OPINION

by Prof. Dr. Magdalena Sabeva Mitkova

regarding the dissertation work of Master Eng. Vasil Kotsev Yankov

author of a dissertation on the topic: "Dependence of the action of the processes "Hydrocracking of heavy vacuum gas oil H-Oil" and "Catalytic cracking of vacuum gas oil" on the properties of the raw material and the hardness of the regime in H-Oil"

Pursuant to Order No. UD-257 dated 27.09.2022 of the Rector of the University "Prof. Dr. Asen Zlatarov" I have been designated as a member of the scientific jury, and according to order No. UD-282 of 18.10.2022, allocating the activities of the scientific jury, it is necessary to draw up an opinion on the dissertation work presented by Master Eng. Vasil Kotsev Yankov on obtaining an educational and scientific degree "doctor" in the scientific specialty "Technology of natural and synthetic fuels", code 02.10.23, professional qualification 5.10. Chemical technologies, field of higher education 5. Technical sciences on the topic "Dependence of the action of the processes "Hydrocracking of heavy vacuum gas oil H-Oil" and "Catalytic cracking of vacuum gas oil" on the properties of the raw material and the hardness of the regime in H-Oil".

Presented by Master Eng. Vasil Kotsev Yankov set of documents is in accordance with Art. 30 (1) of the Regulations for the Implementation of the Law on the Development of the Academic Staff in the Republic of Bulgaria and Art. 42 of the Regulations for the Terms and Procedures for Acquiring Scientific Degrees and Holding Academic Positions at the University "Prof . Dr. Asen Zlatarov", Burgas.

The dissertation contains 165 pages, 52 figures and 28 tables. 286 literary sources are indicated.

The topic of the dissertation is extremely relevant for modern oil refining, because the fluidized bed hydrocracking process has gained great importance due to the reduced demand for heavy oil products, the increasing share of heavy oil types undergoing processing and the increasing requirements for fuel quality and environmental protection.

The aim of the dissertation is to study the dependence of the reactivity and rate of sediment formation in the hydrocracking process of heavy vacuum gas oil H-Oil on the properties of heavy vacuum gas oil of different origin and the hardness of the regime, as well as the joint action of a solid catalyst on a carrier and a liquid nanocatalyst on the results of the operation of the industrial plant for heavy vacuum gas oil H-Oil hydrocracking and fluid-type catalytic cracking and the hardness of their operating modes. The aim is also extended by researching the reactivity of vacuum gas oils obtained from the heavy vacuum gas oil H-Oil hydrocracking process and fluid-type catalytic cracking in the processing of heavy vacuum gas oil from different types of oil.

As a result of a large-scale and precisely conducted experiment, it was found that the reactivity and the tendency to form sediments during fluidized bed hydrocracking of the H-Oil catalyst of heavy vacuum gas oil originating from 26 different types of oil depend on their density, the content of sulfur, nitrogen and asphaltenes. At the same time, it was found that increasing the density and sulfur content lowered the tendency of the tar to form sediment. Increasing the regime stiffness in the H-Oil fluidized bed tar hydrocracking plant by increasing the reaction time results in higher conversion and lower sediment content in the residual hydrocracked fractions. Research confirms that asphaltenes are a major cause of sediment formation in hydrocracked residual fractions of H-Oil, and as they increase, sediment formation increases linearly.

When using a nano-disperse catalyst containing molybdenum, sediment formation in the atmospheric residue is reduced, allowing an increase in the reaction temperature and hence the hydrocracking conversion of H-Oil tar. Increasing the reaction temperature during hydrocracking in a pseudo-fluidized bed with the H-Oil catalyst leads to an increase in aromatic components in gas oils. A contribution to world practice is the finding that the reactivity of heavy oil fractions from " Heavy vacuum gas oil H-Oil Hydrocracking" correlates with their 50% boiling point (T50%). These fractions have a higher nitrogen and aromatic content than the heavy oil fractions of primary origin, which suggests a low reactivity and a tendency to form coke in their catalytic cracking. Heavy oil fractions with the highest content of condensed aromatic structures and with high density accelerate catalyst deactivation due to coke formation in catalytic cracking.

It was found that the reason for the variation in the reactivity of the H-Oil vacuum gas oils is the different quality of the feedstock processed in the H-Oil fluidized bed heavy vacuum gas oil hydrocracking plant.

The presented dissertation has scientific and scientific-applied contributions expressed in the following:

- ✓ The derived regression equation that describes the dependence between the reactivity and the properties of the raw material for hydrocracking H-Oil can be used to evaluate the economic efficiency of the processing of new, alternative types of oil and their mixtures from the Lukoil Neftohim Burgas refinery. This dependence can be used for daily monitoring and evaluation of the reactivity of the hydrocracking feedstock, which allows to predict and optimize the technological regime of the H-Oil tar hydrocracking plant.
- ✓ Revealing the influence of the quality of the raw material and its reactivity, as well as the hardness of the regime, expressed by the reaction time and

temperature, on the sediment formation in the hydrocracking of K-Oil heavy vacuum gas oil allows to timely and correctly manage the sediment content, which is the main and most - a difficult to control indicator of the quality of commodity boiler fuel.

- ✓ Establishing the influence of regime stiffness in the H-Oil heavy vacuum gas oil hydrocracking plant on the yield and quality of the gas fractions, which are feedstocks for catalytic cracking, allows predicting the behavior of the catalytic cracking plant and optimizing the joint action of the two economic the most effective processes for deep processing Hydrocracking and Catalytic cracking.

5 articles with Impact Factor were published on the dissertation work, 18 citations were noticed.

The abstract is compiled according to the requirements.

In conclusion, I can summarize that the presented doctoral work contains scientific and scientific-applied results, the candidate acquired in the course of the work in-depth theoretical knowledge of the specialty and the ability for independent scientific research, as well as for team work, which allows me to vote with conviction FOR awarding the educational and scientific degree "Doctor" to Master Eng. Vasil Kotsev Yankov.

November 18, 2022

Signature: Подпис заличен Чл.2 от ЗЗЛД

(Prof. Dr. Magdalena Mitkova)