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Increasing The Yield Of Kerosene-Gasoil Fraction From Crude Oil Under The Influence Of Oxygen Containing Additives

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Abstract: The study was conducted by using oxygen containing (oxygenates) additives into crude oil during atmospheric distillation process to increase yield of light fractions from oil. This fact does not take place during distillation without adding oxygen containing additives.

Various mixtures of oils, as well as individual light (Satskhenisi) and heavy (Mirzaani) oils of Eastern Georgia were taken as objects of study.

The study of the possibility of increasing the yield of fractions from various mixtures of oil in the presence of the above oxygenates is due to the opinion that oil refineries mainly process a mixture of oils, and not individual oil. However, the studies were conducted using of Satskhenisi (light) and Mirzaani (heavy) oils.

Keywords: Yield, Kerosene-gasoil, Crude oil, Oxygen, Additives.

It is known that in the atmospheric rectification of crude oil, the addition of oxygen containing (oxygenates) additives in small quantities increases the yield of light fractions from oil. This fact does not occur during distillation without oil additives.

Various oil mixtures and individual light (Satskhenisi) and heavy (Mirzaani) oils from Eastern Georgia under atmospheric distillation conditions were taken as research objects.

Residues from the production of cognac alcohol were used as oxygenates.

The study of the possibility of increasing the yield of fractions from various oil mixtures in the presence of the aforementioned oxygenates was conditioned by the fact that oil refineries mainly process mixtures of oils, and not individual oils. Nevertheless, studies were conducted using individual Satskhenisi (light) oil and Mirzaan (heavy) oil.

Increasing the yield of fractions from oil has been studied in the case of using chemically pure individual organic compounds as additives. Similar compounds are often liquid components of alcohol production, and it is the fact that has led to their use as oxygenates during atmospheric distillation of oil.

For this purpose, the following additives were selected: Fusel oil, cognac alcohol production by-product, their mixture in a ratio of 1:1, and also the composition of this mixture with oxalic acid in a ratio of 1:1:1.

Fusel oil is a fraction boiling above 80°C, which is obtained as a by-product (waste) in a cognac alcohol production plant (Table 1).

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Cognac alcohol production by-product is a fraction boiling below 75°C, which is obtained as a by-product or waste in alcohol plants. The components that make up the additive have the ability to dissolve well in each other. Their physicochemical characteristics are presented in Table 1.

The effect of oxygen-containing additives on increasing the yield of the kerosene-gasoil fraction from oil was studied on the atmospheric-vacuum oil rectification apparatus APH-2.

Physico-chemical characteristics of the additives

Table 1.

№	Characteristics	Fusel oil	Cognac alcohol production headstock
1	Boiling temperature, °C	81-106	65-75
2	Density, 20°C, kg/m3	690	610
3	Content, %		
	Ethyl alcohol	16.1	22.5
	Fatty alcohols	60.5	53.5
	Aldehydes	17.0	14.4
	Ketones	1.7	6.0
	Unidentified	4.7	3.5

The rectification regime: the amount of oil for each experiment – 1 liter, atmospheric pressure and temperature 190–350°C.

The rectification was carried out both in the presence of individual additives – fusel oil and cognac alcohol production head fraction, as well as their mixture, and the composition of this mixture with oxalic acid. The aim of the study was to determine the influence of the amounts of individual additives, their mixture and the composition of the mixture on the yield of the kerosene-gasoline fraction from oil. In parallel, during the experiments, the activity of the additives was determined by the formula:

$$A = \frac{\Delta G}{Cg},$$

Where ΔG is the yield increase of the kerosene-gasoil fraction, in mass %;

Cg is the concentration of the additive, in mass %.

The additives were added to the oil in an amount from 0.005% to 0.5%, relative to the amount of oil to be extracted. The aim of the experiments was to determine the minimum amount of additives that would ensure the complete separation of the C_{11}-C_{20} carbon-containing compounds of the kerosene-gasoil fraction components from the oil. When using 0.005% of the additive, the yield increase was not observed; when using 0.01% of the additive, the yield increase did not exceed 1%; when using 0.02% of the additive, the fraction yield increased to 3–5%, to different degrees for different additives. In the presence of 0.05% additive, the yield of the kerosene-gasoil fraction increases insignificantly. As for 0.1% and 0.2%, the increase in yield is very small. Analyzing the results, it was determined that 0.02% additive is the optimal amount that maximally separates the components of the kerosene-gasoil fraction from the oil. Subsequently, the oil was rectified with 0.01%, 0.02%, 0.1% and 0.2% additive amounts. The additives were added in the amount of 0.1 ml, 0.2 ml, 1 ml and 2 ml, depending on the percentage, using a micropipette at the beginning of the oil boiling in the rectification cube.

It is known that oil belongs to liquids consisting of associated – complex structural units (CSU). In the center of the CSU are high-energy and high-molecular compounds, and around it are associated low-energy and low-molecular compounds. Intermolecular poly van der Waals bonds (forces) operate between them, which determine the strength of the surface tension of complex units.

The role of oxygen-containing additives during atmospheric rectification of oil is precisely to weaken the surface tension of the CSU, break poly van der Waals bonds and displace low- and high-energy compounds from each other and enrich the rectification with low-energy compounds, which are components of the kerosene-gasoline fraction. This fact does not occur during conventional oil rectification (without additives).

The effect of these additives on increasing the yield of the kerosene-gasoil fraction from oil is in Table 2.

The influence of the production process of Fusel oils, cognac alcohol production headstock, their mixture (1 : 1), as well as the composition of this mixture with oxalic acid (1 : 1 : 1) on the yield of the Kerosene-gasoline fraction from the oil mixture

Table 2.

Kerosene-Gasoil fraction yield without additives, %	Fraction yield in the presence of additives %															
	Fusel oils, %				Cognac alcohol production headstock, %				Their mixture (1 : 1), %				Composition of the mixture with oxalic acid (1 : 1 : 1), %			
	0.01	0.02	0.1	0.2	0.01	0.02	0.1	0.2	0.01	0.02	0.1	0.2	0.01	0.02	0.1	0.2
49.7	51.2	53.7	53.8	53.7	51.4	55.6	55.7	55.8	54.8	56.6	56.5	56.6	56.4	57.6	57.6	57.4

The data in Table 2 show that better results are obtained with the following amounts of cognac alcohol production headstock: 0.01; 0.02; 0.1 and 0.2.

The fraction yield from oil is 55.6% (5.9% higher than the initial one) with an addition of 0.02%. A mixture of cognac alcohol production headstock with Fusel oil in a ratio of 1 : 1 increases the fraction yield by 6.9% and it is 56.6%; the composition of the mixture with oxalic acid in a ratio of 1 : 1 : 1 also increases the fraction yield to 57.6%. The yield increase in this case is 7.9%. The connection of the mixture of fusel oil and cognac alcohol production headstock with oxalic acid and the creation of a single composition from them is due to the high oxygen content in oxalic acid – 71.1%.

Based on experimental data, the minimum optimal amount of active oxygen-containing additive to be added is 0.02%, relative to the amount of the mixture of oils to be distilled. The activities of fusel oil, cognac alcohol production head, as well as their mixture, in a ratio of 1 : 1, and the composition of this mixture with oxalic acid, in a ratio of 1 : 1 : 1, have been determined.

The possibility of increasing the yield of kerosene-gasoil fractions during atmospheric rectification of light and heavy individual oils was studied using the composition – fusel oil + cognac alcohol production residue + oxalic acid, in a ratio of 1 : 1 : 1.

The influence of the composition on the yield of kerosene-gasoil fractions from Satskhenisi and Mirzaani oils is presented in Table 3 and Fig. 1.

Effect of composition on the yield of kerosene-gasoil fractions

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Table 3.

Crude Oils	Yield of Kerosene-gasoil fraction %, (mass) without additives	Yield of fractions %, (mass) with additives							
		0.01	0.02	0.022	0.025	0.028	0.03	0.1	0.2
Satskhenisi	69.5	72.7	73.13					73.13	73.13
Mirzaani	55.3	55.8	56.5	57.9	58.8	59.8	59.9	59.98	59.98

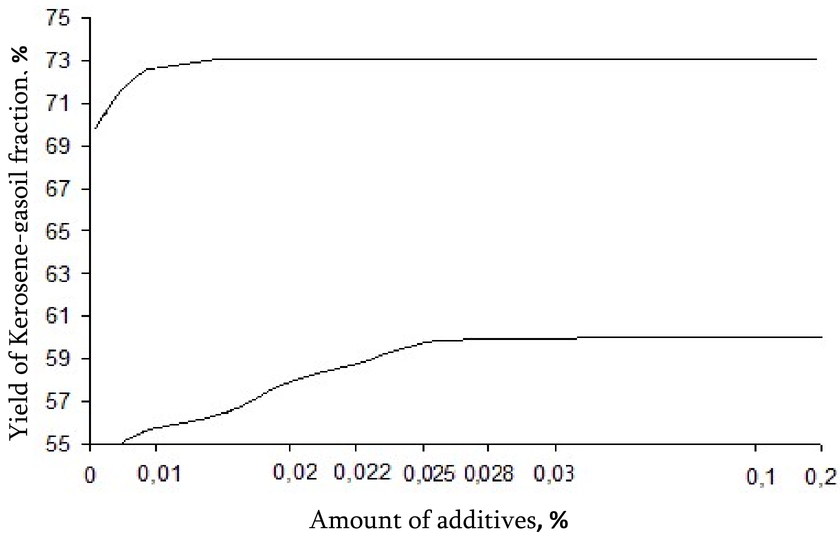
From the data in Table 3, it can be seen that during atmospheric distillation of Satskhenisi oil, the fraction yield with the addition of 0.01% (mass) of the composition is 72.7%, which corresponds to a yield increase of 3.2% (mass); in the case of 0.02% composition, the yield increase is 3.63% and amounts to 73.13%. No yield increase is observed with the addition of 0.1% and 0.2% (mass). During atmospheric distillation of Satskhenisi oil, a fraction separation is sufficient with 0.01% (mass) of the composition.

In the case of Mirzan oil, a relatively high yield was observed in the cases of 0.02%-0.03%: the yield increase at 0.02% is 1.2% and amounts to 56.5% (mass). In the presence of 0.03% (mass) additives, the yield increase of fuels during atmospheric rectification is 4.6% (mass) and amounts to 59.9%. In the cases of 0.1 and 0.2%, the yield increase is insignificant. Additional experiments were conducted to determine the minimum optimal amount of additives at 0.022; 0.025 and 0.028% of the composition

(Table 3). A relatively high increase in yield was observed at 0.028%, which was considered the minimum optimal amount of addition to increase the yield of the heavy, namely Mirzania oil fraction during atmospheric rectification of oil.

Influence of the yield of the kerosene-gasoil fraction during atmospheric rectification of Satskhenisi (1) and Mirzaani (2) oils on the composition – fusel oils + cognac alcohol production headstock + oxalic acid – 1 : 1 : 1, quantities

Fig. 1.



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Thus, the composition consisting of fusel oil + cognac alcohol production head + oxalic acid, in a ratio of 1 : 1 : 1, can be successfully used as an additive to increase the yield of fuels during atmospheric rectification of both oil mixtures and light and heavy oils. In addition, the minimum optimal amount of additive for oil mixtures is 0.02% (mass), in the case of light oil 0.01% (mass) and for heavy oil 0.028% (mass), calculated on the distillate oil.

Increasing the yield of fractions from oil is of great practical, economic and ecological importance. As a result of studies, it was found that when the amount of additive used is 0.01-0.03% (mass), the yield of fractions increases by an average of 3-6%. The amount of additive used does not exceed – 0.05% (mass), which is an important factor.

It is very important that the environmentally polluting liquid waste can be used to increase the yield of fuels during atmospheric rectification of crude oil. This fact will eliminate two problems - the increased amount of kerosene-gasoil fraction and economic profit to the crude oil refining sector. At the same time, it will reduce environmental pollution.

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