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Effect of group composition of the vacuum distillate from heavy Kazakhstan and West Siberian oil on the yield of light fractions during the catalytic cracking

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Abstract

This paper presents the research results aimed at the assessment of the impact of the group composition of Kazakhstan and West Siberian heavy vacuum distillate on the yield and composition of the catalytic cracking products. The laboratory research was performed to determine the physical and chemical characteristics and group composition of two samples of the heavy vacuum distillate of Kazakhstan and West Siberian oil. The patterns of changing yield of wet gas, light and heavy gas oil, coke, and gasoline depending on the composition of the feedstock were established using mathematical model of catalytic cracking.

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Keywords: deep processing, vacuum distillate, physico-chemical characteristics, group composition, mathematical model, wet gas, gasoline

1. Introduction

The worldwide trend to increasing the depth of petroleum feedstock processing and to improving the environmental specifications of motor fuels is directing the refinery industry on the construction of new and reconstruction of existing oil processing units that allows to produce valuable light fractions from heavy oil residue [1-3].

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Thus, oil and oil feedstock, extracted from them for refining processes, are significantly different in physical and chemical characteristics, depending on the geographical location of oil fields, the depth and geological age [4,5]. The difference in the physical and chemical indicators of oil is directly related to the methods of transportation and refining of crude oil and the quality of oil products obtained from them.

Products yield from catalytic cracking unit may significantly vary depending on the feed composition, hydrodynamic regimes, process conditions, catalysts type and etc. [6-9]. Application of the mathematical models allows adjusting the process conditions of industrial refining unit, taking into account the composition of the feedstock to provide the desired ratio of petroleum product and quality in accordance with international environmental requirements [10-20].

Laboratory researches to determine the group composition of two samples of vacuum distillate from Kazakhstan and West Siberian oil obtained by vacuum distillation of fuel oil and directed as a raw material in the catalytic cracking work were conducted in this research.

The aim of research is to evaluate the effect of group composition of a vacuum distillate from Kazakhstan and West Siberian oil on the yield and composition of catalytic cracking products using a mathematical model.

2. Study subject

The study subject is a catalytic cracking unit, part of a combined installation of fuel oil CT-1/1 deep processing.

Vacuum distillate after vacuum distillation (C-001) is directed to the hydrotreatment unit (C-100), after that is used as feedstock for catalytic cracking unit (P-200). Wet gas, unstable gasoline (end boiling point of 195 or 205°C), light (195 - 310°C) and heavy gas oil (310 - 420°C) and slop containing catalytic dust (fr.> 420 C) are products of C-200 section. Wet gas and unstable gasoline from section C-200 is directed to the C-300 section, where gasoline stabilization, gas cleaning and gas separation to formation a propane-propylene and butane-butylene fraction and stable gasoline occur.

The cracking of vacuum distillate hydrocarbons occurs on the surface of the zeolite powdered catalyst in a riser reactor with continuous regeneration of the coked catalyst [21, 22].

The process conditions of the reactor-regenerator block of C-200 section KT-1/1 unit are shown in Table 1.

Table 1. Process conditions of the reactor-regenerator block of catalytic cracking unit.

Parameter of process conditions	Value
Consumption of feedstock, m3/h	160-420
Temperature of feedstock, °C	240-350
Steam consumption in the reaction zone, kg/h	2000-14000
Steam consumption in the desorber top, kg/h	No less than 1400
Steam consumption in the middle part of desorber, kg/h	No less than 360
Steam consumption in the desorber bottom, kg/h	No less than 360
Process temperature, °C	495-535
Pressure, Pa	78453,2-156906
Temperature of the regenerated catalyst, °C	630-700
Catalyst/feedstock ratio, tonnecat/tonnefeed	5-9

Process conditions of riser reactor can vary significantly depending on the required yield of wet gas, gasoline and diesel fractions, types of catalysts and characteristics of the feedstock.

3. Approaches and methods

Group composition of two samples of vacuum distillate from Kazakhstan and West Siberian was determined by gas-adsorption chromatography as described in VNII NP [23].