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Karpukhin A. K.

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk)

The Central Volga Research Institute on Petroleum Refining: Achievements of Science for the Benefit of Production

Abstract. In 2023, the Middle Volga Research Institute for Oil Refining (SvNIINP) turns 65 years old. All these years, the staff of the institute has been solving complex problems facing the industry, forming scientific ideas, developing modern technologies for producing high-quality petroleum products, lubricants, additives and bitumen. The starting point in the recent history of the institute can be considered 2007, when it entered the structure of PJSC NK Rosneft. The directions of scientific and technological activity of the institute were set by the Company's Innovative Development Program, aimed at the creation and implementation of modern technologies at refineries and gaining a leading position both in the Russian market and in the export supply of petroleum products.

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Sheykina N. A.

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk)

Innovative Achievements and Developments of JSC “MidVolgaNIINP”, Implemented and Planned for Implementation

Keywords: research institute; innovative development; target innovative project; import substitution; oil refining and petrochemical products; implementation.

Abstract. JSC “MidVolgaNIINP” (Middle Volga Research Institute for Oil Refining) carries out its innovative activities in the direction of “Science in oil refining and petrochemistry” as part of a complex of research and design institutes of Rosneft. Institute specialists conduct scientific research in the field of development of lubricants, additive packages for oils and fuels, production of oil bitumen and processing of heavy oil residues. The priority direction of scientific and technical activity of the Institute is the import substitution of lubricants and additives to them.

This article presents the results of the scientific activities of the Institute in connection with the 65th anniversary of its foundation. The main long-term tasks requiring solutions and the state of the scientific potential of the institute are considered.

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Radchenko L. A.¹, Morshanskaya Yu. A.¹, Beskova A. V.¹, Zhumlyakova M. A.¹, Leimeter T. D.²

(¹ JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk;

² LLC “Rosneft-Lubricants”, Ryazan)

Experience in Developing Domestic Packages of Additives to Hydraulic Oils for Industrial Equipment and Machinery

Keywords: additive package; hydraulic oils; qualification tests; test tests; approval of OEM.

Abstract. Based on many years of experience and scientific school in the field of hydraulic oil development, the specialists of JSC “MidVolgaNIINP” in 2016 developed a package of additives PH-II-ИГС for hydraulic oils of the HLP level, in 2018 — a package of additives PH-AP-4.001 for all-season hydraulic oils of the HVLP level. The developed additive packages have passed qualification tests for compliance with the requirements of the international standard DIN 51524 with positive results and have

been approved by the world's leading manufacturers of hydraulic equipment from Danieli and Bosch Rexroth. Currently, JSC "MidVolgaNIINP" produces a package of additives for hydraulic oils of the HLP and HVLP levels, which in 2021 was recognized as one of the "100 best goods in Russia" and is used in the lines of Rosneft Gidrotec HLP, HVLP and ИГП oil lines.

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Dimitrieva N. V.¹, Gavrilova I. A.¹, Voronina A. V.¹, Kulikova I. A.¹, Sheikina N. A.¹, Tyshchenko V. A.²

¹ JSC "Middle Volga Oil Refining Research Institute" (JSC "MidVolgaNIINP"), Novokuibyshevsk;

² Samara State Technical University, Samara)

Development of the Composition and Technology for Obtaining a Synthetic Component of the Basis of Hydraulic Oils for Special Equipment

Keywords: hydraulic oil; synthetic component of the oil base; hydrogenation of ditolylmethane; cycloalkane hydrocarbons; oxidative stability; guaranteed shelf life and operation; production technology.

Abstract. The rapid development of technology, the creation of promising products with characteristics corresponding to or exceeding the characteristics of the best world analogues, dictate the need to create a new level of quality oils — synthetic. The advantages of synthetic-based oils are excellent viscosity-temperature characteristics, good low-temperature fluidity, high anticorrosive properties, as well as increased thermal-oxidative stability, compatibility with materials. Since synthetic oils are chemically stable, they retain their original characteristics longer under adverse operating conditions. Other advantages of synthetic oils include increased resistance to shear deformations (due to the uniformity of the structure), high dispersing ability, fire resistance, chemical inertia and non-toxicity. It is also important that the synthetic base requires the introduction of a minimum amount of thickening additives. In addition, their resource significantly exceeds the resource of petroleum oils of a similar purpose. Among the numerous lubricants, a special place is given to low-viscosity hydraulic oils used in autonomous hydraulic drives of special equipment. The use of a basic synthetic base makes it possible to increase the guarantees of the shelf life and operation of hydraulic oil in products and ensure a quality preservation resource for 20 years or more.

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Tyukilina P. M.¹, Pleshakova N. A.¹, Markova M. G.¹, Kulikov I. V.¹, Ovsyannikov S. Yu.¹, Tulchinsky M. E.¹, Fedorov I. I.¹, Trusov O. A.²

¹ JSC "Middle Volga Oil Refining Research Institute" (JSC "MidVolgaNIINP"), Novokuybyshevsk; ² PJSC "Rosneft Oil Company", Moscow)

Development of Engineering and Technological Support of Oil Refining Processes

Keywords: engineering and technological support; monitoring of oil refining processes; key performance indicators; chemical and technological protection of equipment; oil refining catalysts; recycling water supply system.

Abstract. The approach to engineering and technological support of oil refining processes at the refineries of PJSC "Rosneft Oil Company" is described. The results of technological monitoring of the main processes of oil refining are presented: atmospheric-vacuum distillation, reforming, isomerization, hydrotreating, catalytic cracking, visbreaking, delayed coking, production of elemental sulfur, bitumen production, as well as chemical and technological protection of equipment of installations, stabilization treatment of recycled water on local and centralized systems of recycled water supply of oil refineries. The given examples of completed tasks have shown the high efficiency of the built system of engineering and technological support in ensuring the operational, energy and economic efficiency of oil refining.

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Tyukilina P. M.¹, Markova M. G.¹, Kirillova E. V.¹, Trusov O. A.², Chernobrovin K. A.², Boldinov V. A.²

¹JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk;

²PJSC “Rosneft Oil Company”, Moscow)

Evaluation of the Reactivation Efficiency of Hydrotreating Catalysts

Keywords: hydrotreating of diesel fractions; hydrotreating of vacuum gas oil; hydrotreating catalysts; regeneration of catalysts; reactivation of catalysts; activity; stability.

Abstract. Tests of diesel fuel hydrotreating catalysts have been carried out, which have passed the reactivation procedure according to the technology developed by JSC “all-Russian Oil Refining Research Institute”. The efficiency of the reactivation technology was evaluated of catalysts for hydrotreating diesel fuels and vacuum gas oil. Based on a comprehensive analysis of the physico-chemical and catalytic properties of regenerated, reactivated and fresh hydrotreating catalysts, the dynamics of changes in the operating characteristics of catalysts is investigated. The results obtained at the pilot plant were confirmed during an industrial run at the L-24/7 hydrotreating plant of JSC “Syzran Oil Refinery”. The presented results demonstrate the high activity and stability of reactivated catalytic systems in the process of hydrotreating diesel fuel and vacuum gas oil, in comparison with the results of operation of fresh catalysts of similar brands. We confirm the results of monitoring the operation of reactivated catalytic systems at an industrial technological installation.

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Zanozina I. I., Babintseva M. V., Garina N. Yu., Zanozin I. Yu., Karpukhin A. K.

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk)

Oil is an Object of Research. Analytical Solutions

Keywords: oil, oil fractions, analytical support, scientific school, complex physico-chemical studies, chromatography, metrological support, interlaboratory comparative tests.

Abstract. The historically developed integrated approach is shown when conducting scientific, technical and research work in the field of studying petroleum raw materials and target fractions using physical and various methods of analytical chemistry, metrologically secured, which allows forming a database as a basis for certification of oil fields, in technical and economic calculations when designing new technological installations and productions. To this day, the Institute continues to develop and improve the scientific school of analytical support for the processes of oil production, refining and petrochemistry, which began in the 70s of the last century.

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Baklan N. S.¹, Timofeeva G. V.¹, Nosova E. V.¹, Khoroshev Yu. N.², Luksha S. V.², Guniakova O. V.²

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk;

²LTD “Novokuibyshevsk Oils and Additives Plant”, Novokuibyshevsk)

Investigation of New Macroporous Catalysts in the Process of Phenol Alkylation by Ethylene Oligomers

Keywords: sulfocationites; alkylation; phenol; ethylene oligomers; laboratory studies.

Abstract. The features of phenol alkylation by higher alpha-olefins in order to obtain mono-substituted alkylphenols (*o*-AF and *p*-AF) using commercial industrial samples of sulfocationites: Hydrolite ZG CD552, ND-102 and the line of catalysts Purolite CT275DR/4503, CT275DR/4883, CT151DR, CT169DR, which belong to macroporous and are in different price categories. A feature of these cationites is a particularly strong matrix of regularly cross-linked divinylbenzene styrene copolymer. The structure of the granules combines the increased rigidity of the polymer mesh with a highly developed surface of the pores for exchange, which provides a large concentration of available exchange groups and high diffusion permeability of the granules.

A comparative analysis of the catalytic activity of alkylation catalysts was carried out, which showed that, despite the high activity of all the studied catalysts in the reaction of alkylation of phenol with ethylene oligomers (OE) of the C₁₆...C₁₈ fraction, most of the studied catalysts showed low thermal stability and showed a tendency to rapid mechanical destruction.

During the research, optimal technological parameters for each catalyst were established, including temperature and molar ratio of reagents, providing maximum yields of the target monoalkylphenol at the level of 97–98%.

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Alekhin V. S., Tsederbaum V. G., Pershin A. B.

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk)

Extraction of Phenol from Phenolcontaining Waters when Using Extractants

Keywords: methyltretamyl ether; phenol; diisopropyl ether; methyl *tert*-butyl ether.

Abstract. Phenol and its derivatives are among the most dangerous pollutants entering the environment as part of wastewater from oil refineries and petrochemical plants, as well as pharmaceutical industry and construction materials. In surface water bodies, phenols occur in the form of their derivative (free phenols, phenolate ions and phenolates). The listed compounds have different degrees of toxicity, forming humus-like compounds as a result of polymerization and condensation reactions. For this reason, the treatment of phenolic wastewater is a very urgent problem in the petrochemical industry due to the high carcinogenicity of these impurities. Deep purification of water effluents is complicated by the fact that none of the known methods of removing phenols can achieve, with relatively acceptable technical and economic indicators, the required degree of purification.

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Pozdnyakov V. V., Lipatova V. M., Egorov A. G., Tyukilina P. M.

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuibyshevsk)

The Possibility of Obtaining Promising Road Bitumenes of PG Grades under the Conditions of the Project for the Installation of AVT-6 PJSC “Bashneft-Ufaneftekhim”

Keywords: oxidized petroleum road bitumen; heavy oil residues; processing depth; heavy oil.

Abstract. The article investigates possible options for processing heavy oils entering refineries separately or when they are processed together with the oils of West Siberian deposits according to the bitumen profile. It is shown that the production of demanded unmodified grades of road bitumen PG 64-28 and PG 58-34 according to GOST R 58400.1 in the conditions of weighting of crude oil during the implementation of the ELOU-AVT-6 installation project at Bashneft-Ufaneftekhim, it is possible if measures are taken to compensate for the deficit in paraffin-naphthenic and aromatic compounds. For the production of these PG grades, an increased introduction of the TVG of this installation is required (from 25 to 40 %), however, it will not require the use of the TVG from AVT, which are in demand for oil

production, processing mainly oil from West Siberian fields, or plasticizing components from the oil production complex (selective purification extracts).

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Pozdnyakov V. V.¹, Parshukova O. R.¹, Rodina N. A.¹, Tyukilina P. M.¹, Solov'ev R. E.²

(¹JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuibyshevsk;

²PJSC “Rosneft Oil Company”, Moscow)

Obtaining Modern Brands of Road Bitumen in the Conditions of Deepening Oil Refining at the JSC “SNPZ”

Keywords: heavy oil residues; processing depth; oxidized petroleum road bitumen.

Abstract. The results of studies of oxidized road bitumen according to GOST 33133 and GOST R 58400.1 obtained from tars of JSC “Syzran Refinery” of different viscosities of 100, 150 and 200 seconds under conditions of deepening oil refining achieved at the enterprise for the period 2019–2022 are presented. It is shown that the production of road bitumen with the required level of properties under conditions of weighting of petroleum raw materials is possible with the implementation of measures that help compensate for the shortage of paraffin-naphthenic and aromatic compounds, however, the quality reserve of the resulting binders decreases.

It has been established that the involvement of light oils of the Orenburg deposits type and, especially, gas condensates in the processing of West Siberian fields into oil at AVT leads to a deterioration in the low-temperature properties of both standard oxidized road bitumen produced according to GOST 33133 (tensility at 0°C, brittleness temperature) and new bitumen materials according to GOST R 58400.1–2019.

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Zanozina I. I., Babintseva M. V., Garina N. Yu., Zanozin I. Yu., Kuznetsov V. G., Karpukhin A. K.

(JSC “Middle Volga Oil Refining Research Institute” (JSC “MidVolgaNIINP”), Novokuybyshevsk)

Physical-chemical Characteristics of Oil Samples of the Tagulskoye Field

Keywords: oil, high-viscosity oil; oil fractions, distillation; rectification; sulfur compounds; paraffins; pour point.

Abstract. The article presents the data of a comprehensive study of three samples of high-viscosity borehole oil of the Tagulskoye field. Using the instrumentation and methodological base of JSC “MidVolgaNIINP”, information was obtained on the composition and properties of samples of high-viscosity oil (HVO) after preliminary dehydration and desalination, as well as oil distillate fractions and residues from distillation obtained in laboratory conditions according to GOST 11011, ASTM D2892/5236. In addition, it is shown that the objects of the study have valuable properties: a low content of total sulfur, a low content of paraffins and a fairly low pour point for heavy oils. The authors have proposed options for further use of the studied objects.

In general, valuable basic information has been obtained for the long-term planning of production and the choice of options for the use or processing of unique raw materials.