 4.12·10-5 mD. In single-stage heating, the open porosity reached 6.87%, and the permeability coefficient arose to 7.07·10-6 mD.



(a) ***(b)***

Fig. 1 Effect of temperature on the open porosity (a) and permeability (b) of the Southern deposit samples



(a) ***(b)***

Fig. 2 Effect of temperature on the open porosity (a) and permeability coefficients (b) of the Yuzhno-Kinyaminskoye deposit samples

During the core sample pyrolysis of the Southern deposit, the porosity and permeability get up with rising temperature. In the core sample of the Yuzhno-Kinyaminskoye deposit while the temperature increases, the porosity goes up and the permeability decreases. The permeability depends on the shape of the pressure curve, which obtained as a result of the GRI measurement and the porosity. For the sample of the Southern Kinyamin deposit, the shape of the pressure curve corresponds to a sample with a lower permeability, however, since the porosity lift significantly, the permeability also rises.

Comparing the efficiency of step heating and heating in one stage, it can be concluded that the collector properties are obtained higher with stepwise heating than in one stage.

It is known that the results of studying the effect of temperature on permeability behavior are quite contradictory because of the different scientists view [1,6]. Experimental studies show the high temperatures effect model on the reservoir properties of shale rocks. The heating of a low-permeable rock promotes an increase in permeability and porosity at 350 °C.

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PROBLEM OF GAS PRODUCTION IN RELATION TO GAS HYDRATE FORMATION

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The technology of gas production is complicated by the problem of gas hydrates [2]. In general the formation of gas hydrates depends on the presence of a water phase in a gas stream.

Moreover, during certain thermobaric conditions the water phase has an ability to form hard snow-like compounds of cubic structure with gas components mainly withVan der Waals natura of interaction [6].

The process of hydrate formation depends on the physico-chemical characteristics of the gas [2]. The probability of hydrate formation increases with increasing pressure and lowering temperature [6]. The formation of hydrates in the bottomhole zone for the initial temperature below the equilibrium temperature by 2 K leads to drop of the production rate to 18-19% [3].

Figure 1 shows the hydrate curves of some gases as a function of temperature and pressure. The density of hydrates of various gases varies from 0.8 to 1.8 g/cm3. The heat of formation of hydrates at 0 ° C is from 50 to 140 kJ / mol.

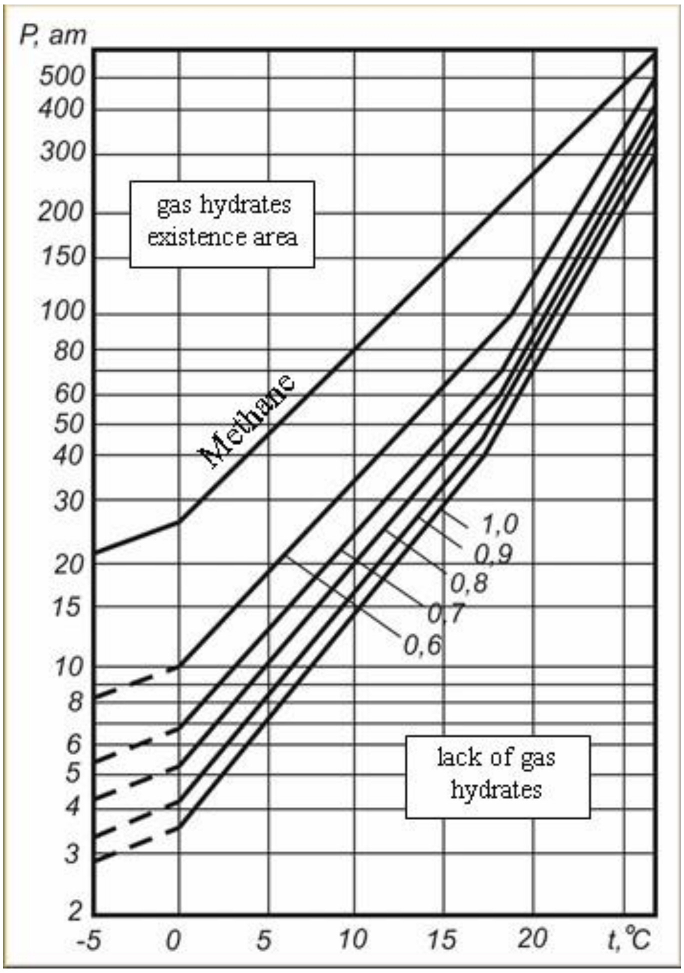

Fig. 1 - Conditions for the formation of hydrates.

There are technogenic and natural gas hydrates. Technogenic gas hydrates can be formed in gas production systems. They are deposited in the wellbore, thereby dramatically reducing its throughput. This leads to a decrease in production of the well and may lead to an emergency stop of its operation. Natural gas hydrates can form accumulations of gas hydrate deposits around production columns. With the rise of warm oil from the underlying horizons, the temperature of the surrounding rocks increases. This circumstance leads to a change in the phase state of water and gas in the hydrate-saturated intervals around the wells. This process is analogous to the process of "thawing" of frozen rocks in the development of hydrocarbon fields in permafrost regions and it leads to severe accidents: collapsing casing strings, gas leakage behind the conductor during gas manifestations, formation of griffins and a hole in the wellhead [4].