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Study of Antiwear Properties of Plant-Mineral Based Fuels for Airbreathing Jet Engines

A. V. Yakovleva, S. V. Boichenko, K. Leida, O. A. Vovk, and Kh. Kuzhevskii

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The antiwear properties of fuels for airbreathing jet engines (AJE) and three types of biocomponents derived from rapeseed oil and their blends are studied experimentally. It is shown that the lubricating capacity of the biocomponents is much higher than those of conventional petroleum fuels for AJE. The studies disclosed that addition of biocomponents to aviation fuel strengthens boundary layers and thereby improves the antiwear properties of the fuel blends. It is demonstrated that additional modification of the biocomponents enhances their lubricating capacity vis-à-vis standard components derived from rapeseed oil.

Keywords: AJE fuel, alternative fuel, antiwear properties, biocomponents, lubricating capacity, scoring load, friction.

Production of synthons for synthetic oils having high-viscosity properties

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Cyclopentadiene is alkylated by C6–C10 monoatomic alcohols in the presence of an alkali catalyst. The influence of cyclopentadiene to alcohol molar ratio, reaction time, and temperature on the yield of respective normal dialkyl cyclopentadienes is studied. It is shown by the example of dioctyl cyclopentadiene that its hydrogenation yields the respective dialkyl cyclopentane with high viscosity properties, which can be used as a synthetic oil and an additive to mineral oils.

Keywords: synthons, cyclopentadiene, alkylation, nano-sized alkali catalyst, viscosity index.

Effect of Lubricating-Oil Foamability on Oil-System Operation in Aviation Gas-Turbine Engines

A. S. Novikov, L. S. Yanovskii, V. M. Ezhov, A. A. Molokanov, and K. V. Sharanina

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The foaming properties of lubricating oils for aviation gas-turbine engines were studied experimentally. The dependences of the aviation oil foamability on the air flow and temperature were found. Addenda to the standard method of GOST 21058-75 for more accurate determination of aviation oil foamability were presented. It was shown that the oil-system operating characteristics changed if the oil foaming properties changed.

Keywords: aviation oils, foamability, foaming properties

Kinetics of sulfone accumulation upon catalyzed peroxide oxidation of petroleum sulfoxides

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Kinetic analysis of the proposed scheme of sulfone production by oxidation of petroleum sulfoxides under the action of hydrogen peroxide and molybdenum (VI) oxide catalyst is performed. It is shown theoretically and experimentally that at the initial stages of the reaction sulfone concentration depends linearly on the square of time. The effective activation energy of the process is found to be E_{act} = (31 ± 7) kJ/mole.

Keywords: petroleum sulfoxides, sulfones, catalytic oxidation, molybdenum (VI) oxide.

Comprehensive technological scheme for reprocessing spent sulfuric acid from alkylation of isobutane by olefins

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The technological principles for recycling spent sulfuric acid from alkylation of isobutane by olefins were developed. A scheme of technological operations for reprocessing spent sulfuric acid that enabled sulfuric acid monohydrate to be used for production of sodium and ammonium sulfates was presented. The maximum yields of sodium and ammonium sulfates (up to 90 mass%) were obtained by extracting organic contaminants with an EtOH:Me_2CO mixture (1:1). The obtained sodium and ammonium sulfates satisfied all requirements for commercial products. The organic contaminants in them were ≤0.2 mass%. The isolated organic component was certified in oil-displacement formulations and feedstock mixtures for production of technical carbon and detergents.

Keywords: spent sulfuric acid, alkylation, olefins.

Modeling of low-temperature carbonization of sulfur-bearing oil shales in fluidized-bed reactor

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A mathematical model of the process of low-temperature carbonization of sulfur-bearing oil shales in a fluidized-bed reactor, which takes account of the characteristics of hydrodynamics and heat exchange in the thermal shale decomposition process as well as the kinetics of thermal degradation of the organic matter, is developed. A block diagram of the calculation algorithm and the results of numerical experiment based on the developed mathematical model are presented. It is shown that the properties of the sulfur-bearing shale and the conditions of the low-temperature carbonization process affect the parameters of the fluidized-bed reactor.

Keywords: oil shale, kinetic modeling, low-temperature carbonization, fluidized-bed, heat exchange.

Thermodynamics of gasification of organic matter of brown coal using oxidants of various compositions

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The results of thermodynamic calculations of temperature dependence of equilibrium composition of products of gasification of brown coal from the Kiyakty field (Kazakhstan) using feedstock of various compositions are reported. It is shown that the composition of the gasification products with a fixed $CO:H_2O$ ratio, required for producing synthesis gas that can be used as a feedstock for organic synthesis or fuel, can be predicted by thermodynamic modeling.

Keywords: coal gasification, thermodynamic calculation, equilibrium composition, synthesis gas.

Predicted dependence of gas—liquid diffusion coefficient on capillary pressure in porous media

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Theoretical and experimental studies of the change of diffusion coefficient in porous media are reported. Mathematical equations were derived for calculating the diffusion coefficient in oil and gas phases. Experiments were conducted by measuring pressure decline in both a PVT-cell and a sample of actual core. The medium porosity was found to have a significant effect on the system pressure decline. The diffusion coefficient in the PVT-cell was two orders of magnitude greater than that in the core. The diffusion coefficient was studied as a function or rock permeability and porosity. It was found that the porosity was the main factor affecting the diffusion coefficient whereas the permeability could be neglected.

Keywords: diffusion in pores, diffusion coefficient, rock permeability, core

A new method of studying stress sensitivity for low-permeability tight gas reservoirs

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Conventional methods of determination of rock sensitivity to stresses at which the confining pressure changes, but the pore pressure remains unchanged, are not suitable for low-permeability tight gas reservoirs. In this work, a new method of determination is proposed, where the pore pressure is varied, but the confining pressure is kept constant. For determining the actual formation pressures, the method of synchronous elevation of confining and pore

pressures was applied. An equation correlating gas reservoir productivity with reservoir stress sensitivity is derived and the adequacy of the developed simulation method is proved.

Keywords: low-permeability tight gas reservoir, effective stress, effective stress coefficient, confining pressure, pore pressure, stress sensitivity coefficient.

Viscometry as a method for determining concentration of fatty acid ethyl esters in biodiesel fuel

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The reaction of transesterification of rapeseed oil in ethanol under supercritical fluid conditions in the 320-380ºC range, 30 MPa pressure, ethyl alcohol to rapeseed oil molar ratio (6-20):1 is studied experimentally. Dependencies of kinematic viscosity of the reaction product on the temperature, molar ratio of the original reagents, and duration of reaction implementation are obtained. A correlative dependence that allows calculation of the content of ethyl esters of fatty acids in the transesterification product is proposed using experimental data on the kinematic viscosity values of the reaction product.

Keywords: transesterification, rapeseed oil, ethanol, biodiesel, ethyl esters of fatty acids.

Groundwater remediation using a pyrolysis oily sludge composite

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The absorption capacity of pyrolysis oily sludge residue was utilized to prepare oxygen-releasing composites for groundwater remediation. The physical properties of the pyrolysis oily sludge residue were specific surface area 13.936 m2/g and main pore size of the order of nanometers. The pyrolysis residue was nontoxic and would not cause secondary contamination of groundwater. The rate of mass loss of calcium peroxide and the oxygen release rate in water were analyzed. An oxygen-releasing composite containing 35% calcium peroxide, 15% pyrolysis oily sludge residue, 30% fluviatile sand, 10% calcium-based bentonite soil, and 10% deionized water was proposed. Addition of oily sludge to the composite plugged the parts of the surface releasing oxygen and slowed the rate of oxygen release. Continuous precipitation of CaCO3 on the surface and in the pores of the composite also reduced the initial oxygen release rate and slowed it.

Keywords: oily sludge pyrolysis, groundwater remediation, oxygen-releasing composite, bentonite.

Wangfu low-permeability volcanic gas reservoir microstructure and damage mechanism

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The microstructure of Wangfu volcanic reservoir and the predicted permeability reduction of this reservoir are investigated. It is found that water block (strata permeability reduction due to water penetration into the pore space) and fracturing fluid residue are the main causes of reduced deposit gas

permeability. A subsuite of this reservoir, Quan-1, is sensitive to water whereas Huoshiling and Shahezi deposits are sensitive to acids. Therefore, an acidic fracturing fluid should be used in the first instance; fluid with a low concentration of guar gum and minimal acid content, in the second. However, fracturing fluids with anionic surfactants should be used to solve the water-block problem in all three deposits, thereby increasing the process efficiency.

Keywords: volcanic deposit, low-permeability reservoir, reservoir permeability reduction, strata hydrofracturing, water block, hydrofracturing fluid

Optimum acid-fracturing treatments for ultradeep limy dolomite resevoirs based on conductivity tests

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Acid-fracture conductivity has a major impact on acid-fracturing effects. In this paper, influences of acid concentration, temperature and closure-stress loading time on conductivity under different acid-fluid systems have been researched based on experimental analysis for deep limy dolomite reservoirs. The measured conductivity showed high correlation and specific changing patterns with the above factors. Quantified relationships and equations between the conductivity and these factors were suggested in this paper. Additionally, a strong acid-etching effect caused by crosslinked acid and diverting acid has been observed during the tests. This could lead to high conductivity as well as broken rocks due to pressing with high-concentration acid. In this study, a 50-hour long-term conductivity test has been designed under the closure stress of 60 MPa which was closest to the actual reservoir conditions. The results showed that conductivity retention rate for each test group is less than 40%. By establishing assessment criteria of long-term and short-term conductivity based on the conductivity retention rate, linear
relationships with high correlation and quantified equations of the conductivity retention rate in the same acid-rock reaction system could be obtained.

Keywords: limy dolomite, acid fracture, conductivity, influencing factors, quantified equations.

Dynamics-based classification of horizontal wells and its application to ultralow-permeability gas reservoirs as an example

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Classification and evaluation of gas wells using a scientific and justified approach are important for managing gas reservoirs in low-permeability rock. A new classification of horizontal wells that was based on the dynamics of 40 wells in area Su-14 of Sulige gas field is presented. The evaluation included parameters such as the drop of well production with reduced pressure, pressure drop over time, and open flow. Cluster analysis was proposed for evaluating the operation of Su-14 wells and classifying them. The adequacy and accuracy of the proposed method was confirmed by analyzing three wells. This

classification method has great theoretical and practical significance and can be used at other similar gas fields.

Keywords: ultralow-permeability gas reservoir, field development, horizontal well, classification of horizontal wells, pressure drop in well, cluster analysis, Sulige field

Influence of cross-linked polymer profile-control agent on oil reservoir permeability

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General principles of polymer flooding technology were elucidated based on existing profile-control studies. The current situation and problems of filtration profile-control technology were analyzed. Oil-reservoir permeability was studied as a function of cross-linked polymer concentration. Several recommendations for the optimal implementation were given.

Keywords: cross-linked polymer, filtration-profile control, polymer pumping volume, reservoir permeability

Replacement criterion based on strain estimation for third-party damage to oil and gas pipelines

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Collateral damage, which can result from the actions of any third parties other than service staff, is a major cause of unexpected pipeline failure. A finite-element model for the impact between an excavator bucket tooth and a pipeline is proposed based on non-linear dynamics theory. Four different conditions, i.e., transporting a gas, striking a pipeline with a bucket tooth, separating the bucket tooth from the pipeline, and unloading the pipeline pressure, are simulated. The damage mechanism of a pipeline is analyzed. The effect of dent depth on residual strain and residual stress is investigated. A comparison of the finite-element results and ASME B31.8 criteria indicates that the latter have some deficiencies.

Keywords: oil pipeline, gas pipeline, third-party damage, non-linear dynamics, finite-elements method, ASMI B31.8