РИНЦ #2-2023
JSC “MidVolgaNIINP” 65 years

CHEMISTRY AND TECHNOLOGIES OF OIL-REFINING

Lavrova A. S.[1,2], **Bessonov V. V.**[1,2], **Plehno N. N.**[2], **Golovachev V. A.**[1], **Korovchenko P. A.**[1], **Vasil’ev V. V.**[3]
([1] LLC Gazpromneft — Industrial Innovations, Saint Petersburg; [2] Saint Petersburg State Institute of Technology, Saint Petersburg; [3] Saint Petersburg State University of Economics, Saint Petersburg)
E-mail: Lavrova.AS@gazprom-neft.ru

Catalytic Cracking Heavy Gas Oil Thermolysis

Keywords: thermolysis; heavy crude oil; thermal cracking; X-ray diffraction analysis method.

Abstract. The article discusses the process of thermolysis of heavy gas oil of catalytic cracking KT-1/1 “Gazpromneft-ONPZ JSC”. Trends in the group composition of the thermolysis residue detected by IR spectroscopy and X-ray diffraction analysis method are presented.

PETROCHEMISTRY: TECHNOLOGY, PROCESSES

Fitch J.
(Noria Corporation, USA)

The Wrath of Unscheduled Downtime: Why Oil Analysis is a Wise and Effective Defense

Abstract. Causes and consequences of unscheduled downtime are described. Statistical data on failure detectability using different diagnostic techniques are presented. The correlation between failure detection and the cumulative damage and cost to production is analysed. The advantages and capabilities of oil analysis for early failure detection are formulated.

Naghiyeva M. V., Rasulov Ch. K., Salmanova Ch. K., Aliyeva K. Sh.
(Institute of Petrochemical Processes of the Ministry of Education and Science of Azerbaijan, Baku)
E-mail: mehri.nagieva@mail.ru

Catalytic Cycloalkylation of 4-hydroxyphenylpropionic Acid Methyl Ester with Methylcycloalkenes

Keywords: methyl ester of 4-hydroxyphenylpropionic acid; methylcycloalkenes; catalyst; *o*-cycloalkylation; hindered phenols; stabilizer.

Abstract. Research has been carried out in the field of catalytic cycloalkylation of phenol derivatives. In the course of research, the method for the synthesis of hindered phenols was developed by cycloalkylation of 4-hydroxyphenylpropionic acid methyl ester with 1-methylcyclopentene, 1- and 3-methylcyclohexenes in the presence of a KU-23 cation exchanger catalyst. The influence of different kinetic parameters (temperature, time of the reaction, molar ratio of the initial components, amount of catalyst) on the yield and selectivity of the target product was determined, thereby determining the optimal process mode. It has been established that at low temperatures (60–80°C) of the reaction of cycloalkylation of phenol with 1(3)-methylcycloalkenes in the presence of a KU-23 catalyst, *o*-alkylation of phenol is observed, with the formation of alkylphenyl ethers. With an increase in the temperature of the cycloalkylation reaction, the concentration of alkylphenyl ethers gradually decreases, and the alkyl

substituent migrates to the ortho position (Claisen rearrangement). The optimal conditions for the reaction of cycloalkylation of methyl ester of 4-hydroxyphenylpropionic acid with methylcyclenes are: temperature 90–110°C, reaction time 5-5.5 h, molar ratio of ether to cyclene 1:1, amount of catalyst — 10% per taken ether. Under these conditions, the yield of target products is 68.7–79.5% of theory per taken ether, and the selectivity is 93.4–97.3% for the target product.
The structure and composition of the products of the cycloalkylation reaction were confirmed by spectral and chromatographic methods of analysis.
Synthesized methyl esters of 3-mono-cycloalkyl-substituted 4-hydroxyphenylpropionic acid were tested as stabilizers for polyurethane polymer, the tests gave positive results.

Keywords: phenol; 3-methylcyclohexene; cycloalkylation; *p*-(3-methylcyclohexyl)phenol; acetic acid; benzoyl chloride; catalyst; acylation; acetophenone; benzophenone.

Abstract. The results of studying of the cycloalkylation reaction of phenol with 3-methylcyclohexene in the presence of zeolite Y impregnated with phosphoric acid are presented. It was found that in order to achieve a high yield (71.2%) and selectivity (93.7%) during the cycloalkylation reaction of phenol with 3-methylcyclohexene, the reaction conditions should be as follows: reaction temperature 120 °C, molar ratio of phenol to 3-methylcyclohexene 1:1, volume velocity 0.5 h^{-1}. The results of the synthesis of 2-hydroxy-5(3-methylcyclohexyl)aceto- and benzophenones by the reaction of *p*-(3-methylcyclohexyl)phenol with acetic acid (AcOH) and benzoyl chloride (BzCl) with the participation of nanosized $ZnCl_2$ as a catalyst are presented. It was found that at a temperature of 140 °C, a reaction time of 40 minutes, and a molar ratio of p-(3-methylcyclohexyl)phenol to AcOH (BzCl) of 1:2, the yield of the target products was 63.3–66.7%.

Keywords: cracking; slurry catalyst; spent hydrotreating catalyst; fuel oil; heavy oil residues.

Abstract. An urgent task of the oil refining industry is the development of a thermodestructive process for the processing of heavy oil residues. This paper presents the results of a study of thermal cracking of fuel oil in the presence of aluminocobaltmolybdenum regenerated spent hydrotreating catalyst. The experiments were carried out using an autoclave, as well as using a number of instrumental methods of analysis. The effect of the degree of dispersity and catalyst content on the results of the process under study was studied. The material balance of the thermal cracking process in the presence of catalyst samples of different fractional composition is compared with the material balance of thermal cracking in the temperature range of 450–470 °C. The physical and chemical properties of the samples of catalysts, raw materials and products of the process were determined. The analysis of the obtained experimental data was carried out, the conditions for the most efficient processing of raw materials in the process of thermal cracking in the presence of a catalyst were determined, and conclusions were drawn about the prospects for its use for processing heavy oil residues.

Keywords: carbon emissions; combustion; oxygen; hydrocarbon gas; carbon footprint; technical and economic assessment.

Abstract. In the article, the authors solve the problem of urgent search for effective and affordable (in the short and medium perspective) technological solutions for oil and gas processing, petrochemical enterprises to reduce gross (total) emissions of carbon dioxide (CO_2) and related combustion products that fall under the definition of greenhouse gases nitrogen oxides (NO_x and N_2O) from combustion. The subject of the consideration in this article is the process of burning hydrocarbon fuel, and the object of consideration is a typical fire heater — a vertical cylindrical tubular furnace.

Keywords: xanthates; ditiocarbamates; extreme pressure additives; gear oil (transmission oil); tribological properties.

Abstract. The synthesis of a new synthon of 2-butoxymethoxy-1-bromo-3-chloropropane is described, on the basis of which a number of new derivatives of 2-butoxymethoxypropylene-3-chlorobutyl xanthate, diethyldithiocarbamate and thiocyanate containing an ether group in the molecule are obtained. The synthesized compounds were studied as extreme pressure additives in MS-20 oil on a four-ball friction machine (FFM). Research results have shown that these compounds have high extreme pressure properties. The dependence of the antiseize efficiency of the obtained compounds on their composition and structure was revealed. The relationship between the extreme pressure efficiency of the obtained compounds with their composition and structure was revealed. It has been established that with the introduction of a simple ether group ($–OCH_2OC_4H_9$), the tribological properties of these compounds are improved. The structure of 2-butoxymethoxypropylene-2-chloroxanthogenate, diethylditiocarbamate and thiocyanates derivatives has been proven by determining their physicochemical characteristics, elemental analysis, and also by IR spectroscopy data.

Keywords: additives; lubricants; alkylphenol.

Abstract. The lubricant additives market has sufficiently high requirements for the quality and cost of products. The most crucial component of the modern motor oils is detergent-dispersing additives. Specialists draw special attention to the analysis of available technologies and breakthroughs in order to identify opportunities for enhancement additive manufacturing technologies. Ultra-alkaline alkylphenol additives have been showing high performance in various operating modes for many years, and this is exactly what corresponds to the nowadays' requirements. Particular attention should be drawn to the feedstock accessibility. The primary goal is to find optimal industrial-scale conditions for the synthesis of alkylphenol and to obtain alkylphenol salts with a selected metal cation that will comply with operational conditions.

Pp. 56–59

Lashkhi V. L., Chudinovskikh A. L.
(JSC firm "NAMI-CHEM", Moscow)

Chemmotological Evaluation of Oils and Additives

Keywords: oils; additives to oils; a set of methods; modeling; modeling installations; qualification assessment.

Abstract. Preliminary evaluation of oils and additives, when creating a working composition, is extremely relevant. This allows you to significantly reduce the time for development and, quite objectively, recommend the created samples for further engine bench tests. The article deals with the general aspects and directions of chemmotological evaluation of oils for automotive engineering.