# STUDY OF THE IMPACT OF INHIBITOR ON PARAFFIN CRYSTALLIZATION TO RHEOLOGICAL PROPERTIES OF CRUDE OIL

**A.V. Sidorenko, A.A. Kustubaev**
Scientific advisor - assistant professor Chekantseva L.V.
***National Research Tomsk Polytechnic University, Tomsk, Russia***

Paraffin deposition is one of the serious problems in oil industry. It has got a crucial attention to overcome this issue in more hostile environment in new oil fields exploration especially in deep water. Paraffins, that are known as mostly heavy saturated paraffins, tend to precipitate when the temperature and pressure of oil fields drop during the production and transportation.

In order to overcome paraffin deposition problem, the better understanding of the physical characterization of crude oil is necessary. Viscosity, density and pour point are properties that ascertain handling characteristics of crude oils.

Paraffin related problem appears through out the production process of nearly all kinds of crude oils all over the world. It also appears in the dewatering process and the long distance crude oil transportation. Operators spend millions of dollars each year to control the deposition of paraffin and to deal with other sand related problems. Expenditures of this magnitude obviously have a significant impact on profits. [2]

At low temperatures, crude oil containing high amounts of paraffin shows high pour points due to paraffin deposition; that is, paraffins tend to crystallize forming paraffin crystals. The paraffin deposition is a result of cooling down the crude oil below certain temperatures during transportation or storage. This temperature depends upon the constituents of crude oil and is called pour point temperature (PPT).

Oil production with the presence of paraffin in it is complicated by the sedimentation of paraffin deposits in pipes, in the annular space, in the oil flowline. [1] With the right choice of techniques and technology to prevent paraffin sediments, it is possible to avoid a decrease in the reservoir, productivity factor, maintain constant well flowrate, reduce well servicing time, lower the cost of extracting the oil.

Currently, chemicals and their mixtures are widely applied, which, when added to oil in an appropriate concentration, affect the crystallization process of paraffins, the so-called inhibitor on paraffin crystallization (IPCs). One of the results of their influence is the reduction of low-temperature viscosity of oil associated with the structuring of paraffins. The main feature of an IPC is the high selectivity of their effect on oil [7]: An IPC that reduces viscosity in one oil may not change, or even increase it, in another.

In this research presents the definition of the most appropriate paraffin deposition inhibitors and the selection of concentrations for reducing the low-temperature viscosity of oil. Evaluation of the effectiveness of IPC are the results of laboratory tests: how much IPC lowers the viscosity of oil at a certain temperature. [3]

Studies were conducted with samples of oil from the Archinsckoe and Yuzhno-majskoe oil fields, the physicochemical properties of which are presented in the table (Table 1).

***Table 1***

***Physico-chemical property and petroleum composition***

| Sample | ρ, kg by 20 ºC | Content in the crude oil, % by weight | | |
|---|---|---|---|---|
| | | paraffins | tar | asphaltene |
| Oil of Archinsckoe field | 867,3 | 6,3 | 17,3 | 2,9 |
| Oil of Yuzhno-majskoe | 832,5 | 10,14 | 6,93 | 0,64 |

As the IPC, two reagents with different concentrations were analyzed, presented in Table 2. They are designed to prevent paraffin deposits in oil-field equipment in the process of oil production and during its transportation. Used as an IPC for oils with a high content of paraffins and resinous substances. Inhibitors of these grades protect oilfield equipment and oil pipelines from asphalt-resin-paraffin sediments (ARPS), reduce viscosity, and the pour point of oil. Concentrations were adjusted according to manufacturers recommendations. [6]

***Table 1***

***Inhibitors on paraffin crystallization***

| | SNPCH-IPG 11A | HPP-007 |
|---|---|---|
| Concentration, g/t | 100 | 150 |
| | 150 | 200 |
| | 200 | 250 |

Viscosity measurements were carried out on a Brookfield DV-II + PRO programmable viscometer. Brookfield rotary viscometers are designed to measure low dynamic viscosity according to GOST 1929-87. Viscosity measurement is carried out by recalculating the torque required to rotate the spindle of the device at a constant speed when immersed in the test medium. The temperature range ranged from 20 ° C to 50 ° C in 5-degree increments in direct and reverse motion. Measurement processing was performed using the Rheocalc software. [5]

Initially, the viscosities of the studied samples were measured without the addition of reagents over the entire temperature range. The results are presented in Fig.1, 2.

Then, IPC with specified concentrations were added to the oil samples. The mixture of each oil sample with the reagent was aged for 24 hours for better mixing. [8]

The results of measurement of viscosity with the addition of reagents for the samples under study for a temperature of 20 ° C are presented in Fig.3,4,5,6.

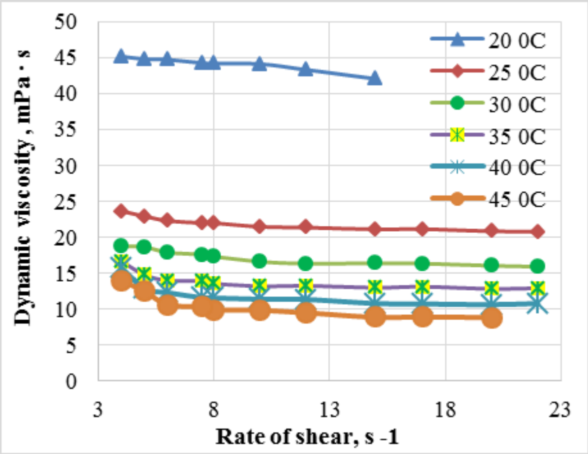


***Fig.1 Oil rheological curve of Archinsckoe fields without additional agent***

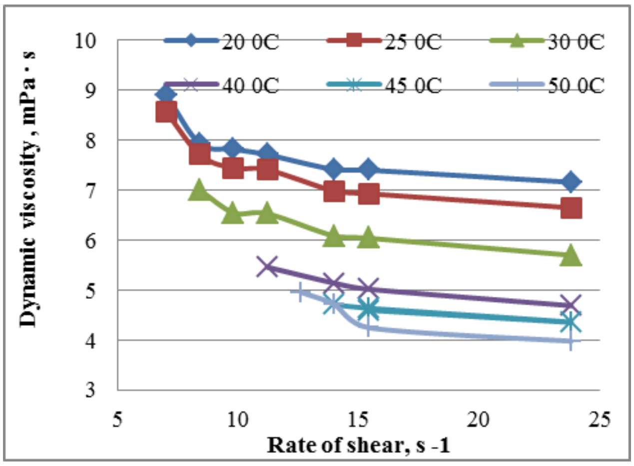


***Fig.2 Oil rheological curve of Yuzhno-majskoe without additional agent***

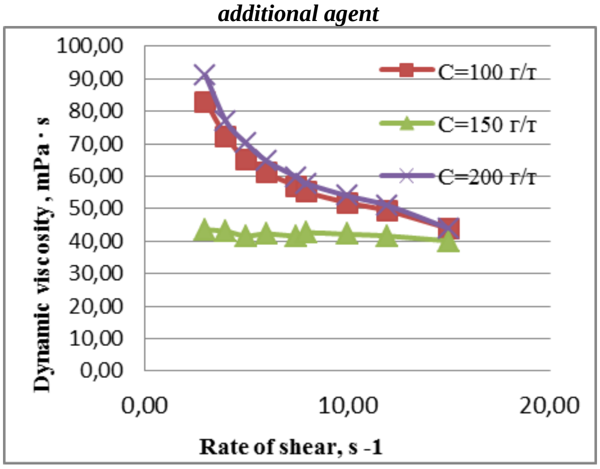


***Fig.3 Oil rheological curve of Archinsckoe fields with additional agent SNPCH-IPG 11A at t=20 °C***

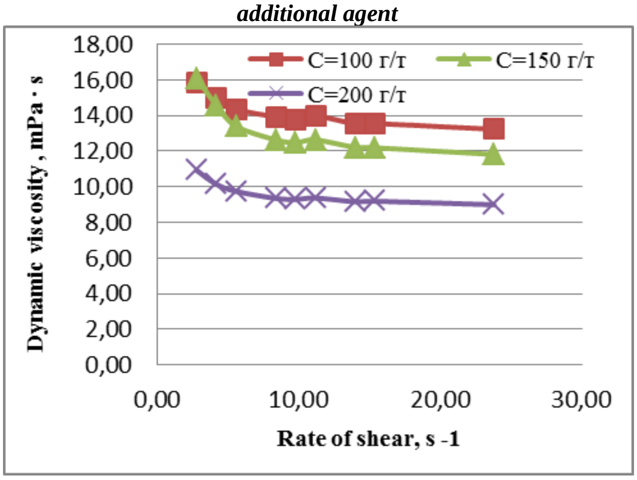


***Fig.4 Oil rheological curve of Yuzhno-majskoe fields with additional agent SNPCH-IPG 11A at t=20 °C***

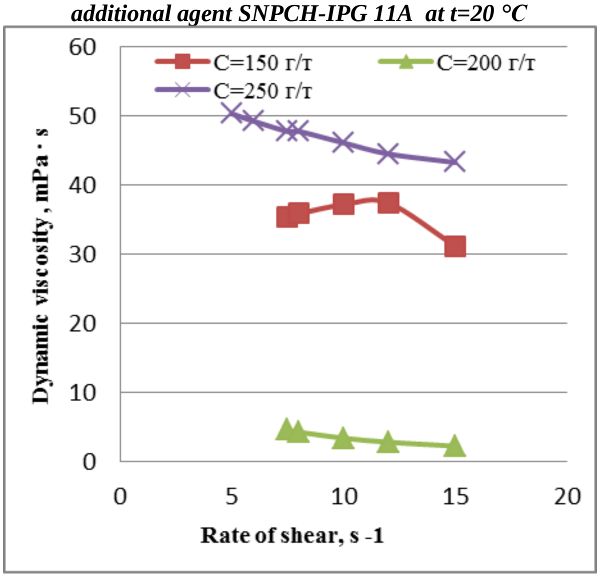


***Fig.5 Oil rheological curve of Archinsckoe fields with additional agent HPP-007 at t=20 °C***

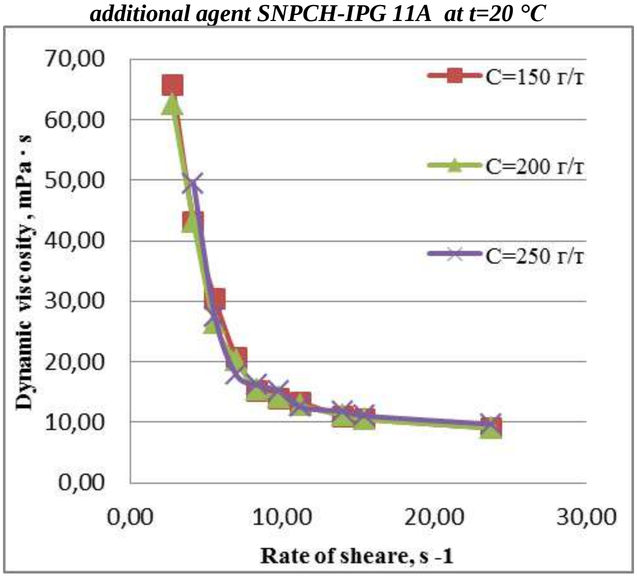


***Fig.6 Oil rheological curve of Yuzhno-majskoe fields with additional agent HPP-007 at t=20 °C***

Conclusions: A study was conducted of the impact of inhibitor on paraffin crystallization on the crude oil of the Archinsckoe and Yuzhno-majskoe fields. According to the results of these studies, it was found that for oil of the

Archinsckoe field for inhibiting on paraffin crystallization the best additive was HPP-007 with a concentration of 200 g / t, this inhibitor significantly reduces the viscosity of this oil. These inhibitors are not suitable for the oil of the Yuzhno-majskoe field, since none of them reduces viscosity compared to the breakdown of oil without additives. Least of all, the viscosity of this oil increases the inhibitor on paraffin crystallization SNPCH-IPG 11A with a concentration of 200 g / t.

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# HYDRAULIC FRACTURE CRACK REDESTRIBUTION BY OPTIMIZATION OF THE RESERVOIR PRESSURE MAINTENANCE SYSTEM

**K.V. Sinebryukhov, V.P. Solomatin**
Scientific advisor - associate professor Bolsunovskaya L.M
***National Research Tomsk Polytechnic University, Tomsk, Russia***

The purpose of the article is to highlight the importance of the development a technology to control the direction of hydraulic fracturing cracks. Article includes an analysis of existing technologies and offers new possible solutions.

The great part of oil and gas fields in Russia is being developed in final stages. These stages are characterized by a strong decline in oil production, a reduction in the well stock and an intensive increase of water cut. The most effective geological and engineering operations are now beginning to be used to fully develop oil and gas reserves [7].

Hydraulic fracture is one of the commonly used ways to intensify an oil production. According to statistics for 2018, only 66% of hydraulic fracture operations in OAO "Tomskneft" were successful. The reported statistics are also influenced by the following factors: [7]:

1. Non-compliance with the technology of hydraulic fracture operation
2. Low knowledge of the developing object
3. Man-made reasons that are not amenable to outside control
4. Wrong choice of hydraulic fracture parameters

A crack is one of the key parameters that defines hydraulic fracture success. The result mainly depends on the crack propagation in the reservoir. In most cases a crack direction is not controlled in any way. Failure of fracture direction control also leads to an error in the design of hydraulic fracture. As a result, we can get an incorrect calculation of additional oil production and economic evaluation [2].

For the direction of hydraulic fracture group of authors from the China University of Petroleum offer to install the ABAQUS extended final element [8]. This end element helps to redirect the crack through radial holes. However, this technology does not work at great depths.

In our researches, we exploited the laws of solid mechanics, then a hydraulic fracture crack should go along the maximum line of tension. The smaller the horizontal stress difference is, the easier the hydraulic fracture tends to be perpendicular to the natural fracture, and the direction of propagation of hydraulic fractures is easier parallel to the natural fracture in the natural [5] For the most cases this line coincides with the line of regional tension of the rock. Using the system of maintenance formation pressure it is possible to locally and temporarily redistribute pressure in the reservoir. It will help change the azimuth of the tension line and therefore the direction of the crack [3]. Azimuth of the regional tension line of a rock was taken as a 120°.

To test this theory we created a sector deposit model with a row development system using "tNavigator" software [4]. The average parameters of reservoir properties and physicochemical properties of a fluid were taken as a basic. The amount of water injection into the reservoir was chosen as a variable parameter. The pressure isoline map changes when the injection wells change [6]. The result of injection change is the redistribution of tension lines. Picture 1 shows the change in crack propagation depending on different levels of fluid injection into the reservoir.