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Effect of feed composition changing at naphtha catalytic reforming unit due to involvement of gasoline fraction obtained by diesel fuels hydrodewaxing into the processing

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Abstract

One of the primary products of hydrodewaxing process is stable gasoline, which is characterized by low octane number on the one hand. On the other hand, it contains a significant amount of iso-paraffins (on average 45 % wt.) and naphthenes (on average 25 % wt.), which are reagents in the naphtha catalytic reforming process primary reactions. Feasibility of stable gasoline obtained by means of diesel fuel catalytic hydrodewaxing process involving into the processing at the naphtha catalytic reforming unit has been estimated using naphtha catalytic reforming mathematical model. Technological scheme of stable gasoline from hydrodewaxing unit supply to the reforming unit is presented. Naphtha catalytic reforming and diesel fuels hydrodewaxing processes resource efficiency increases by 15–20 % due to rise in catalytic reforming feed source.

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Keywords: Catalytic hydrodewaxing, naphtha catalytic reforming, mathematical model, feed composition, gasoline fraction;

1. Introduction

The most complex problems that occur whereby aspiration to the modern motor fuels quality standards are required gasoline octane number achievement[1,2] and low sulfur and ultra low sulfur diesel distillates production[3,4] with improved low temperature characteristics[5,6].

One of the contemporary high quality diesel fuels production technologies is straight run diesel cuts catalytic

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hydrodewaxing[7-9]. Besides, a considerable amount of gasoline fraction is received in the hydrodewaxing process[10]. This gasoline fraction is characterized by low octane number, but contains a great deal of iso-paraffins (on average 45 %) and naphthenes (on average 25 %), which are reagents in the naphtha catalytic reforming process primary reactions. In order to increase stable gasoline octane number and catalytic reforming unit feed source it can be directed to the further refining in the reforming process.

The purpose of the current work is reasonability of involvement of stable gasoline which is obtained by diesel fuel catalytic hydrodewaxing into the processing at the naphtha catalytic reforming unit estimation by means of naphtha catalytic reforming mathematical model.

2. Experimental part

When gasoline fraction from hydrodewaxing unit is involved into the catalytic reforming unit feed flow, the feed composition changes significantly. With a view to proof the reasonability of stable gasoline from hydrodewaxing unit using as the catalytic reforming raw materials, calculations of feed composition changing influence on key catalytic reforming parameters have been carried out via the use of the catalytic reforming mathematical model[11]. Initial data for calculations is presented in Table 1.

Table 1. Initial data for calculations

Technological parameter	Value
Hydrogen containing gas volumetric flow rate, m^3/h	94000
Feed volumetric flow rate, m^3/h	93
Pressure in reactor R-2, atm	21.90
Pressure in reactor R-3, atm	20.80
Pressure in reactor R-4, atm	20.30
Temperature in reactor R-2, °C	503
Temperature in reactor R-3, °C	500
Temperature in reactor R-4, °C	497

Calculations results are presented in Fig. 1-3.

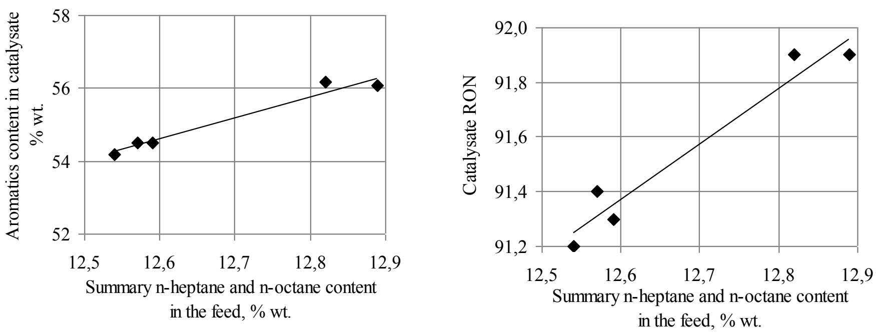

Fig. 1. Summary n-heptane and n-octane content influence on aromatics concentration in the catalysate and the catlysate research octane number (RON)

Increase in summary n-heptane and n-octane content in the feed due to gasoline fraction from hydrodewaxing addition provides conversion of these components to toluene and xylene, which leads to rise in aromatics concentrations in the catalytic reforming product (catalysate) and the catalysate RON growths. As it can be seen in Fig. 1 aromatics concentration goes up by 1.97 % wt. from 54.19 to 56.16 % wt. The catalysate RON increases by 0.7 points from 91.4 to 92.1 points.

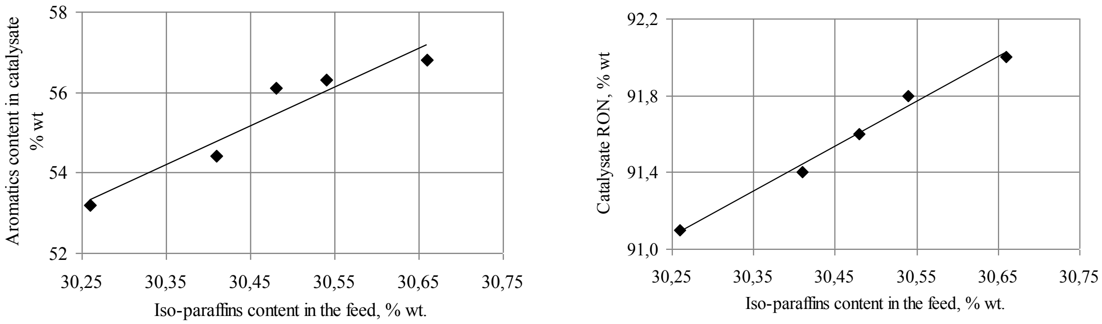

Fig. 2. Iso-paraffins content in the feed influence on aromatic content in the catalysate and the catalysate RON

The increase in i-paraffins in the reforming feed leads to rise in aromatic content in catalysate by 3.6 % from 53.2 to 56.8 % wt. The catalysate RON goes up by 0.9 points from 91.1 to 92.0 points (Fig. 2).

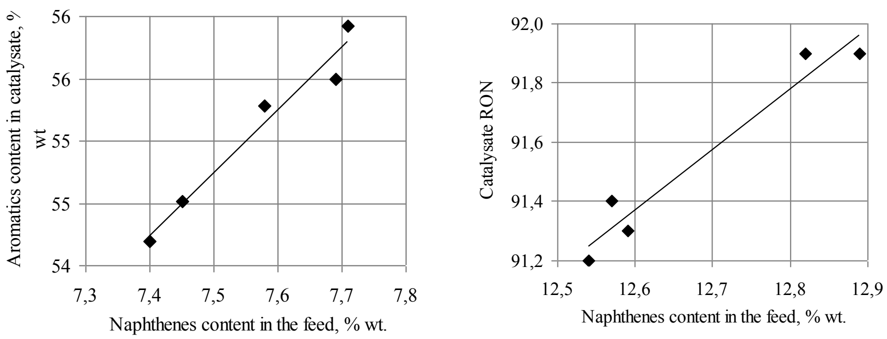

Fig. 3. Naphthenes content in the feed influence on aromatics concentration in catalysate and catalysate RON

One of the catalytic reforming desired reactions is naphthenes dehydrogenation with aromatics formation. Consequently, the feed which contains a significant amount of naphthenes is more preferable for refining in the catalytic reforming process in order to receive gasoline. So, if naphthenes content in stable gasoline from hydrodewaxing goes up by 0.13 % wt, the aromatics content in the catalysate rises by 1.73 % wt., catalysate RON increases by 0.7 points from 91.2 to 91.9 points (Fig. 3).

3. Technological scheme of stable gasoline from hydrodewaxing unit supply to the reforming unit

Taking into account gasoline fraction from hydrodewaxing addition, the catalytic reforming feed composition influence research has showed that stable gasoline composition changing has a significant positive effect on catalytic reforming indicators, namely isomerization degree, aromatics and isomers content, and catalysate RON increase. Hence, stable gasoline from hydrodewaxing unit involving into the catalytic reforming feed flow is reasonable and necessary from the point of plant resource efficiency increase due to raw materials amount enlargement.

Thus, the gasoline fraction from hydrodewaxing unit supply to reforming unit has been organized on a petroleum refining factory (Fig. 4).

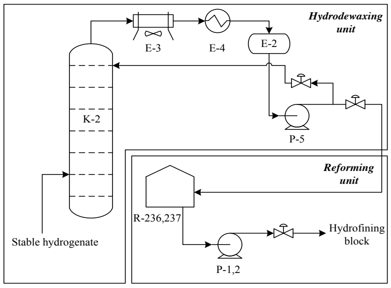

Fig. 4. Catalytic reforming process implementation for gasoline fraction from hydrodewaxing refining: K-2 – hydrogenate stabilization column; E-3 – air condenser; E-4 – water condenser; E-2 – reflux accumulator; P-1,2 – feed pumps; P-5 – reflux pump; R-236, 237 – feed reservoirs

However, it should be taken into account that stable gasoline composition depends on feed composition and technological regime realized at the hydrodewaxing unit. That is why hydrodewaxing process mathematical model application is needed for investigating feed composition and technological parameters influence on the yield and products composition. The further work is devoted to this purpose.

4. Conclusions

The present research has showed that stable gasoline from hydrodewaxing unit involving into catalytic reforming feed flow is reasonable and necessary in the context of industrial unit resource efficiency increase by means of the feed amount enlargement and gasoline fraction from hydrodewaxing unit quality improvement. Thereby, due to high iso-paraffins and naphthenes content in stable gasoline from hydroisomerization, aromatics concentration in catalysate, isomerization degree, and catalysate RON increase.

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