As can be seen from the data presented in Table 2, injection of benzene resin sat a temperature of 55 °C negatively affects Cp, while the injection of benzene resins at a temperature of 80 °C improves Cp (ΔCp = 1 °C).

Injection of BR at temperatures 55 and 80 °C improves Pp (ΔPp = 1–5 °C). Introduction of BS at a temperature of 55 °C has no effect on the CFPP of the sample (ΔCFPP = 0 °C), while at a temperature of 80 °C CFPP of the DF sample improves (ΔCFPP = 4 °C).

The revealed effect can be explained as follows: with increasing injection temperature, the solubility of petroleum resins improves, which leads to the formation of a larger number of micelles that surround and modify n-paraffin crystals. Micelles formed by petroleum resins act as stabilizers by dispersing n-paraffin crystals in the fuel. The injection temperature affects the size and stability of the micelles. Higher temperatures can result in formation of smaller and more stable micelles, improving dispersion. In addition, the injection temperature affects the rate and extent of adsorption. Higher temperatures promote faster and more complete adsorption of petroleum resins on n-paraffin crystals.

Table 1. Low temperature properties of DF sample

Sample	Cp, °C	CFPP, °C	Pp, °C
DF	0	0	–8

Table 2. Results of a study of low-temperature properties of mixtures of DF with benzene resins at an injection temperature of 55 and 80 °C

Property	DF + benzene resins injection at 55 °C					DF + benzene resins injection at 80 °C				
	Concentration, % wt.									
	0.0025	0.0050	0.0100	0.0250	0.0500	0.0025	0.0050	0.0100	0.0250	0.0500
Cp	2	1	0	1	2	–1	–1	–2	–1	–1
CFPP	0	0	0	0	0	–3	–4	–4	–4	–4
Pp	–9	–14	–13	–13	–9	–13	–13	–14	–13	–13

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THE INFLUENCE OF TEMPERATURE ON THE COMPOSITION OF THE PRODUCTS OBTAINED BY PROCESSING STABLE GAS CONDENSATE ON ZEOLITE MODIFIED WITH NICKEL SALTS

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The rapid expansion of the car fleet worldwide requires a proportional increase in the production of motor fuel. One of the ways to solve this problem is to use stable gas condensate (SGC) as a blended component of commercial gasoline. However, the use of SGC without catalytic processing is limited due to its operational characteristics, so the use and improvement of existing catalysts for SGC processing is an urgent task.

The purpose of this work was to process SGC on a zeolite catalyst of the ZSM-5 type modified with nickel salts under conditions of varying the process temperature.

For modification, an industrial catalyst of the ZSM-5 type, brand KN-30, was used. The starting catalyst is granules that have been crushed and sorted by particle size using two sieves with opening sizes of 0.5 mm and 1.0 mm. The modifying component was a solution of $Ni(NO_3)_2$ salt. The solution concentration was 1 % wt. The initial catalyst was impregnated with a salt solution with constant stirring. The exposure time of the catalyst in the solution was 5 hours. Afterwards, the catalyst was dried at a temperature of 80 °C for 2 hours. The final stage was calcination of the catalyst in a muffle furnace at a temperature of 350 °C for 4 hours.

For catalytic processing, SGC was used, obtained as a by-product of natural gas treatment at one of the fields in the Tomsk region. The technological parameters of the process are similar to the parameters under conditions of varying temperature given in [1].

The products of the processing of SGC and the initial SGC were analyzed by gas-liquid chromatography on a «Chromatec Crystal 5000» chromatograph with a built-in software product Chromatec Analyst, which is used to process chromatograms.

The results of determining the hydrocarbon group composition of feedstock and processed products under varying process temperatures are presented in Table.

The table results show that the composition of processed products has a non-linear dependence on the process temperature. By studying the effect of process temperature on the composition of processed products, the researchers [1] found that an increase in temperature leads to a decrease in the content of n-paraffins and isoparaffins, and an increase in the proportion of arenes and olefins. In this work, it is observed that the addition of a nickel-containing component leads to the appearance of a maximum and minimum content of components. The lowest content of n-paraffins is achieved at a process temperature of 400 °C (by 18.468 % vol.), the smallest reduction in the content of isoparaffins is achieved at temperatures of 400 and 425 °C (by 6.686 and 6.662 % vol., respectively). Compared to the feedstock, the naphthenes content is reduced, but a further increase in temperature has little effect. The smallest increase in olefin content is observed at a temperature of 400 °C. Modification of the zeolite catalyst helps to increase the content of arenes. The highest content increase (by 35.490 % vol.) is observed at a process temperature of 400 °C. Thus, the composition of the processing products on a zeolite catalyst modified with nickel salts depends on the process temperature. The best results are achieved at a process temperature of 400 °C, since the most valuable components of gasoline are formed. These patterns can be explained by the fact that nickel-containing centers intensify the hydrogenation-dehydrogenation reactions, and an increase in temperature accelerates the reactions, but at higher temperatures the equilibrium is disturbed and deactivation of the catalyst occurs as a result of coking.

Table 1. Hydrocarbon composition of SGC and its processing products on a zeolite catalyst modified with nickel salts

Substances content	Feedstock	Process temperature, °C		
		375	400	425
	% vol.			
N-paraffins	40.960	28.818	22.492	24.293
Isoparaffins	37.736	22.639	31.050	31.074
Aromatic hydrocarbons	1.073	25.307	36.563	28.623
including benzene	*0.137*	*0.063*	*3.263*	*0.000*
Naphthenes	19.551	16.559	7.724	6.448
Olefins	0.681	6.679	2.170	9.563

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