The energy of interaction "n-paraffin - additive" is the highest (56.72 kJ/mol). It can be assumed that for high n-paraffin fuel (sample No.3 content 44.92 % %wt of n-paraffins) the smallest concentration of the CIA will significantly increase the CN, ensuring its good pick-up to the additive.

In samples 6, 7 (Tab. 3), the content of n-paraffins is less than in sample №2, however, the increase in the CN is greater. This is due to the fact that the total content of paraffins is greater than the sum of aromatic and naphthenic HC. The interaction energies of aromatic and naphthenic HC are negative, which confirms their poor response to a CIA. For samples 1, 3, 5, the increase in CN with the addition of the CIA is minimal, despite the high content of paraffins (>55 %). It is associated with a high content of aromatic HC (>20 %), which have a low interaction energy (–0.43 kJ/mol).Thus, the group composition of DF will have a different effect on CN when adding CIA to the DF. This fact is associated with the different influence of HC groups and reflect the injectivity of the DF additive and the increase in the CN with a change in the concentration of the CIA.

This work was supported by the Russian Science Foundation (Project №18-79-00095) at the National Research Tomsk Polytechnic University as part of the Competitiveness Program of the National Research Tomsk Polytechnic University.

References

1. *Maylin M.V., Frantsina E.V., Grinko A.A. Development of a mathematical model for calculating the cetane number of diesel fractions based on their hydrocarbon composition and intermolecular interactions of mixture components // Combustion Science and Technology, 2019 (DOI: 10.1080/00102202.2019.1684909).*
2. *Frantsina E.V., Grinko A.A., Krivtsova N.I., Maylin M.V., Sycheva A.A. Identification of hydrocarbon compositions of diesel fractions and assessment of their effect on fuel operational characteristics // Petroleum Science and Technology, 2019. (DOI:10.1080/10916466.2019.1705856).*

THE STUDY OF INHIBITORY AND DISSOLVING ABILITY OF HUMIC ACIDS

A.A. Berdnikova, E.V. Beshagina, E.V. Frantsina

Scientific supervisors – Candidate of Engineering Sciences, researcher E.V. Frantsina;
Candidate of Engineering Sciences, assistant professor E.V. Beshagina
Linguistic advisor – Candidate of Engineering Sciences, researcher E.V. Frantsina

National Research Tomsk Polytechnic University
634050, Russia, Tomsk, 30 Lenin Avenue, tpu@tpu.ru

During high-paraffin oil refining, asphaltene-resin-paraffin deposits (ARPD) are formed on the surface of oilfield equipment, reduce the efficiency of the plants and decrease the distillate yields [1]. Applying chemical methods in the fight against paraffin is limited, due to their high cost and metal consumption. A new solution is bioadditives – high molecular weight (HMW) humic acids (HA), which have depressive and surface – active properties. In this work, the ability of HA to inhibit and dissolve paraffin deposits was investigated.

As the objects of study, we selected high-paraffin oil (10.5 %) from the Verkhnesalatskoye field with a density of 0.78 g/sm^3, kinematic viscosity of 1.8 mm^3/s, pour point – plus 12 °C , residue of this oil and humic acids.

Evaluation of the inhibitory ability of HA was carried out on the installation to assess the effectiveness of paraffin inhibitors according to the method of "cold rod", which includes 2 blocks. The first block is a “cold rod” immersed in a water bath, which includes 4 metal cups, U-shaped hollow tubes which are mounted into lids and connected to the refrigerant supply and exhaust system. The temperature in the cells, connected with the cold rod, are maintained by a cryostat and thermostat.

The weight of the sample was 60 g. HA were diluted in solution (0.1 N. NaOH), ratios: 1 : 10, 1 : 15, 1 : 20. Samples were added to oil in concentrations: 0.2 % (vol), 0.4 % (vol), 0.6 % (vol), 0.8 % (vol). The temperature of the oil in the cell was 30 °C, the temperature of the “cold" rod – mi-

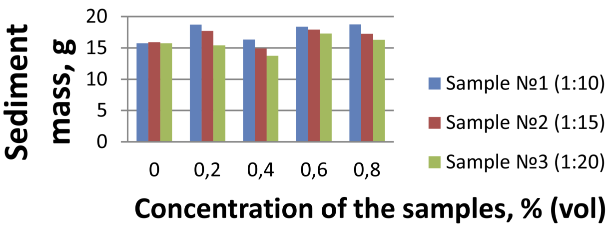

Fig. 1. *The amount of oil residue depending on the concentration*

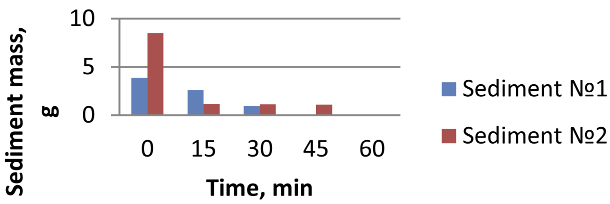

Fig. 2. *The amount of oil residue depending on the exposure time*

nus 10 °C. The experiment time is 40 minutes, the rods were removed from the metal cups and allowed to drain the residual oil for 10 minutes. Next, set the temperature of the "cold" rod plus 50 °C, collecting paraffins. The amount of sediment was determined by the gravimetric method. The inhibitory ability of HA was calculated by the formula:

$$I=(W_0-W_1)\cdot 100/W_0,$$

where I – is the inhibitory ability, %; W_0 – sediment yield for the original oil, g; W_1 – sediment yield for oil with an additive, g.

Figure 1 shows, that the greatest decrease in the amount of sediment caused by addition of sample №2 (0.4 % (vol.)). The inhibitory ability was 13 %. Evaluation of the dissolving ability was carried out according to a technique that allows to determine the ability of HA to keep in suspension the HMW compounds that are part of the ARPD. Oil residues of similar mass were collected in sieves and were lowered into a glass of HA with a volume of 50 ml for 15 minutes. Next, we established destruction, swelling and volume reduction in percent of samples. Then we repeated procedure for 15 minutes until the deposits were completely dissolved (figure 2).

The saturation of the solvent with HMW compounds was determined by the formula:

$$C_n=m/V\cdot 1000,$$

where m – is the mass of the sample, g; V – is the volume of solvent (V1 + V2 + ... + Vn), sm^3.

According to the results of the experiment, it is also seen that the saturation of HA increased from 26, 34 to 148.60 g/sm^3, in proportion to the increase in the initial sediment volume. The dissolution time of the precipitate increased by 2 times. It was found that HA have an inhibitory effect. The most effective way is to add them in the ratio with NaOH (1 : 20), in an amount of 0.4 % (vol.). A further increase in concentration is impractical. Established humic acids dissolving ability, the time of which increases in proportion to the increase in the initial amount of sediment.

References

1. *Alimohammadi S., Zendehboudi S., James L. A comprehensive review of asphaltene deposition in petroleum reservoirs: Theory, challenges, and tips // Fuel, 2019.– V.2.– P.753–791.*

INVESTIGATION OF THE TEMPERATURE EFFECT ON CHARACTERISTICS OF THE PRODUCTS, OBTAINED BY UPGRADING STRAIGHT-RUN DIESEL FUEL ON ZEOLITE

I.A. Bogdanov, A.A. Altynov
Scientific supervisor – PhD, associate professor M.V. Kirgina
Linguistic advisor – PhD-student I.A. Bogdanov

National Research Tomsk Polytechnic University
634050, Russia, Tomsk, 30 Lenin Avenue, bogdanov_ilya@mail.ru

Providing remote regions with high-quality diesel fuel is very important task for the domestic oil industry, since at the moment, the cost of its transportation is a significant part of the cost of fuel sold in such areas.

The solution to this problem is also complicated by the need to supply low cold-test fuels, since