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CHANGING OF PHYSICO-CHEMICAL PROPERTIES OF PETROLEUM FOR THE PURPOSE OF PRIMARY PROCESSING INTENSIFICATION

O. Y. Mishina, post-graduate student, A. I. Vasilkevich, PhD in Chemistry, E. V. Kofanova, PhD in Chemistry, O. A. Beskletna, associate professor (National Technical University of Ukraine "KPI")

Методом віскозиметрії досліджено вплив домішки аніонної поверхнево-активної речовини на збільшення виходу світлих фракцій у ході первинної переробки нафти.

Ключові слова: нафта, нафтопродукти, первинна переробка нафти, невідновлювальні ресурси, віскозиметрія.

Методом вискозиметрии исследовано влияние добавок анионного поверхностно-активного вещества на увеличение выхода светлых фракций в ходе первичной переработки нефти.

Ключевые слова: нефть, нефтепродукты, первичная переработка нефти, невозобновляемые ресурсы, вискозиметрия.

The influence of anionic surfactant additive on the increasing of light petroleum output during the primary oil refining was investigated. The method of viscosimetry was chosen as the investigation tool.

Key words: crude oil, oil processing, oil refining, unrenewable resources, viscosimetry.

Introduction. Oil is one of the main sources of energy that belongs to the group of the unrenewable resources. Nowadays the problem of efficient use of oil is one of the most urgent problems of human society. In many cases it is possible to decrease the petroleum production bulk by means of its refining processes intensification. The oil refining is subdivided into two stages such as primary and secondary processing. The primary one includes the processes of oil dividing into some fractions without any chemical conversion. The processes of secondary refining include the chemical structure changes while petroleum products receiving. They are thermal, thermo-catalytic, hydrogenization processes, etc [1].

Today the problem of oil refining intensification mainly has been solved by means of secondary processing. However, it is also possible to increase the light-oil products output at the stage of oil primary refining. Thus, while preparing crude oil its physico-chemical properties can be changed for light-oil fractions output increase. Such methods include superposition of cavitational, sonic, ultrasonic [2], and electromagnetic oscillations [3].

The main aspects of the problem. There are many different methods of crude oil physico-chemical properties changes; one of them is the influence of special additives on the primary processes of oil refining. That effect consists in changing of such physico-chemical properties of crude oil as viscosity, fluidity temperature [4], surface tension, sedimentation characteristics, etc.

Urgency of the issue is based upon the search of the optimal investigation methods for changing the physico-chemical characteristics of petroleum products. These changes directly affect to the primary oil refining processes. So it is possible to determine the optimal concentrations of additives while carrying out the atmospheric distillation without considerable time expenditures.

Analysis of literature. Viscosity determination is one of the common analysis methods of crude oil and petroleum products. Thus, there are several kinds of viscosity determination in petroleum processing industry [5]. In particular dynamic viscosity is usually determined by automatic capillary viscosimeter AKV-4 [6]; kinematical viscosity is estimated with the time of flowing out of certain volume of investigated liquid under the influence of gravitation force [7]. Relative viscosity is measured with the help of VU-type viscosimeters [8] and effective viscosity of petroleum lubricants is determined by plasticoviscosimeter PVR-1 type.

The ways of boiling processes of oil systems intensification were suggested by O. F. Glagoleva [9]. The influence on petroleum products properties of some organic compounds and of residual oil fractions separated at different stages of refining has been investigated. Among such substances are polyethylsiloxane, ionol, oxyethylized alkylphenols, fatty alcohols, heavy catalytic gasoil, stripping of bitumen production and others. It was discovered that in order to achieve the same effect, it is necessary to have a bit smaller concentrations of organic compounds than of residual fractions additives.

Positive influence of nickel containing surfactant $Ni(RCOO)_2$ (where R = C9 - C15) on the crude oil processing is also represented in patent [10].

The research aim is the usage of viscosimetry method using for the purpose of expressing estimation of changing of physico-chemical parameters of crude oil and of it's disperse structure after putting the additives.

Statement of basic material. Oil is a multicomponent system consisting of a mixture of different molecular weight and structure hydrocarbons and of non-hydrocarbon impurities. The main part of it consists of alicyclic and naphthenic saturated hydrocarbons. Paraffin hydrocarbons up to C4 are the gases that are presented in crude oil in the dissolved form in miserable quantities. Paraffin hydrocarbons C5 - C16 are liquids presented in all fractions of oil; they can have both linear and branching structure (isoparaffin hydrocarbons). The linear paraffin hydrocarbons are undesirable ones for gasoline fractions that reduce the octane rating, but they are a preferred component of jet and diesel fuels. And paraffin hydrocarbons above C17 are solids.

Naphthenic (cyclic) hydrocarbons (cycloalkanes) are presented in crude oil in quantity of 25–75 %. They are eligible components of gasoline, diesel fuels, etc. Unsaturated hydrocarbons are presented in crude oil in miserable quantities and can be oxidized and polymerized that change for worse the petroleum products quality.

Oil is separated into some fractions according to the difference of boiling temperatures of different oil components. Thus, gasoline boils from the initial boiling point up to 180 °C; kerosene fraction – from 140 up to 280 °C, and diesel oil group – from 180 up to 350 °C. All fractions that were boiled up to 350 °C are determined as

light oil products and the groups that boil above 350 °C – as heavy oil products accordingly.

The investigation of process that occurs in the oil-disperse system (further ODS) is easily considered according to the concept that oil is a thermodynamically unstable self-formed colloid system. The importance of the choice of ODS investigation methods consists in the possibility of the crude oil capability express-analysis. In order to achieve the right results they have to correlate with the oil distillation results accordingly [11].

The distillation intensity and the total yield of light oil products depend on the physical and chemical crude oil properties. According to the concept of the oil as liophilic and liophobic system, it is necessary to take into account that the highest increasing effect on the light products yield is reached during the ODS destabilization with the help of external influences.

We consider that the changes of physico-chemical characteristics of crude oil occur due to special regrouping in the oil system and to changes in its disperse structure. Of course, the changes in colloidal structure of ODS find the reference in the changes of viscosity, the fluidity temperature, surface tension, sedimentation characteristics, etc. Generally, a kinematical viscosity ν (m^2/s) is used as a parameter of the oil viscosity characteristic; it is the ratio of dynamical viscosity η (Pa*s) to the density of the fluid at the fixed temperature of the experiment.

According to the aim of the work it was important to obtain not the absolute meanings of the viscosity but its changes. That's why we have used such parameter as the time of relative oil flowing out from the viscosimeter. In our opinion it qualitatively describes the changes in the oil disperse characteristics.

The experimental part. Flowing time definition was carried out with the help of the capillary viscosimeter, in which the oil flows through the capillary tube of the appropriate diameter. The viscosimeter RG 29, 78-II with the capillary diameter of 2 mm was used for the experiment (fig. 1) [12].

Before the research activity, the oil-filled viscosimeter was kept in the thermostat; the temperature measuring was carried out with the help of the thermometer with the point of 0,1 °C. The thermometer was fixed in a way that its reservoir was approximately in the middle of the viscosimeter capillary.

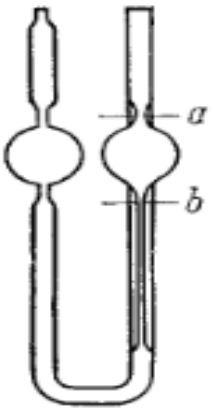

Fig. 1. The capillary visco-simeter: *a*, *b* – the marks of definite volume of the liquid

The viscosimeter was chosen in the way the time of the oil flow had to be no less than 200 seconds. It was washed out with the gasoline and dried in a drying box. Further, he viscosimeter was filled with oil up to the mark on the capillary, and then it was fixed vertically in the thermostat and kept at the constant temperature during 20 minutes. The time of oil flowing through the capillary was assessed with the help of stopwatch with accuracy up to 0,02 second. There were carried out at least three parallel measurements for every sample.

It has been established the flowing time of the oil with the alkylbenzene sulfate acid (ABSA) put in different concentrations. Next, the data were been compared with the oil distillation results. The oil of Kremenchug refinery was used for the experiment.

The aim of the analysis is to determine the optimum of additive concentration, which affects the ODS's changes in the best way. The practical usage of experimental results is the increase of refined oil yield during the primary distillation process, decrease of the petroleum losses during its storage and decrease of energy expenditure for carrying out the distillation.

The research of petroleum flowing time from the viscometer has been made with the purpose of tracing the connection in petroleum properties changes (such characteristics as refined oil yield and viscosity). The flowing time is the index that is proportional to viscosity, which absolute value we don't have to get. That's why we have used such parameter as the oil flowing time from the viscometer (fig. 2).

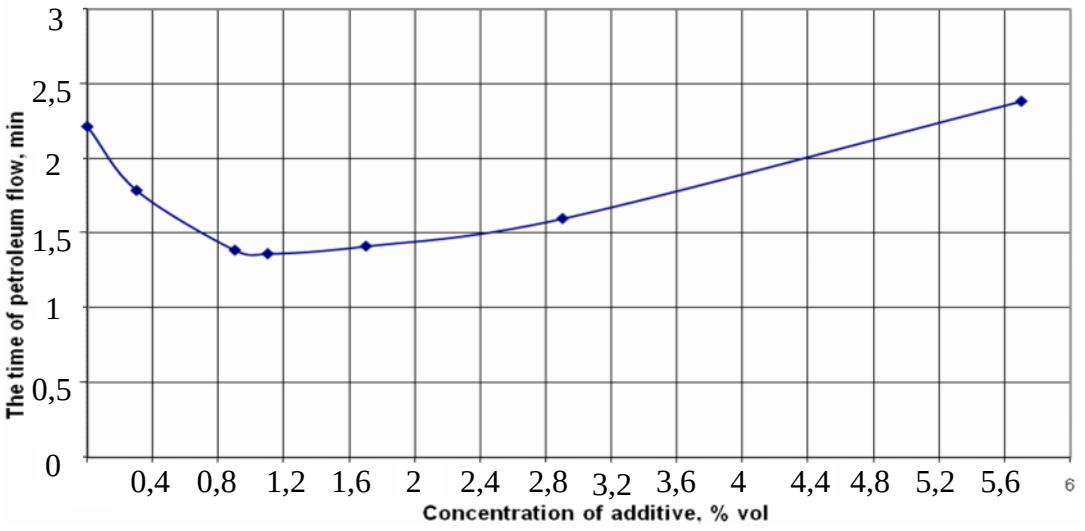

Fig. 2. Dependence of petroleum flowing time from the additive concentration

Then the number of distillations was made for the purpose of

- tracing the correlation between viscosity changes and refined oil yield during the primary distillation process,
- determination of additive optimum concentration, with which it is possible to achieve the higher output of light petroleum during distillation.

The results of refining are shown in the table. It is easier to observe the experimental data in the view of the dependence of light oil products yield from the additive concentration (fig. 3).

Comparing the diagrams of viscosity changes and the light oil products yield (fig. 2 and fig. 3) we can see that there is no direct dependence between them, but it is well seen that the points of maximum yield are in the cavity of the viscosity curve. That's why the research of viscosity changes helps us to define the area of optimal additive concentration and to investigate the influence of the additive concentration on the yield of light fractions in detail.

Dependence of light petroleum volume on the additive concentration

Additive concentration, %	0	0,3	0,9	1,1	1,7	2,9	5,7
Light petroleum volume,	Temperature, °C						
0,0	82	82	83	85	83	91	90
2,5	130	130	135	130	131	147	150
5,0	180	181	190	181	186	177	190
7,5	202	202	217	177	209	184	202
10,0	211	216	240	241	198	246	195
12,5	213	218	258	255	264	261	247
15,0	262	263	268	265	273	272	263
17,5	270	270	271	270	272	277	276
20,0	282	285	286	275	298	284	282
22,5	295	296	300	300	302	284	277
25,0	305	305	302	304	304	282	290
27,5	304	305	303	306	306	308	320
30,0	304	306	305	306	307	312	324
32,5	309	307	302	307	306	320	322
35,0	304	305	301	307	304	322	321
37,5				305	303	322	

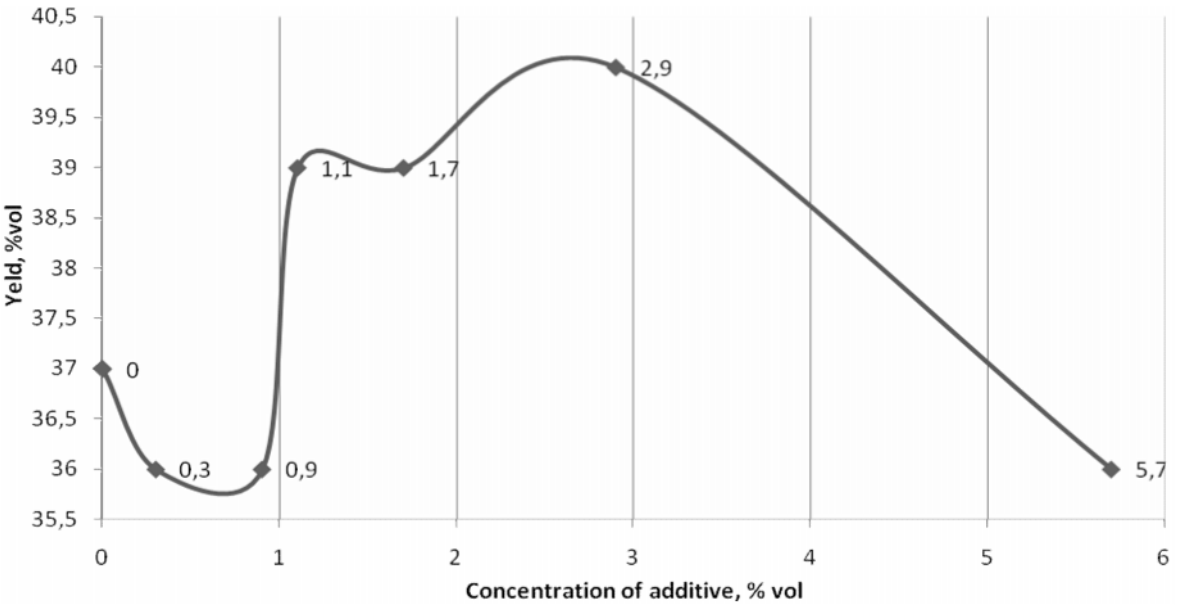

Fig 3. Dependence between the light petroleum yield and the concentration of the additive

Conclusions and prospects for further research. Oil is complicated multicomponent system and fossil energy source. That's why the actuality of the research is in the investigation of the oil processing with the purpose of its

intensification. The influence of the additive on the crude oil processing was investigated with the help of the viscosimetry method.

It was found that the higher output of light petroleum during primary refining could be achieved in the presence of the additive within definite (optimal) concentrations. So the research of viscosity changes helps us to define the area of optimal additive concentrations.

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