ABSTRACT AND REFERENCES

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STUDYING TRUCK TRANSMISSION OILS USING THE METHOD OF THERMAL-OXIDATIVE STABILITY DURING VEHICLE OPERATION (p. 6-12)

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Development of technical maintenance of transport means consists in providing their technical state at a significant level of functional operability for which the use of quality lubricants is a key requirement. Therefore, determination of technical state of truck transmission oils by the method of thermal-oxidative stability during their operation is an urgent problem.

This problem was solved and technical state of the transmission oil was studied on the basis of operational tasks and the results of their chemotologic studies. These results can be used in development of a system of vehicle maintenance and when substantiating feasibility of using concrete oil grades during operation. A procedure for studying, determining state and compliance of the working oils by their thermal-oxidative stability with operating conditions during vehicle operation has been developed. State of transmission oils was studied during vehicle operation in gearboxes of KamAZ 6520 and MAN TGA 6×4 trucks. The study of working transmission oils was conducted at following parameters: light transmission, evaporability, viscosity. The results of studies of light transmission through an oil sample and evaporability after application of the temperature regimes used in testing working oils were used in graphical and analytical representation of the coefficient of thermal-oxidative stability. Variation of the coefficient of thermal-oxidative stability of oils of respective grades depending on their relative viscosity was determined. Analysis of the obtained functions will enable development of recommendations on conformity of working oils to the conditions of their operation.

It was found that the Tedex Gear GL-4 80W90 transmission oil, used in MAN TGA 6×4 trucks, corresponds by its thermal-oxidative stability characteristics to the operating conditions. At the same time, the study of use of YUKO TO-4 80W-85 transmission oil in KamAZ 6520 trucks has shown that the oil did not demonstrate its functional capacity at runs of 8–30 and 45 thousand kilometers. This was confirmed by analysis of the mathematical model of variation of thermal-oxidative stability of oils depending on relative viscosity, namely, by overshoot of some numerical values of the function beyond the level of 0.85 un. for the vehicle runs under study.

It was established that the study data can be applied to substantiation of further operation and selection of transmission oils for the studied vehicle models in transportation activities of the enterprise.

Keywords: truck, run, transmission oil, thermal-oxidative stability, photometry, evaporability, relative viscosity, sample mass, operating conditions.

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DEFINITION OF THE THERMAL AND FIRE-PROTECTIVE PROPERTIES OF ETHYLENE-VINYL ACETATE COPOLYMER NANOCOMPOSITES (p. 13-20)

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To create a fire retardant coating that can be applied in the hydrocarbon fire, the nanocomposites of the ethylene-vinyl acetate (EVA) copolymer with montmorillonite (MMT), thermally expanded graphite (EG) are synthesized and their structure, physicochemical and thermal properties are studied. Using IR spectroscopy and X-ray phase analysis, it is found that the EVA nanocomposites with montmorillonite and nanographite obtained in solution and melt have the same structure.

Thermal-oxidative degradation of the EVA copolymer and nanocomposites on its basis in the temperature range of 100–700 °C is investigated. It is proved that nanoclay and nanographite as a part of nanocomposites increase thermal characteristics of the original polymers. The thermal stability of the studied compounds increases in the series: polymer<polymer-EG<polymer-MMT<polymer-MMT-EG. It is shown that the presence of nanoparticles in the polymer matrix reduces the EVA thermal decomposition rate at a temperature above 450 °C and increases the coke residue mass after the destruction of the initial EVA copolymer at a temperature of 250 °C. The synergistic effect of the MMT/EG mixture on the processes of slowing down the thermal degradation of the EVA copolymer is found.

The effect of organomodified montmorillonite and graphite in the EVA nanocomposites on the thermal destruction of the intumescent system of ammonium polyphosphate/melamine/pentaerythritol is studied. The synergistic effect of the mixture of clay and graphite nanoparticles in a hybrid nanocomposite is revealed. Synergism consists in increased fire resistance of metal structures by almost 20 % compared with the coating containing the polymer-nanoclay or polymer-nanographite nanocomposite.

Based on the results obtained, the intumescent base of fire retardant paint for steel structures, which is recommended for use to increase the fire-resistance rating of metal in the hydrocarbon fire is developed.

Keywords: organomodified montmorillonite, thermally expanded graphite, nanocomposite, intumescent coatings, hydrocarbon fire.

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ACRYLIC ACID SYNTHESIS BY OXIDATIVE CONDENSATION OF METHANOL AND ACETIC ACID ON B–P–V–W–O_x/SiO_2 CATALYST (p. 21-27)

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The process of oxidative condensation of methanol with acetic acid to acrylic acid on B–P–V–W–Ox/SiO_2 catalyst modified by hydrothermal method has been studied. Modification of the catalyst by hydrothermal treatment of the carrier changes its physical and chemical properties, and therefore its catalytic properties. The influence of the main technological parameters – temperature, contact time and ratio of reagents on the selectivity and yield of the reaction products and on the conversion of acetic acid has been studied when hydrothermally treated catalyst was used. The best time of contact was 8 sec. which allows to reach the highest selectivity and yield of acrylic acid and methyl acrylate. The highest catalytic activity of the designed catalyst is observed at the reaction temperature of 673 K, however, it is impossible to increase temperature over this value due to the limited thermal stability of the catalyst and the sharp increase in the formation of complete oxidation products. With an increase of methanol part in the ratio of reagents (methanol: acetic acid) to 1,2:1, the selectivity of acrylic acid and methyl acrylate increases, and the selectivity of by-products is significantly reduced. The highest yield of the target products in the reaction of oxidative condensation of methanol with acetic acid is observed at a ratio of oxygen: acetic acid 1,5:1. The growth of the oxygen: acetic acid ratio promotes reduce of acetone and methyl acetate selectivity but does not change the selectivity of methyl acrylate and significantly increases the selectivity and yield of acrylic acid. At the best conditions of the reaction it was possible to achieve 54.7 % total yield of acrylic acid and methyl acrylate. Due to the wide availability and relatively low cost of the initial reagents (methanol and acetic acid), the synthesis of acrylic acid by the oxidative condensation of methanol with acetic acid in the presence of the developed catalyst is very promising.

Keywords: acrylic acid, methanol, acetic acid, heterogeneous catalysts, hydrothermal treatment.

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REVEALING SPECIAL FEATURES OF HYDRODYNAMICS IN A ROTOR-DISK FILM VAPORIZING PLANT (p. 28-33)

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This paper reports the generalized results of computer simulation of physical processes at a rotor-disk film evaporating plant. Optimization of the operation mode cannot be achieved without establishing patterns in the course of physical processes. We have proposed a computer model of hydrodynamics that accounts for all the features, initial and boundary conditions. The results of computer simulations make it possible to adequately assess the effectiveness of using a rotor-disk film evaporating plant (RDFVP) for the concentration of heat-labile materials. We have established patterns in the course of physical processes within a structure of RDFVP by using computer simulation of hydrodynamics in the programming environment ANSYS and applying a k-ε turbulence model. The result of simulation is the derived velocity fields of the concentrated fluid (w_{max}=0.413 m/s) and the gas phase (w_{max}=8.176 m/s), as well as the magnitude of values for shear stress $\tau=0.94\cdot10^{-6}$ Pa. It was established that the gas heat-carrier is characterized by the highly-turbulent flows with maximum values for kinetic energy $TKE_{max}=8.985\cdot10^{-1}$ m^2/s^2. The reliability of results is ensured by the correctness, completeness, and adequacy of physical assumptions when stating the problem and while solving it using the computer aided design system ANSYS. It has been established that the proposed structure is an effective alternative to equipment for the concentration of solutions. The data obtained could be used when designing heat-and-mass-exchange equipment for the highly efficient dehydration of thermolabile materials.

Keywords: rotor-disk film vaporizing plant, heat dissipation, k-ε turbulence model, forced convection, ANSYS, CFX, shear stresses.

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UTILIZATION OF THE PREPYROLYZED TECHNICAL HYDROLYSIS LIGNIN AS A FUEL FOR IRON ORE SINTERING (p. 34-39)

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A promising direction of technical hydrolysis lignin utilization is metallurgical production, primarily iron ore preparation and blast furnace process. A significant potential is concentrated in the sintering process. In order to improve properties of lignin in the role of a fuel, and to remove, with the possibility of trapping, toxic substances, it is necessary to carry out preliminary pyrolysis. The effect of technical hydrolysis lignin of different pyrolization degrees on the iron ore sintering process and properties of the obtained sinter is experimentally studied. Initial lignin was subjected to preliminary heat treatment to the final temperature of 400, 600, 800 and 1000 °C without air access. Sintering with the participation of pyrolyzed lignin has been carried out via lab-scale sinter pot. After sintering, the sinter strength and the macrostructure have been determined. The chemical composition of the sinter samples has been revealed by X-ray fluorescence analysis.

As a result of the experiments, the possibility of replacing 25 % of coke breeze with lignin prepyrolyzed at 800 °C has been determined. Under these conditions, the main indicators of the sintering process, such as vertical sintering rate, product yield and specific capacity of the lab-scale sinter pot, remain virtually unchanged. There is a slight decrease in the impact strengths and the abrasion strengths of the sinter. However, these figures remain at a technologically acceptable level. It should be noted that when using lignin as a sintering fuel, there is a tendency for some decrease in the iron content of the sinter produced with it. The study of the sinter macrostructure has

shown an increase in the pore diameter when the partial replacement of coke breeze with lignin while with the increasing lignin pyrolysis temperature the pore volume increases.

The studies have demonstrated the possibility of solving the urgent environmental issues of technical hydrolysis lignin utilization by applying it in the sintering process with preliminary pyrolization. A promising direction for further research is the development of methods for the preparation of technical hydrolysis lignin for the use in iron ore sintering.

Keywords: industrial waste utilization, technical hydrolysis lignin, pyrolysis, iron ore sintering.

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INFLUENCE OF THE CARBONATE ION ON CHARACTERISTICS OF ELECTROCHEMICALLY SYNTHESIZED LAYERED (α+β) NICKEL HYDROXIDE (p. 40-46)

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Nickel hydroxide is widely used as the active material of supercapacitors. The most active are samples of $Ni(OH)_2$ with (α+β) layered structure, synthesized in the slit diaphragm electrolyzer. Influence of carbonate anion on the structure and electrochemical properties of nickel hydroxide samples has been studied by means of sample synthesis in the slit-diaphragm electrolyzer with the use of the diaphragm and cation-exchange membrane as chamber separator. The experiment revealed that when the diaphragm is used, there is a filtration flow from the anodic chamber (alkali with carbonate) into the cathodic chamber. Thus, the samples synthesized with the diaphragm are formed in the presence of carbonates, while the samples synthesized with the cation-exchange membrane – in the absence of carbonates. Crystal structure of the samples was studied by means of X-ray diffraction analysis, electrochemical characteristics – by means of cyclic voltammetry and galvanostatic charge-discharge cycling in the accumulator regime. Comparative analysis of the samples synthesized in the presence or absence of carbonates has been conducted. By means of X-ray diffraction and cyclic voltammetry, the key role of carbonate ions in the formation of monophase layered (α+β) structure has been revealed. The absence of carbonate resulted in lower crystallinity, α-phase content, the formation of the bi-phase system, composed of the mixture of β-form and (α+β)-structure, at high current densities (12 and 15.7 A/dm^2). The study of electrochemical characteristics revealed a decrease in specific capacity by 14.7–31.4 % for hydroxide samples formed in the absence of carbonate ions. The highest specific capacity was obtained for the samples synthesized in the SDE at i=10 A/dm^2 with the diaphragm (in the presence of carbonates) and with the membrane (in the absence of carbonates), and are 216.8 and 185 mA·h/g respectively. To increase specific capacity, it is recommended to conduct synthesis in the SDE with the use of the diaphragm and introduce an additional quantity of sodium carbonate into the anolyte.

Keywords: nickel hydroxide, layered (α+β) structure, specific capacity, alkaline accumulator, slit-diaphragm electrolyzer, carbonate.

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DETERMINING THE RATIONAL COMPOSITIONS OF LOW-STRENGTH CONCRETES (p. 47-52)

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The paper reports regularities in the influence of the amount of waste from iron ore enrichment at a rational composition of grain components on strength of concretes with a minimal cement consumption. Low-strength concretes are used in the non-reinforced structures, so they are not subject to the requirement for the minimal cement consumption in order to ensure the protection of reinforcement against corrosion. A significant reduction in cement consumption by low-strength concretes while maintaining the required strength can be ensured by a rational grain composition of the components of a concrete mixture, which is characterized by the ratio between large, medium, and small components of 52:23:25. In such formulations, the required amount of fine-grained component is achieved by introducing the fine-grained components, made, for example, from the secondary products of industry, specifically the iron ore dressing waste.

The result of the research conducted established that ensuring the rational grain composition of the concrete mixture components provides for the required low strength of concrete at a significantly less cement consumption than that for concretes whose composition is defined in line with other procedures. It was found that it is advisable to use the iron ore dressing waste as a fine-grained supplement, the introduction of which at rational amount ensures significant improvement in the efficiency of cement utilization in concretes of low strength. Application of concretes of the proposed formulations, which could be used for temporary structures – a concrete cap for making floor slabs at formwork-free molding, could save a significant amount of cement, and dispose of the secondary products from industry. The research has also established that the use of plasticizers

makes it possible to obtain concretes of the rational grain composition with the required workability.

Keywords: concrete, strength, grain composition of fillers, cement, iron ore dressing waste.

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CONVERSION OF N-CONTAINING COMPOUNDS OF FLASH STEAM CONDENSATE FROM CARBAMIDE PRODUCTION INTO HYDRAZINE SULFATE (p. 53-64)

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Formation of 1.5 m^3 of wastewater per 1 ton of carbamide in the form of flash steam condensate accompanies carbamide production. It is necessary to purify flash steam condensate from nitrogen compounds by two-stage desorption and hydrolysis. Disposal of residual N-containing compounds occurs at biological wastewater treatment plants under industrial conditions. Such a multistep purifying method leads to reduction of up to 72–77 % of N-containing compounds, but it requires high electrical and thermal energy costs. The method is the most modern and the most promising one, it is implemented at carbamide synthesis plants everywhere.

The study proposes a new method for the disposal of N-containing compounds in flash steam condensate produced by carbamide production by processing ammonia, carbamide and biuret to hydrazine sulfate. The study on the synthesis of hydrazine sulfate in wastewater from the production of carbamide defined mechanisms occurring during synthesis of raw hydrazine in an electromagnetic reactor. The study proved that the proposed method of disposal is economically viable, environmentally friendly and energy efficient. It reduces a load on biological wastewater treatment plants, reduces the cost of electrical and thermal energy.

The method gives a possibility to process N-containing compounds of flash steam condensate into an expensive product – hydrazine sulfate. Experimental studies confirmed that electromagnetic radiation has a positive effect on the synthesis of raw hydrazine. This leads to an increase in efficiency of the hydrazine synthesis reactor by 88 %. We analyzed three of the most probable chemistries of the process of raw hydrazine synthesis reactions using the non-imperial method of quantum chemistry. The study showed that the initial yield of the finished product is 5.3 kg per 1 m^3 of nitrogen-containing raw materials during disposal of flash steam condensate at a model plant by processing into hydrazine sulfate taking into account an optimization parameter. There is an increase in the yield of the final product to 6 kg per 1 m^3 at repeated multiple use of the filtrate as a source of sulfuric acid. We performed a projection of the results of the model installation at industrial scale taking into account an operation of the carbamide synthesis device, with a capacity of 330,000 tons/year. Thus, we identified that the maximum estimated production capacity of the hydrazine sulfate synthesis unit is 132–150 kg/day. We calculated the profitability of the device for the synthesis of hydrazine sulfate considering the obtained data on the estimated capacity of the device. We established that the net profit is at least 12 % according to the proposed scheme in the production of hydrazine sulfate.

Keywords: carbamide production, flash steam condensate, hydrazine sulfate, raw hydrazine, electromagnetic reactor, electromagnetic radiation.

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