Chemistry and Technology of Fuels and Oils

2(600)'2017

Publisher— ICST «TUMA Group» LLC

Редактор
В. С. Дмитриева

Ответственный секретарь
О. В. Любименко

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Формат 60 84 1/8.
Печать офсетная.
Усл. печ. л. 7.
Тираж 1000 экз.

Отпечатано ООО «Стринг»
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Antiknock properties of blends of 2-methylfuran and 2,5-dimethylfuran with ethanol fuel

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The antiknock properties of blends of 2-methylfuran and 2,5-dimethylfuran with ethanol fuel containing toluene are studied. The octane numbers of blends of these substances in various concentrations and the change in sensitivity of the fuel are calculated. It is shown that in research method the octane number of the blend attains the maximum at additive concentration of 10 vol. %, at which the sensitivity of the fuel increases at a smaller degree when 2-methylfuran is used.

Keywords: methylfuran, dimethylfuran, oxфygenates, octane number, alternative fuels.

Determination of compositions and properties of plastic lubricants based on used oils

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The method of oil cleaning using monoethanolamine and isopropanol, which allows cleaning of used synthetic oils for their subsequent utilization as a dispersing medium for producing plastic lubricants, is examined. The compositions of plastic lubricants of Solidol J and Lithol-24 cousins produced from used oils are determined. The basic physicochemical and performance properties of experimental compositions of the lubricants are evaluated. It is shown that plastic lubricants based on used oils are comparable or even superior in properties to the commercial cousins produced from costly base oils.

Keywords: used oil, plastic lubricants, oil cleaning, dispersing medium, disperse phase, dropping point.

Influence of hydrocarbon composition on quality and performance properties of middle distillates and low-viscosity marine fuels

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The physicochemical properties of middle distillates of exhaustive refining of crude oil of one of the Russian refineries are studied from the point of their utilization as components of low-viscosity marine fuels. The performance properties of diesel fractions after hydrofining and of light gas oils of catalytic cracking and delayed carbonization are determined and compared. The physicochemical and performance properties of the studied fractions are found to depend on the hydrocarbon composition of the fractions. Based on the noted dependencies, the optimum

component composition of low-viscosity marine fuel is developed and recommended for introduction.

Keywords: low-viscosity marine fuel, diesel fuel, middle distillates, hydrocarbon composition.

Change in hydrocarbon and component compositions of heavy crude oil from ashalchinskoe field in catalytic aquathermolysis process

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A physical model of the process of aquathermolysis of heavy crude oil from Ashalchinskoe oilfield at 250, 300, and 350°C has been developed. Nickel and cobalt carboxylates were used as oil-soluble catalyst precursors. It was found that at 300°C process temperature in the presence of hydrogen proton donor the oil content increases substantially and the resin content decreases by 1.8 times, which leads to a decrease in crude oil viscosity by 91% and in density from 960 to 933 kg/m3. The hydrocarbon composition of liquid aquathermolysis products was studied by chromato-mass spectrometry and the average molecular weight of asphaltenes was determined by matrix-assisted laser desorption/ionization (MALDI) spectrometry. The maximum disproportionation of hydrocarbons in n-alkanes, alkylcyclohexanes, and alkylbenzenes occurs at 300 and 350°C. The composition of hydrogen proton donor (tetralin) conversion products at these aquathermolysis temperatures was determined.

Keywords: aquathermolysis, heavy crude oil, asphaltenes, catalyst precursor, hydrogen proton donor.

Intensification of production various grades of gasolines based on study of intermolecular interactions of blend components and composition of process stock

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The results of improving of gasoline production efficiency using a computer system, taking account of intermolecular interactions of blend components in calculation of octane numbers of various grades of blended products and change in composition of the process stock in reforming, isomerization, alkylation, and catalytic cracking processes, are analyzed. The computer system can be used to determine quickly and precisely the optimal components ratio that ensures

production of commercial gasolines conforming to all current requirements of normative documents.

Keywords: compounding, octane number, dipole moment, mathematical modeling, gasoline production.

Mathematical model for predicting yield of heavy oil residue carbonization products

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Delayed carbonization is one of the most dynamically developing technologies in global petroleum processing. The basic factors determining the material balance and the quality of carbonization products are process parameters and quality of the feedstock used. However, data on the dependence of yield of gaseous and liquid carbonization products on the quality of the feedstock are absent in the domestic literature. This paper presents the developed mathematical models of the yield of heavy oil residue carbonization products, which help control products yield by varying the proportions of the components in the feedstock, taking account of the change in carbonizability of each component of the feedstock.

Keywords: mathematical model, carbonization of heavy oil residues, carbonization feedstock, carbonizability.

Study of physicochemical properties of heavy pyrolysis tar for its utilization as feedstock for producing petroleum pitch

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The results of study of composition and physicochemical properties of ethylene production by-product, namely, heavy pyrolysis tar (HPT) are reported. It is shown that HPT is a complex multicomponent mixture essentially of aromatic compounds and partially of unsaturated hydrocarbons. The composition and physicochemical properties of HPT in an industrial pyrolysis plant vary with time in a wide range even when same type of feedstock is pyrolyzed. In view of this, for using HPT as a feedstock for producing carbon material of a fixed quality, it is necessary to stabilize its composition, structure, and properties with time. The potential paths of solving this problem, among which are production of HPT as one of the target pyrolysis products and

preparation of HPT as an olefin production by-product for processing into carbon materials of a fixed quality, are discussed.

Keywords: gasoline pyrolysis, heavy pyrolysis tar, petroleum pitch, pyrocarbon, carbonizability.

Experimental investigation on fracture geometry in multi-stage fracturing under triaxial stresses

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Multi-stage fracturing of horizontal wells is an effective simulation technique used commonly for unconventional reservoirs. Complex interactions between multiple hydraulic fractures are believed to have a significant impact on fracture geometry in rock mass. Many theoretical models proposed for predicting hydraulic fracture geometry and stress-interference resulting from multi-stage fracturing have not been validated experimentally. In this study, a multi-stage fracturing test using gel solution as fracturing fluid was conducted under triaxial stressed state. The results showed that the first fracturing stage produced a planar fracture, while the second, a concave (bowl-shaped) fracture. Stress interference between these two main fractures caused growth of secondary fractures parallel to the simulated wellbore and decrease in width of subsequent main fractures. Penny (disk)-shaped fracture model is believed to be more suitable than rectangular fracture model for predicting the real fracture geometry in horizontal wells. For multi-stage fracturing in horizontal wells, special attention should be focused on spacing of fracture stages.

Keywords: hydraulic fracture, multi-stage fracturing, horizontal well, fracture geometry, fracture stage spacing.

Microscale investigation of mixing in matrix-fracture medium for intermixing displacement

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A finite element method was developed to solve the Navier-Stokes equation and the convection-diffusion equation in matrix-fracture medium. Using this method, we investigated the effect of molecular diffusion coefficient, fluid velocity, matrix porosity, and fracture space on the mixing pattern. Our research indicates that the dispersion pattern is dominated by convection in the fracture and by diffusion in both the matrix and the fracture. We further discovered that the level of mixing has a direct relationship with molecular diffusion coefficient, matrix porosity, and fracture space, whereas fluid velocity has an inverse relationship with the level of mixing.

Keywords: intermixing displacement, matrix-fracture medium, mixing pattern, finite elements method, micro scale.

Method of monitoring thermal stability of motor oils and influence of thermal degradation products on wear-resistance properties

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The results of determination of thermal stability of mineral and semisynthetic motor oils are presented. The thermal stability criterion is validated and the link between it and the wear-resistance properties of motor oils is determined.

Keywords: motor oils, thermal stability, wear-resistance properties, light absorption factor, vaporizability factor.

Rhombus well pattern reverse five points non-darcy seepage capacity calculation model based on starting pressure gradient and starting coefficient

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A rhombus well pattern reverse five points non-Darcy fluid seepage capacity calculation model has been developed for low-permeability reservoir based on characteristics of water injection into stratum, stream tube model, starting pressure gradient, and staring coefficient, using integral flow line calculation and unit analysis method. To check the adequacy of the method, the data on fluid seepage from a real low-permeability reservoir were used. The method disclosed the correlation among starting pressure gradient, starting coefficient, hole spacing, row spacing, and well production capacity. It also provided the theoretical basis for designing rhombus water injection well pattern in low permeability reservoirs.

Keywords: low permeability reservoirs, non-Darcy seepage, pressure gradient, rhombus well pattern, well production capacity model.

Foam drilling tests and analysis in soft coal mines

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As coal resources in China are becoming scarcer, development and exploitation of soft coal seam is acquiring increasing importance. However, the existing technology of drilling of structurally loose soft coal seams is not well developed. A new technology, in which foamed fluid is injected for drilling, was developed and tested in four drill holes in the Zou coal mine, Huaibei. The problems and hole collapse or pipe-sticking accidents that may occur in the drilling process and ways of their solution were analyzed. In field tests, drilling of hole 1 could not be completed because of lack of foam circulation perhaps because of resistance to foam flow due to high foam viscosity, small diameter of the triangular drill pipe used, and/or air pressure being too low to overcome resistance to foam flow. Drilling of the other three holes were completed to depths of more than 200 m, which demonstrated that the new foam drilling technology can be used to effectively increase drilling depth with reduced coal dust pollution.
Keywords: soft coal seam, foam drilling technology, field tests, hole collapse, accident analysis.

Compound percussive-rotary drilling to increase rate of penetration and life of drill bit in drilling hard rock formation

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It is generally recognized that percussive-rotary motion of polycrystalline diamond compact (PDC) bits is responsible for the low rate of penetration (ROP) and premature failure of drill bits while drilling hard rock formations. An innovative tool designated compound percussion jet (CPJ) was developed in this work to solve the problem. Because the tool generates both axial and torsional percussion, drilling with CPJ is referred as compound percussion-rotary drilling approach (CPRDA). The results of dynamics modeling and stress computation showed that the CPRDA induces more shear stresses in rock formations compared to axial percussion and axial percussion-rotary drilling. The CPRDA was tested on two wells drilled in hard rock formation. The results demonstrated that the CPRDA increased ROP by 56.1-60.4% and extended drill bit life. However, for solving the high stress problem, the tool needs to be optimized further.
Keywords: percussive-rotary drilling, ROP, stick-slip, twisting vibration. PDC, load on bit.

Influence of bound and mobile water on gas well production in low-permeability sandstone gas reservoir

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The influence of mobile and bound water on seepage capability of low-permeability sandstone gas reservoir was studied and formulas were derived to calculate gas well production rate using cores from Xujiahe low-permeability sandstone gas reservoir in China. It is shown that mobile water in the well exerts a stronger negative effect on gas production than bound water. If the pressure gradient is too steep, a small part of the bound water may turn into mobile water, whereupon the gas seepage efficiency falls. So, use of controlled pressure is recommended for gas production, which in the end enhances the gas recovery efficiency of the reservoir.
Keywords: low-permeability sandstone gas reservoir, bound water, mobile water, gas seepage, gas well production rate, production under controlled pressure.

Rheological properties of polymer drilling fluid developed for permafrost natural gas hydrate drilling

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Rheological properties of water-based drilling fluids, being heavily influenced by low-temperature conditions, are one of the most important issues of permafrost natural gas hydrate drilling. In this work, we developed a polymer drilling fluid formula and studied its rheological properties at low temperatures. The rheological properties of four different types of drilling fluids, including macro-polymers, amphoteric polymers, sulfonated polymers, and biopolymers, were tested. Corresponding rheological property/temperature response curves were drawn and the response characteristics of rheological properties with temperature were analyzed. Based on these, a novel research idea was developed to adopt poly-sulfonate drilling fluid system for permafrost drilling, in which SMC (sulfonated lignite) and SMP (sulfonated phenolic resin) were used as the main agents, while XC (xanthan gum) served as the flow pattern modifier. According to the results of orthogonal tests, the optimized drilling fluid formula is: base mud + 20 wt. % NaCl + 0.1 wt. % NaOH + 3 wt. % SMP + 4 wt. % SMC + 0.3 wt. % XC. Moreover, the rheological properties/low temperature response mechanism was analyzed using Fourier transform infrared (FT-IR) spectroscopic tests of the treating agents and scanning electron microscopic (SEM) tests of the mud cakes.
Keywords: permafrost natural gas hydrate drilling, rheological properties, low temperature, polymer drilling fluid, response mechanism.

Numerical simulation of N_2 foam flooding in medium-pemeability light oil reservoir with ultra-high water cut

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This work is the first attempt to investigate the mechanism of N2 foam flooding in an ultra-high water cut reservoir through reservoir simulation approach. The reservoir simulator CMG-STARS with a non-isothermal module is used in this work. The simulation results show that N2 foam flooding has potential for improving oil recovery in a reservoir with high water cut of 97.6%, and the best development strategy is simultaneous injection of N2 and the foaming agent in 0.3-0.4 wt.% concentration at gas-liquid ratio of 2-2.5 with a total amount of 0.3-0.35 PV (porosity volume). Under these conditions, the recovery is expected to increase by 1.2%. Thus, the investigation results indicate that oil recovery can be enhanced appreciably by N2 foam flooding in medium permeability light oil reservoir with ultra-high water cut.

Keywords: numerical simulation, N_2 foam flooding, improving oil recovery, ultra-high water cut, development strategy.