What's more, there is a decrease of n-paraffins content and there's an increase of isoparaffins content.

These changes in group composition of processing products in comparison to feedstock SGC samples can be explained with the following reasons:

1. The increase of isoparaffins content is caused by n-paraffins isomerization reactions.

2. The increase of olefins content is caused by n-paraffins cracking and partially with naphthenes cracking.

3. The increase of aromatic hydrocarbons content is provided with hydrogen transfer reactions in olefins.

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Table 2. Group composition of zeoforming products of SGC samples

Hydrocarbon group, % vol.	ZP 1	ZP 2	ZP 3
N-paraffins	29.56	30.72	27.39
Isoparaffins	48.12	46.08	45.41
Naphthenes	6.89	7.04	9.78
Olefins	3.24	2.22	2.72
Aromatic hydrocarbons	12.18	13.88	14.69

MATHEMATICAL MODELING OF VACUUM GAS OIL HYDROTREATMENT PROCESS

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Hydrotreating is one of the most important technologies in petroleum refining industry. The hydrotreating process removes heteroatomic compounds (sulfur, nitrogen and oxygen containing) from petroleum distillates by selectively reacting these compounds with hydrogen in a catalyst bed at elevated temperature. This reduces the emission of toxic gases during fuel combustion.

In the case of catalytic cracking feed, which are mainly integrated by heavy atmospheric gas oil, light vacuum gas oil and heavy vacuum gas oil, its hydrotreating is more difficult than hydrotreating of light and middle distillates because of the higher sulfur content in heavy streams. At the same time, heteroorganic compounds are characterized by a lower reactivity compared to the compounds that make up the light fractions. [1]. It is well-known that catalytic cracking is one of the main producers of gasoline in a refinery, and cat-cracked gasoline is usually the major contributor to the sulfur levels in the gasoline pool (about 90 %). For these reasons, catalytic cracking feed pretreating is an excellent tool to meet required product quality. Catalytic processes are quite complex, because they cover a huge number of different reactions in which a large number of components are involved. Mathematical modeling is one of the ways to improve the efficiency of chemical and technological processes [2].

The aim of the work is to develop a mathematical model of vacuum gas oil hydrotreatment process that takes into account the change in the hydrocarbon composition of feed.

To create a mathematical model of the process, first of all, it is necessary to determine the reactions and compounds involved in chemical transformations. Thus, in the course of this work, a formalized transformation scheme was developed, which will later become the basis for creating a mathematical model of vacuum gas oil hydrotreatment process (Fig. 1).

Based on the results of liquid adsorption chromatography with gradient displacement of samples before and after hydrotreatment, the separation of vacuum gas oil into resins, saturated (alkanes and naphthenes) and aromatic (light, medium and heavy) hydrocarbons was introduced into the scheme. Benzothiophene and dibenzothiophene were chosen as sulfur-containing pseudo-components, on which
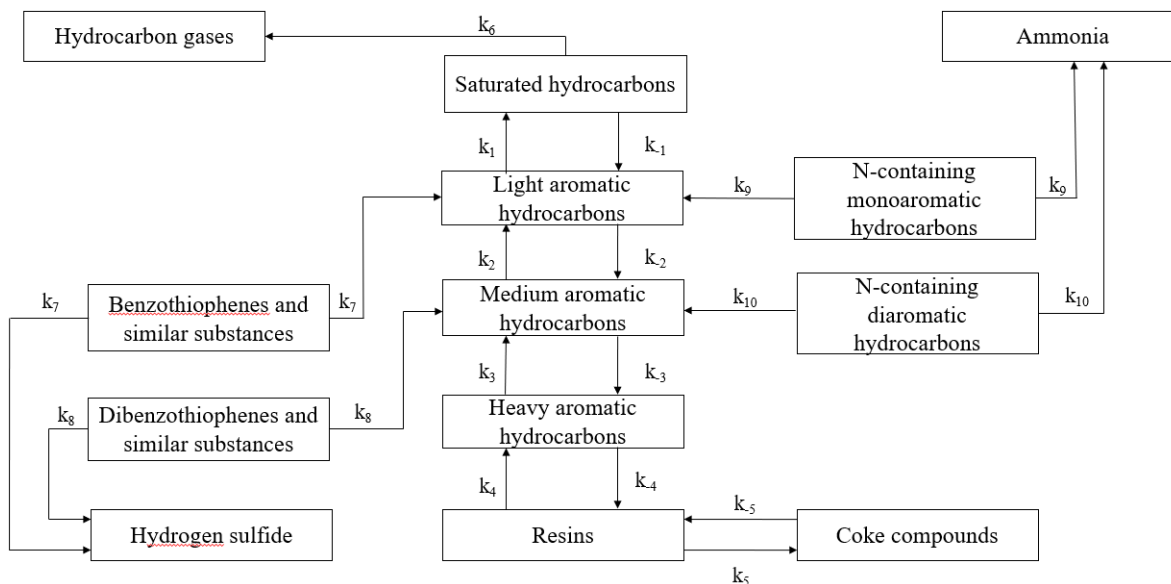
Fig. 1. *Formalized scheme for the conversion of hydrocarbons and heteroatomic compounds in the process of vacuum gas oil hydrotreatment, where k_i – rate constant of the i-th forward reaction; k_{-i} – rate constant of the i-th reverse reaction*

the general kinetics of reactions of sulfur-containing compounds will be based. Nitrogen-containing mono- and di-aromatic hydrocarbons were chosen as nitrogen-containing components. The scheme takes into account the reactions of hydrogenation, hydrogenolysis, dealkylation, hydrocracking and coke formation. In this case, the process of coke accumulation on the catalyst is reversible, since chemical transformations take place in a hydrogen environment. Thus, the model will be sensitive to hydrogen flow.

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SYNTHESIS OF COBALT FERRITE BY SOL-GEL AUTOCOMBUSTION METHOD

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It is clear that from the literature ferrites consist of iron oxide and metal oxide. Cobalt ferrite was obtained by various methods. These methods are such as hydrothermal, co-precipitation, solvothermal, ball milling method, microemulsion method, sol-gel combustion method and etc [1]. The sol-gel method is widely used among them. This method has many advantages. So that homogeneity, composition control, particle size can be well achieved by sol-gel autocombustion method [2].

Cobalt ferrite was synthesized by sol-gel technology with autocombustion. Cobalt nitrate $Co(NO_3)_2 \cdot 6H_2O$, ferric nitrate $Fe(NO_3)_3 \cdot 9H_2O$, citric acid ($C_6H_8O_7 \cdot H_2O$) and ammonia have been used as starting materials for preparation of cobalt ferrite. Citric acid was taken as a fuel. Firstly, metal nitrates were dissolved in minimum amount of mixture solution of deionised water and citric acid was dissolved in a separate dish, finally three solutions are mixed in another dish. Morover, a small