INFLUENCE OF THE n-PARAFFINS ADDITION ON THE EFFICIENCY OF THE DEPRESSANT FOR DIESEL FUEL WITH VARIOUS COMPOSITIONS

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One of the essential, probable and cost-effective way to produce winter and arctic brand of diesel fuel (DF) with improved low-temperature properties is the involvement of depressor additives (D). However, creation of universal additive effective in a wide range of diesel fuel composition changes is practically impossible [1].

Table 1 shows the results of determining the low-temperature properties (cloud point (*CP*), pour point (*PP*) and cold filter plugging point (CFPP)) of two diesel fuel samples with and without the addition of depressor. The difference in depressor efficiency can be explained by the different hydrocarbon compositions of the diesel fuel samples (Table 2).

The results of Table 2 clearly show that the higher the total n-paraffin content the worse *PP* and CFPP temperature we get. This effect is explained in the mechanism of action of depressant additives [2]. The highest susceptibility to depressant additives are n-paraffins, because depressors are designed to interact with nascent crystals of these compounds, keeping under their growth. At the same time, a depressor additive can not take effect until the first n-paraffin crystals appear, so the addition of heavier n-paraffins, which crystals appear first, can increase the effectiveness of the depressor additive (Table 3).

In this work heavy n-paraffins (P) were obtained from vacuum gasoil according to [3] and then added at a concentration of 0.1 % wt. to blends of DF samples with depressor. The results of determining the low-temperature properties of the resulting blends are shown in Table 3.

As it can be seen from the data presented in Table 3, the addition of 0.1 %wt. of heavy n-paraffins enhances the additive's effect with respect to *CFPP* by 6 °C for the first sample of DF and by 2 °C for the second sample of DF, moreover, for the second sample of DF the effect of additive with respect to *PP* is enhanced by 8 °C. Also, the addition of heavy

Table 1. Results of low-temperature properties of the test diesel fuel samples with and without the addition of depressor

Sample of DF	*CP*, °C	Δ	CFPP, °C	Δ	*PP*, °C	Δ
1	–4	↓1	–5	↓20	–16	↓26
1+D	–5		–25		–42	
2	0	↓2	0	↓16	–8	↓21
2+D	–2		–16		–29	

Table 2. Results of the group hydrocarbon composition of the test diesel fuel samples

Sample of DF	Hydrocarbon content, %wt.		
	Aromatics	Naphthenes	Paraffins
1	25.55	23.98	50.47
2	22.16	17.55	60.29

Table 3. Low temperature properties of DT / n-paraffins / depressant blends

Sample of DF	*CP*, °C	Δ	CFPP, °C	Δ	*PP*, °C	Δ
1+D	–5	↑4	–25	↓6	–42	↑3
1+D+P	–1		–31		–39	
2+D	–2	↑3	–16	↓2	–29	↓8
2+D+P	1		–18		–37	

n-paraffins increases the *CP* of the DT samples, which clearly indicates a change in the onset temperature of crystallization and the earlier appearance of n-paraffin crystals.

Thus, the addition of heavy n-paraffins was found to increase the effectiveness of the depressant additive against CFPP and *PP*.

References

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MATHEMATICAL MODELING OF SULFONATION REACTOR

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Global demand for safe and effective detergents is driving the development of biodegradable anionic surfactant technologies. Alkylbenzenesulfonic acid is the base component for these surfactants. Alkylbenzenesulfonic acid is obtained by sulfonation with sulfuric anhydride of a thin film of linear alkylbenzene with a side chain of 10–13 carbon atoms. The most efficient technologies include sulfonation in multi-tube film reactors. The sulfonation reaction is exothermic, cooling is carried out by supplying water to the annular space. An increase in temperature in the reaction zone leads to the occurrence of side reactions, during which viscous tetralins and sulfones are formed, which settle on the inner surface of the reaction tubes and reduce the quality of the final product. To remove by-products, it is necessary to periodically shut down the reactor and rinse the reaction tubes with water.

The use of mathematical modeling for the selection of optimal technological parameters makes it possible to increase the duration of continuous operation of the reactor without deteriorating the quality of the final products [1]. At present, various versions of mathematical models are known for film reactors for the sulfonation of linear alkylbenzene. Early models assumed turbulent motion in the liquid and gas phases, as well as the absence of entrainment of liquid droplets by the gas phase or the capture of gas bubbles by the liquid. Later, other models were proposed. They assumed a laminar flow of the liquid phase, supplemented by assumptions about the diffusion of gas into the liquid, as well as the adsorption of SO_3 by the liquid phase.

This paper presents the results of calculations using the developed mathematical model based on the following assumptions: plug flow, the liquid film is located over the entire surface of the tubes and is symmetrical about the reactor axis, the reaction rate decreases due to the formation of a viscous component [3].

An important advantage of the mathematical model is that it allows you to calculate the quality indicators of the product flow depending on the concentration of aromatic compounds in the sulfonation feed.

Calculations using a mathematical model made it possible to establish the effect of the content of aromatic hydrocarbons in the feed on the mass fraction of alkylbenzenesulfonic acid in the product stream and the optimal consumption of sulfur supplied for combustion in the furnace to obtain a gas mixture of sulfuric anhydride and air used for sulfonating linear alkylbenzene. The calculated optimal consumption of combusted sulfur at different concentrations of aromatic hydrocarbons in the feed are presented in the table.

Thus, an increase in the content of aromatic compounds in the feed leads to a decrease in the yield of the target product and an increase in the optimal consumption of combustion sulfur. According to calculations carried out using a mathematical model, it was found that alkylbenzenesulfonic acid