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PETROLEUM PRODUCTS: TECHNOLOGY, INNOVATION, MARKET

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Dubrovskiy D.A., Dyachkova S.G., Semenov I.A.,
Kuzora I.E., Starikova O.V., Artem'eva Z.N., Ganina A.A.
Expansion of the range of additives for the base fuel of Angarsk Petrochemical Company. Problems and prospects **4-13**

*Keywords***:** disiel fuels, additives, import substitution, cetane-increasing additives, depressant-dispersing additives, antiwear additives, staging on the product.

Abstract. The shortcomings of the existing system of production launch of new products using additives for various functions have been identified including the one on account of the regulatory level. Physical and chemical studies of cetane boost additives for diesel fuels have been conducted. It is shown that the main component of most cetane boost additives is 2-ethylhexyl nitrate. Our tests of samples of imported and domestic additives based on 2-ethylhexyl nitrate showed similar results as for the increase of cetane number to the initial number of the basis of EURO diesel fuel of Class 2. It is proposed to allow a fuel manufacturer to make his own decision whether there is a necessity to conduct additional qualification tests while having full data on physicochemical properties, composition of the of cetane boost additives and their chemmotology effects on fuel. The work carried out has made it possible to reduce the consumption of imported additives in JSC ANHK and expand the range of additives and marketable products used.

A study of the chemical composition and performance efficiency on diesel fuels of anti-wear additives available on the Russian market has been conducted. It has been determined that an urgent task for manufacturers and consumers of anti-wear additives is to determine indicators sufficient to assess the effectiveness and acceptability of additives as well as test methods and equipment used.

Tests of depressant-dispersant additives of wide range of action from 11 manufacturing companies for the production of EURO diesel fuel, winter class 2, environmental class K5 according to GOST 32511-2013 have been conducted at JSC ANHK. A list of additives has been established that ensures both the required low-temperature characteristics of diesel fuel and its stability during storage at negative temperatures.

The reasons for the low level of development of the small-scale chemical production in the Russian Federation are identified and the ways to solve this issue have been suggested.

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Klimov N.A, Klimova T.A., Ershov M.A., Goryacheva A.A., Golovachev V.A., Esipenko R.V.
Study of chemical stability and color change during storage of unleaded aviation gasoline grade B-92/115 **13-20**

*Keywords***:** unleaded aviation gasoline, chemical stability, N-methylaniline.

Abstract. The article presents the results of the study of chemical stability and color change of new russian unleaded aviation gasoline B-92/115, prepared according to STO 00148725-010-2015, containing N-methylaniline, as a high-octane additive, for three years in a laboratory. Shown a significant effect of daylight, as well as the presence of antioxidant additive on the kinetics of accumulation of existent gum. The pronounced effect of Agidol-1 (2,6-ditretbutyl-4-methylphenol) antioxidant additive to the kinetics of accumulation of potential residue during storage of unleaded aviation fuel B-92/115 in the daylight and the absence of such effect during storage without daylight was shown. The significant influence of daylight on the change in color of the samples was shown. It has been established that the presence of Agidol-1 anti-oxidant additive accelerates the color changing of unleaded aviation gasoline B-92/115 in the first half-year of storage in the daylight, and does not affect the rate of color changing in the first six months of storage, but reduces it further. The positive effect of the TETA (triethylenetetramine), as a color – stabilizer of N-methylaniline in unleaded aviation gasoline B-92/115 containing was established. The effects of N-methylaniline from various manufacturers, with content of color stabilizers – TETA (triethylenetetramine), and AEP (aminoethylpiperazine), as well as the shelf life of N-methylaniline itself on the chemical stability of unleaded aviation gasoline B-92/115 have been investigated. The absence of accumulation of oxidation products during storage of the first industrial batch for one year in the tank is shown. The absence of any dependence of the accumulation of oxidation

products on the presence of any of these color stabilizers, as well as on various producers of n-methylaniline, was established. Evaluation of the concentration of total and potential gum in industrial batch of unleaded aviation gasoline B-92/115 stored in tank for one year. No significant accumulation of products of the destruction of fuel components and discoloration was established.

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Gasanov A.G., Aliyeva S.T., Gasanova G.J., Memmedova I.M., Qurbanova M.M., Qurbanova F.S.
Methods of reducing of acidity of kerosene and diesel fuel_____21-24

Keywords: total acid number, acidity. kerosene, diesel fuel, decarboxylation, naphthenic acids

Abstract. It is known that the acidity of the fuel is determined by the amount of mg KOH required to neutralize 100 ml of fuel. The acidity of the fuel shows how much organic (naphthenic) acids and other acidic impurities (phenols, sulfur compounds). Increased acidity of the fuel is dangerous from the point of view of possible corrosion of engine parts and the fuel injection system. With an increase in the acidity of the fuel, not only its corrosivity increases, but engine wear also increases. Two basic methods are used to determine the acidity of fuels – ASTM D1093, which is used to quantify the acidity of liquid hydrocarbon fuels and their distillation products, and ASTM D3242 (IP 354), which is designed to determine the acidity of aviation turbine fuels in the range of 0.05-01 mg KOH/g.

There are various methods for reducing the acidity of crude oils and extracting petroleum acids from the latter. These methods were described in detail in our research and review publications. However, studies on reducing the acidity of the kerosene and diesel fractions used as fuels are not fully implemented. In this regard, the development of new methods for reducing the acidity of kerosene and diesel fuels is of important both scientific and practical interest. However, most of the proposed methods are preparative. On an industrial scale, the Napfining process, licensed by Merichem in 1977, is used to extract naphthenic acids. This technology includes two main stages of fuel processing: a decrease in the total acidity and oxidation of mercaptans. The process is based on the extraction of naphthenic acids with caustic soda to form stable emulsions of sodium naphthenates.

In the current work, we presented a new method of reducing the acidity and the total acid number of kerosene and diesel fuel, based on the catalytic decarboxylation of the latter in the presence of various catalysts. Natural and synthetic aluminosilicates, as well as nano-sized oxides of magnesium and titanium were used as catalysts. The results of the research allow us to conclude that the method of catalytic decarboxylation of the kerosene and diesel fractions, the acidity of the latter is significantly reduced and reaches 1.4 and 1.6 mg KOH/100 ml, respectively. In accordance with this, their acid number decreases to 0.0194 and 0.0219 mg KOH/g, respectively. It should be noted that the best results are observed when using nano-sized metal oxides.

The results obtained suggest that the proposed method of reducing the acidity of kerosene and diesel fuel is acceptable both in laboratory conditions and on an industrial scale and create prerequisites for using this method in industrial practice.

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MATHEMATICAL SIMULATION TECHNOLOGICAL PROCESS

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Belinskaya N.S., Frantsina E.V., Ivanchina E.D., Lutsenko A.S., Afanas'eva D.A.
Studying the process of diesel fuel catalytic dewaxing using unsteady mathematical model_____25-32

*Keywords***:** hydroprocessing, diesel fuel, catalytic dewaxing, mathematical model, catalyst deactivation.

Abstract. Low-temperature properties of diesel fuel are the determining parameters for the operation of diesel fuel in cold climates. The presence of paraffins of unbranched structure (*n*-paraffins) in diesel fuel leads to the formation of crystals that prevent the passage of fuel through the filter, which makes it impossible to use the fuel at low ambient temperatures. In order to improve low-temperature

properties and to produce diesel fuel of winter and arctic grades, catalytic dewaxing process is used in oil refining industry.
The study and improvement of the efficiency of oil refining processes are currently being successfully implemented using the method of mathematical modeling. The method of mathematical modeling makes it possible to determine the composition and yield of products with high accuracy, to predict the service life of the catalyst under the conditions of the changing composition of hydrocarbon raw materials.
In this work unsteady mathematical model of diesel fuel catalytic dewaxing process was developed based on actual data from the industrial unit. The model takes into account the composition of the raw materials and the activity of the catalyst. The mathematical model allows calculating the material and heat balance of the catalytic dewaxing process, as well as assessing the influence of technological parameters and catalyst activity on the main process indicators: *n*-paraffins content in the produced diesel fuel, cold filter plugging point and diesel fuel yield. The effect of temperature, composition of raw materials and catalyst activity on the catalytic dewaxing process was shown by the calculations using the developed model. Optimal conditions were determined for production of winter grade diesel fuel with cold filter plugging point equal to -26°C depending on the raw materials composition and catalyst activity. It was shown that carrying out the process under optimal conditions, determined by calculations using the mathematical model, provides extension of the catalyst service life by 6%. Due to extension of the catalyst service life, production of diesel fuel was increase by 500 thousand tons.

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Bystrov A.I.
Method of calculation and refinement coefficients of approximating functions of arbitrary structures in a simulated the processes of oil refining 33-38

Keywords: approximation function, Taylor series, weight coefficients, average relative error, technological calculations in oil processing.

Abstract. Developed the methodology and software to determine the coefficients of approximating functions of arbitrary structures according to the experiment, to clarify the factors known empirical formulas. The technique includes for determining the coefficients of the required functions the method of expansion of the function in the Taylor series and finding the correction factors by the least squares method using weight coefficients. The Newton optimization method is used to refine the required coefficients. A detailed algorithm for determining the coefficients of approximation models of arbitrary structure is described. As a criterion of adequacy of the considered models, the average relative error is chosen. The use of this criterion allows taking into account the weight characteristics of the considered table functions. In MS Excel there is no possibility to take into account weight functions when calculating approximation functions (trends) using the classical least squares method. It is shown that the efficiency of the proposed method in the determination of the coefficients of the approximation functions is increased when the start and end values of table-valued functions, obtained according to the experiment; differ by 1-2 orders of magnitude. According to the above algorithm, a program of approximation by arbitrary functions in the VBA language in the MS Excel programming environment was created. It automatically computes partial derivatives of any function given by text as a formula using numerical differentiation. Allows you to calculate formulas with any number of points of table functions, coefficients and factors. Examples of calculation of indicators used in the modeling of petrochemical processes, with a decrease in the average relative error in formulas with the same structure of coefficients and factors are given. The initial data of the arguments and table functions in the calculations were taken the same. A comparison was made with calculations using known empirical formulas using known methods and the developed method. For example, it is shown that the accuracy of the calculation of the molecular masses of oil fractions by the known two-factor model with the coefficients known from the literature and the new coefficients calculated by the proposed program is 1.5-2 times lower by the average relative error. The use of the developed program will clarify the known formulas used in the technological calculations of the processes of petrochemical processing, develop new ones on the basis of laboratory and industrial experiment data, and will reduce the error in the technological calculations. The article can be useful for specialists in the field of technological calculations in the modeling of various dependencies on the experimental data, reflecting the physic-chemical and other properties in the processes of petrochemical processing.

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