OPINION

Of dissertation for the acquisition of educational and science degree "DOCTOR"

Scientific field: 5. Technical sciences
Professional field: 5.10. Chemical technologies
Scientific specialty: Technology of natural and synthetic fuels
Author of the dissertation: mag. eng. Ivan Petrov Petrov
Topic of the dissertation: "Impact of the H-Oil heavy oil residue hydrocracking process on the passing of other oil refining processes in a modern oil refinery (LUKOIL NEFTOCHIM BURGAS AD)"
Member of the scientific jury: assoc. prof. PhD eng. Todor Vasilev Palichev

1. STRUCTURE AND RELEVANCE

The thesis submitted to me for opinion for the acquisition of educational and science degree "DOCTOR" is written on 169 pages and contains 66 figures, 39 tables and a bibliography of 315 reference sources. The work includes: introduction 2 pages, literature review 44 pages, experimental part 19 pages, results and discussion 75 pages, conclusions 2 pages and contributions 1 page. The dissertation is prepared according to the requirements and traditions of this field and covers the scientometric the requirements.

The abstract is very well designed and correctly reflects the results of the research.

The list of publications includes articles in full text in specialized magazines with an impact factor and an Internet edition - a total of 8 nos. The candidate is the first author in 1 article, the third author - in 4 and the fourth - in 3. The co-authorship with the scientific supervisors and other researchers shows the importance of the conducted research, both from a scientific and a practical point of view.

In 2015, the H-Oil heavy oil residue hydrocracking complex was put into operation at LUKOIL Neftochim Burgas AD. Along with mastering the H-Oil fluidized bed heavy oil residue hydrocracking technology, the quality of the resulting products as a function of feedstock type, catalyst properties, and applied process operating conditions had to be investigated. These data, together with the data on the amount of products produced, are extremely important for evaluating the impact of the hydrocracking process of residual oil fractions on the other processes involved in the technological scheme of an oil refinery. In this regard, the topic of the dissertation and the conducted research are extremely relevant from a scientific and applied point of view.

2. LITERATURE REVIEW

In the literature review, the PhD student very well describes the theoretical foundations of the hydrocracking and catalytic cracking processes, their varieties, the types of catalysts, the types of industrial installations, the influence of the type of raw material and the technological parameters on the ongoing physicochemical processes. Attention is also paid to the quality of the secondary oil fractions of gasoline, diesel and vacuum gas oil, obtained during the conversion of vacuum oil residues.

Through the literature review, the PhD student found that there is no information in the literature about the quantity and quality of the products obtained during the processing of different raw materials and at different hardness of the regime in an industrial installation for hydrocracking of heavy oil residue with a pseudo-fluidized bed of the catalyst. No information was also found on the effect of the type of oil being processed in a refinery, the properties of the catalysts, and the properties of the vacuum gas oils from the hydrocracking of pseudo-fluidized bed heavy oil residue on the performance of the industrial "Catalytic Cracking" plant. There is a paucity of literature on the oil desalination and dewatering process where emphasis is placed on the extent of sodium removal, which is a strong catalytic poison for both the solid catalyst and the nanodispersed molybdenum-containing liquid catalyst.

As a result of the findings and conclusions from the literature review, the PhD student sets the following goal: To evaluate the impact of the hydrocracking process of H-Oil heavy oil residue, included in the oil processing scheme in the refinery of "LUKOIL Neftohim Burgas" AD (LNB) on the passing of the other processes, involved in the technological scheme of the refinery.

3. EXPERIMENTAL

The PhD student analyzed the technological scheme of the LUKOIL Neftochim Burgas refinery. The thermocatalytic plants, namely "H-Oil hydrocracking", "Catalytic cracking", "Catalytic reforming" and "Hydrotreating plant of primary and secondary diesel fractions" are presented and analyzed separately. The flow chart is shown and the "Crude Desalination Section" in the atmospheric distillation plant is examined. The methods used for the characterization of oil derivatives are shown.

4. RESULTS

It has been shown that the Kw-characterizing factor of the mixed heavy oil residue feedstock increases as the amount of catalytic cracking sludge and recycle from partially blended boiler fuel decreases.

The properties of the unconverted residue from the catalyst fluidized bed heavy oil residue hydrocracking process (density, Conradson carbon, viscosity, and softening temperature) were found to correlate with the Kw-characterization factor of the blended tar feedstock.

The Kw-characterizing factor of the vacuum gasoil from the pseudo-fluidized bed heavy oil residue hydrocracking process increases as the amount of feedstock processed increases, as the reaction temperature decreases and the amount of catalytic cracking sludge and partially blended boiler fuel recycle in the process feedstock decreases tar hydrocracking.

The influence of the raw material and the mode of the hydrocracking process on the cetane index of the obtained diesel fraction was also investigated and it was found that it increases with an increase in the amount of processed raw material, with a decrease in the reaction temperature and a decrease in the amount of sludge from catalytic cracking in the mixed feedstock.

When studying the operation of the "Catalytic Cracking Installation" with raw material containing vacuum gas oil from the process of hydrocracking of heavy oil residue, it was found that the higher the content of vacuum gas oil and the lower its Kw-characterizing factor, the lower the conversion.

Regarding catalytic cracking catalysts, the PhD student found that catalysts with the highest content of rare earth oxides (RE_2O_3) were the most active and most coke-selective in the processing of

vacuum gasoils containing vacuum gasoil from heavy oil residue hydrocracking. The higher the RE_2O_3 content of the catalyst, the higher the conversion; the lower the content of alkenes in the propane-butane fraction; the lower the content of naphthenes and the higher the content of arene hydrocarbons in gasoline.

One of the catalysts studied in this dissertation is catalyst D. Research has shown that it shows a weaker dependence of the catalytic cracking process performance upon changing the composition of the feedstock by adding vacuum gasoil from heavy oil residue hydrocracking.

It was found that the most active and selective Δ coke catalyst can provide higher conversion in an industrial catalytic cracking plant regardless of the lower catalyst/feed ratio resulting from the higher Δ coke if the plant does not limited by reaching the maximum allowable temperatures in the regenerator.

When investigating the possibility of controlling the level of Na in the unit for the primary distillation of oil, it was proven that the replacement of NaOH with organic nitrogen compounds with alkaline properties, in order to reduce the sodium content of the feedstock for the heavy oil residue hydrocracking process, caused poisoning of the catalytic "Catalytic reforming" installation system with basic nitrogen, deactivates the catalyst and lowers the octane number of the reformer. The sodium content above 20 ppm in the heavy oil residue accelerates the deactivation of the solid catalyst and prevents the use of liquid nanodispersed HCAT catalyst in the heavy oil residue hydrocracking process. Its removal depends on the operation of the crude oil desalination unit and the cost of injecting caustic soda into the desalted crude oil.

5. CONTRIBUTIONS

The results of the PhD student's research have scientific and applied contributions, which can be summarized in two directions, as follows:

- The composition and properties of the catalyst for catalytic cracking were optimized in the processing of raw materials of different quantity and quality of vacuum gas oil from hydrocracking.
- The operation of the oil desalination and dewatering unit has been improved and the sodium content of the tar has been minimized below 20 ppm.

The contributions in the dissertation are of great scientific and practical value and their use contributes to the realization of a significant economic effect in "Lukoil Neftochim Burgas".

5. TECHNICAL DESIGN, RECOMMENDATIONS, AND NOTES

The thesis is very well laid out. There are no spelling and punctuation errors. In places, names outside the IUAPAC nomenclature are used, but the names used are extremely popular in practice.

A large number of experiments, both laboratory and industrial, have been carried out. Despite the difficulties in conducting industrial experiments, the doctoral student managed to collect very valuable information from a scientific and practical point of view. The experimental data are very well analyzed and relevant conclusions are drawn.

The dissertation impresses me with the volume, the quality of the experimental work performed and the analysis of the results. The PhD student successfully coped with his tasks, showed a very good knowledge of the primary and secondary processes in oil processing, which he successfully applied in the development of the dissertation work.

6. CONCLUSION

In terms of volume, quality and achieved scientometric indicators, the dissertation work fully meets the requirements of Law on the development of academic staff and the Regulations for the acquisition of scientific degrees and holding academic positions at the University "Prof. Asen Zlatarov"- Burgas. These findings and the contributions of the dissertation give me reason to confidently propose to the Honorable Scientific Jury to award Master Eng. Ivan Petrov Petrov the educational and scientific degree "Doctor" in the scientific specialty "Technology of Natural and Synthetic Fuels".

Подпис заличен
Чл.2 от ЗЗЛД

Burgas, november 2022

Signature:
/Assoc. Prof. PhD Todor Palichev/