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Contents

CURRENT PROBLEMS.

Alternative Feedstock

*B. P. Tumanyan, P. Yu. Shcherbakov, E. A. Sharin,
M. E. Matin, O. A. Matveeva.* 3

Performance Study of Fatty Acids from Vegetable Oils
as Lubricity Additives to Diesel Fuel

E. A. Chernysheva, Yu. V. Kozhevnikova, E. Yu. Serdyukova, T. I. Stolonogova. 12

Possible Components for Increasing the Resources of Automobile Gasoline

TECHNOLOGIES

*S. A. Antonov, R. V. Bartko, A. I. Matveeva, B. P. Tonkonogov,
A. Yu. Kilyakova, R. V. Filatov, O. B. Dogadin, P. A. Nikulshin.* 16

Use of Modifying Additives in the Process of Solvent Dewaxing

RESEARCH

K. V. Shabalin, V. V. Neklyudov, L. E. Foss, D. N. Borisov. 27

Quantum Chemical Calculation of Asphalten Reactivity

in Electrophilic Substitution Reaction

*K. V. Shabalin, L. E. Foss, L. I. Musin, O. A. Nagornova,
A. T. Gubaidullin, A. F. Saifina, A. A. Khannanov,
I. R. Vakhitov, D. N. Borisov.* 33

Oxidation of Oil Asphaltenes Conjugated with Iodination

V. I. Vigdorovich, L. E. Tsygankova, L. G. Knyazeva, N. V. Shel. 41

Protective Efficiency of Oil Compositions in the Presence

of Sulfur-Containing Corrosion Stimulants

Cao Bo, V. S. Dergunov, S. N. Chelintsev. 48

Application of Microwave Technology to Prepare Commodity Heavy Oils
for Trunk Pipeline Transportation

ECOLOGY

A. Yu. Tshivadze, A. Ya. Fridman, B. P. Tumanyan, A. K. Novikov, 53

I. Ya. Polyakova, A. P. Sudarkin.

Promising Reagents for Accelerated Bioremediation of Oil-Contaminated Soils

INNOVATIVE TECHNOLOGIES OF OIL AND GAS

Jiang Wei, Wang Yang. 57

Using Big Data to Establish Mathematical Model Method

to Identify the Safety Displacement System of Oil Storage Tank

Yihang Zhang, Miao He, Jianjian Song, Mingbiao Xu, Peng Xu. 62

Applicability of a New Drilling Fluid System for Temporary Plugging
of Low Permeability Carbonate Reservoirs Containing H₂S and CO₂

Futang Hu, Liang Cheng, Tao Cheng, Yan Zhou, Zhiwei Jia, Yi Zhang, Liming Shao. 69

Three-dimensional Numerical Simulation of Influence of Physical Parameters

of Cement Sheath on the Stability of Separated Cementing Interfaces

Zhaozhong Yanga, Su Yanga, Jinxuan Hanb, Xiaogang Lia, 74

Yanjuan Lub, Guofa Jic, Qiang Fud.

Molecular Simulation on Competitive Adsorptions of CO₂, CH₄ and N₂ in Deep Coal Seams

Si Gong, Tinghao Jia, Lun Pan, Genkuo Nie, Xiangwen Zhang, Li Wang, Ji-Jun Zou. 80

Enhanced Thermal Oxidation Stability of Jet Fuel by Deoxygenation Treatment

Zhao Yang, Sun Tengfei, Wang Meizhu, Han Yongsheng, Mu Fuyuan, 88

Li Lin, Jiang Bo, Zhang Jidong.

Study on Production Decline Law of Junlian Coalbed Methane Development Test Well

Yihang Zhang, Jin Tian, Miao He, Jianjian Song, Yi Qin, Peng Xu, Mingbiao Xu. 93

Preparation and Properties of Single-Channel

Slim-Hole Fiber-Elastic Emulsion Cementing Slurry System

Nan Li, Xian-hong Tan, Zhong-ying Ren, Zhu Guo-jin, Xiao-feng Tian, Liu Fan. 100

Study on the Micro-Sweep Characteristic of CO₂ Flooding

Qianqian Li, Min Chen. 106

Oil Pipeline Network Evaluation Based on Multi-channel Convolution

and H-Markov Model with Co-evolution Mechanism

Qianqian Li, Min Chen. 117

Comprehensive Transportation Network Planning Method Based
on Energy Conservation Concept

Haidong Wang, Yikun Liu, Tenglong Yu, Jiqiang Zhi. 125

Study on Adaptability of Polymer Molecular Coil Dimension

in the Pore Structure of the Reservoir

Hui Li, Yan Wang, Lin Qiao, Hanxu Yang, Wei Zhou. 131

Preparation and Performance Evaluation of Hydrophobically Associating Polymer

as High-Strength Water-Swelling Temporary Plugging Material

Danchao Huang, Gang Xie, Jianguo Zou, Niyuan Peng, 139

Yao Xu, Mingyi Deng, Pingya Luo.

Molecular Structure Design Principles for Clay Hydration Inhibitors

Б. П. Туманян¹, П. Ю. Щербаков^{1,2}, Е. А. Шарин², М. Е. Матин², О. А. Матвеева²

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Исследование эффективности жирных кислот растительных масел

в качестве противоизносных присадок к дизельным топливам

Работа посвящена вопросу применения жирных кислот растительных масел в качестве противоизносных присадок к современным дизельным топливам с ультранизким содержанием серы. Приведены результаты сравнительной оценки эффективности действия жирных кислот касторового, льняного, кокосового и подсолнечного масел в базовых компонентах дизельных топлив процессов гидроочистки, гидрокрекинга и гидроизомеризации. Установлено, что все исследованные жирные кислоты растительных масел эффективны в качестве противоизносных присадок в сравнении с промышленно вырабатываемой присадкой, при этом наибольшую эффективность в качестве противоизносной присадки проявляют жирные кислоты касторового масла, которое на 90% состоит из рицинолевой кислоты.

Ключевые слова: противоизносные присадки, жирные кислоты, растительные масла, дизельное топливо, касторовое масло.

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Performance Study of Fatty Acids from Vegetable Oils

as Lubricity Additives to Diesel Fuel

Current study is devoted to the use of fatty acids of vegetable oils as lubricity additives for modern diesel fuels with ultra-low sulfur content. The results of a comparative evaluation of the effectiveness of liquid castor, linseed, coconut and sunflower oils in the base components of diesel fuels for hydrotreating, hydrocracking and hydroisomerization are presented. It has been established that all investigated FA vegetable oils are effective as anti-wear additives in comparison with a commercially available additive, while fatty acids of castor oil, which consist of 90% ricinoleic acid, are most effective as anti-wear additives.

Key words: lubricity additive, fatty acids, vegetable oils, diesel fuel, castor oil.

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Возможные компоненты для увеличения ресурсов автомобильных бензинов

В статье представлен обзор широко применяемых в мировой практике биокомпонентов и биодобавок автомобильного бензина. Исследована возможность вовлечения в систему производства моторных топлив альтернативного сырья — биомассы.

Ключевые слова: автомобильные бензины, растительное сырье, биотоплива, золькеталь.

E. A. Chernysheva, Yu. V. Kozhevnikova, E. Yu. Serdyukova, T. I. Stolonogova

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Possible Components for Increasing the Resources of Automobile Gasoline

The article presents an overview of widely used in the world practice of bio-components and additives of automobile gasoline. The possibility of involving alternative raw materials – biomass-in the system of motor fuel production is investigated.

Key words: gasoline, vegetable raw materials, biofuels, solketal.

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Использование модифицирующих добавок в процессе сольвентной депарафинизации

В статье представлены варианты интенсификации процесса сольвентной депарафинизации, среди которых перспективным и малозатратным является использование модифицирующих добавок. Описаны модифицирующие добавки, относящиеся к различным классам химических веществ. В настоящее время среди модифицирующих добавок наибольший интерес представляют полимерные композиции на основе поли(мет)акрилатов с 10–30 атомами углерода в алкильном радикале. Использование соединений данного типа в процессе сольвентной депарафинизации позволяет значительно увеличить скорость фильтрации сырьевой суспензии, что сказывается на увеличении производительности установки. При этом увеличивается выход депарафинированного масла в среднем на 5% и снижается содержание масла в гаче/петролатуме.

Ключевые слова: модифицирующая добавка, рафинат, депарафинизация.

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Use of Modifying Additives in the Process of Solvent Dewaxing

The article uses versions of intensification of solvent dewaxing process, among which the use of modifying additives is promising and low-cost. Modifying additives belonging to different classes of chemicals are described. Polymer compositions based on poly(meth)acrylates with 10-30 carbon atoms in an alkyl radical are currently of greatest interest among the modified additives. The use of compounds of this type in the solvent dewaxing process significantly increases the filtration rate of the suspension. This aspect affects the increase in plant productivity. At the same time the content of dewaxed oil increased by 5% on average and the content of oil in paraffin slop wax/petrolatum decreased.

Key words: *modifying additive, raffinate, solvent dewaxing.*

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Моделирование реакционной способности асфальтенов в реакциях электрофильного замещения

Проведено квантово-химическое моделирование пространственной и электронной структуры асфальтенов, содержащих различное число электроноакцепторных заместителей, с помощью метода DFT/B3LYP-6-31G(d,p) для предсказания реакционной способности нефтяных асфальтенов при их химической модификации. Изучено изменение торсионного угла поликонденсированной ароматической асфальтеновой структуры в зависимости от типа заместителя. Проанализированы электронная структура и зарядовое распределение электронной плотности по ароматическим атомам углерода с целью определения преимущественного направления реакции электрофильного замещения изученных модельных структур асфальтенов. Показано, что высокая степень поликонденсированности асфальтенов, а также наличие ароматических гетероциклических фрагментов, выступающих в качестве электронодоноров, не оказывает значительного влияния на направление атаки электрофильного реагента, введение электроноакцепторных заместителей снижает скорость реакции электрофильного замещения.

Ключевые слова: квантово-химическое моделирование, асфальтены, реакционная способность, электрофильное замещение.

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Quantum Chemical Calculation of Asphaltene Reactivity in Electrophilic Substitution Reaction

Quantum-chemical modeling of the spatial and electronic structure of asphaltenes containing different numbers of electron-withdrawing substituents was carried out using the DFT / B3LYP-6-31G (d, p) method to predict the reactivity of petroleum asphaltenes upon their chemical modification. The change in the torsion angle of the polycondensed aromatic asphaltene structure depending on the type of substituent was studied. The electronic structure and charge distribution of the electron density over aromatic carbon atoms are analyzed in order to determine the predominant direction of the electrophilic substitution reaction for the studied model structures of asphaltenes. It was shown that the high degree of polycondensation of asphaltenes, as well as the presence of aromatic heterocyclic fragments acting as electron donors, does not significantly affect the direction of attack of the electrophilic reagent; the introduction of electron-withdrawing substituents decreases the rate of the electrophilic substitution reaction.

Key words: *quantum chemical calculations, asphaltenes, reactivity, electrophilic substitution.*

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Окисление нефтяных асфальтенов сопряженное с иодированием

В работе описано окисление нефтяных асфальтенов йодатом калия. Показано, что в мягких условиях окисление сопровождается иодированием ароматического ядра асфальтенов. Индуцирующей реакцией является окисление сульфидных атомов серы, входящих в состав асфальтенов с восстановлением иодат-аниона до молекулярного йода, а сопряженной — электрофильное замещение. Методом рентгеновской фотоэлектронной спектроскопии зафиксировано увеличение массовой доли кислорода по сравнению с исходным образцом, а также образование связей типа углерод — йод. С помощью ИК-спектроскопии установлено, что окисление асфальтенов сопровождается образованием карбоксильных и сульфоксидных групп. Спектроскопией комбинационного рассеяния света выявлено уменьшение размеров молекул окисленных асфальтенов по сравнению с нативными асфальтенами. Методом порошкового рентгеноструктурного анализа показано уменьшение межплоскостного расстояния продукта окисления асфальтенов за счет упорядочивания и более плотного расположения алифатических фрагментов.

Ключевые слова: асфальтены, иодирование, окисление, рентгеновская фотоэлектронная спектроскопия, комбинационное рассеяние света.

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Oxidation of Oil Asphaltes Conjugated with Iodination

The paper describes the oxidation of petroleum asphaltenes by potassium iodate. It was shown that under mild conditions, oxidation is accompanied by iodination of the aromatic core of asphaltenes. The inducing reaction is the oxidation of sulfide sulfur atoms that are part of asphaltenes with the reduction of the iodate anion to molecular iodine, and the conjugated one is electrophilic substitution. By the method of X-ray photoelectron spectroscopy, an increase in the mass fraction of oxygen as compared with the initial sample was recorded, as well as the formation of carbon-iodine bonds. Using the method of IR spectroscopy, it was found that the oxidation of asphaltenes is accompanied by the formation of carboxyl and sulfoxide groups. Raman spectroscopy revealed a decrease in the size of molecules of oxidized asphaltenes compared to native asphaltenes. The method of powder X-ray diffraction analysis was showed a decrease in the interplanar spacing of the asphaltene oxidation product due to the ordering and denser arrangement of aliphatic fragments.

Key words: asphaltenes, iodination, oxidation, X-ray photoelectron spectroscopy, Raman scattering.

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Защитная эффективность масляных композиций в присутствии серосодержащих стимуляторов коррозии

Изучена защитная эффективность масляных композиций против коррозии стали в присутствии диоксида серы. С ростом относительной влажности воздуха и исходной концентрации сернистого газа в атмосфере возрастает влагопроницаемость масляных пленок, а также скорость коррозии стали, как защищенной, так и незащищенной масляными пленками. Рассмотрен вклад отдельных компонентов в защитное действие пленки синтетического масла Мобил-1, ингибированного присадкой Эмульгин, в присутствии диоксида серы. Общая защитная эффективность системы через 1 сут. может достигать 93–96% в 0,5М растворе хлорида натрия, содержащем диоксид серы и продукты его взаимодействия с водой. Замедление коррозии стали под слоем ингибированной и неингибированной масляной пленки обусловлено преимущественно замедлением катодного процесса при незначительном торможении анодной реакции.

Ключевые слова: масло, диоксид серы, коррозия, сталь, ингибитор, защитная эффективность, дифференциация вкладов.

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Protective Efficiency of Oil Compositions in the Presence of Sulfur-Containing Corrosion Stimulants

The protective effectiveness of oil compositions against steel corrosion in the presence of sulfur dioxide was studied. Moisture permeability of oil films; the corrosion rate of steel, both protected and unprotected with oil films, increases with increasing relative humidity and the initial concentration of sulfur dioxide in the atmosphere. The contribution of individual components to the protective effect of a film of synthetic Mobil-1 oil inhibited by the additive of Emulgin in the presence of sulfur dioxide is considered. The total protective effectiveness of the system can reach 93-96% for a day in a 0.5 M sodium chloride solution containing sulfur dioxide and the products of its interaction with water. The slowdown in steel corrosion under a layer of inhibited and non-inhibited oil film is mainly due to a retardation of the cathodic process with a slight inhibition of the anodic reaction.

Key words: oils, sulfur dioxide, corrosion, steel, inhibitor, protective efficiency, contribution differentiation.

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Применение микроволновой технологии для подготовки товарных тяжелых нефтей к перекачке по магистральным трубопроводам

В работе рассматриваются технические и экономические аспекты применения технологии транспортировки по магистральным трубопроводам товарной тяжелой нефти после ее обработки сверхвысокочастотным электромагнитным полем (2450 МГц), которая рассматривается как альтернатива перекачки предварительно нагретых нефтей. Сравнение стоимостей жизненных циклов (LCC) названных технологий показало, что для обеспечения требуемой пропускной способности транспортировка нефти после ее микроволновой обработки является предпочтительной по сравнению с «горячей» перекачкой. При транспортировке нефти после микроволновой обработки уменьшение эксплуатационных затрат на перекачку и обработку/нагрев объясняется снижением ее вязкости из-за термоллиза гетероатомных высокомолекулярных компонентов и одновременным объемным разогревом ее до температуры близкой к начальной температуре нефти при «горячей» перекачке.

Ключевые слова: товарная тяжелая нефть, микроволновая обработка нефти, «горячая» перекачка, неизотермические нефтепроводы, тепловой и гидравлический расчеты, стоимость жизненного цикла технологии.

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Application of Microwave Technology to Prepare Commodity Heavy Oils for Trunk Pipeline Transportation

This paper studies technical and economic aspects of the application of transporting heavy commodity oils by trunk pipelines after its microwave treating (2450 MHz), which is considered to be an alternative to a transportation of preheated crudes. A comparison of the abovementioned technologies life cycle costs (LCC) indicated that to provide required pipeline capacity a crude transportation after its microwave treating is the preferred technology compared to the transportation of the preheated oil. During the crude oil transportation after its microwave treating a reduction of pumping and treatment/heating operational costs is explained by its viscosity decrease due to a thermolysis of heteroatomic high molecular weight components and its simultaneous volumetric heating to a temperature close to the initial temperature of the oil during preheated oil pumping.

Key words: commodity heavy oil, microwave oil treatment, transportation of the preheated crude oil, non-isothermal crude oil pipelines, thermal and hydraulic designs, technology life cycle cost.

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Перспективные препараты для ускоренной биоремедиации нефтезагрязненных почв

Нефтяные загрязнения представляют серьезную угрозу для животного мира и растений.

Техногенные нарушения могут привести к полному или частичному уничтожению почвенного покрова.

Создание новых и совершенствование существующих способов очистки почв и рекультивации почвенного покрова является актуальной проблемой. В статье рассматриваются перспективные реагенты для очистки и рекультивации нефтезагрязненных почв путем биоремедиации. Показана перспективность применяемых реагентов в сравнении с существующими аналогами.

Ключевые слова: нефтяные загрязнения, биоремедиация, нефтезагрязненные почвы, переработка нефтешлама, поликомплексон.

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Promising Reagents for Accelerated Bioremediation of Oil-Contaminated Soils

Oil pollution is a serious threat to wildlife and plants. Man-made disturbances can lead to complete or partial destruction of the soil cover. Creation of new and improvement of existing methods of soil cleaning and soil cover reclamation is an urgent problem. The article discusses promising reagents for cleaning and reclamation of oil-contaminated soils by bioremediation. The prospects of the used reagents in comparison with existing analogues are shown.

Key words: oil pollution, bioremediation, oil-contaminated soils, oil sludge processing, polycomplexon.

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Using Big Data to Establish Mathematical Model Method to Identify the Safety Displacement System of Oil Storage Tank

According to the requirements of the topic, this paper establishes the corresponding mathematical model for the specific problem, and solves the problem accurately. The problem is analyzed step by step to the data and the theoretical solution value, and the relationship between them is obtained. Based on this, a reasonable conclusion is obtained. For the problem, firstly, the cross-sectional method is used to establish the mathematical model for the relationship between the theoretical oil capacity and the oil level height without displacement and displacement. Then, according to the oil-free high oil level given in Annex 1, the corresponding theoretical oil quantity is obtained and compared with the actual oil quantity value, and the relative deviation between the two is found. Basically, the stable value is 3.371%, and the correction function of the theoretical oil quantity is obtained according to the relationship between the two. At the same time, the deviation function is applied to the oil without displacement, and the relative error of the absolute oil output is compared by comparing the two adjacent moments. Verify the correctness of the correction function. Then, according to the corrected theoretical oil quantity corresponding to the tilting displacement oil and the actual oil quantity, it is analyzed that when the liquid level is small, the tank volume reading is small when the liquid level is small, and the reading is too large when the liquid level is high. in

conclusion. Finally, using MATLAB to write the program, the tank capacity is calibrated according to the oil level height interval of 1cm after the displacement.

Key words: cross-section method, big data, triple integral, ergodic method, ndepso algorithm.

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Applicability of a New Drilling Fluid System for Temporary Plugging of Low Permeability Carbonate Reservoirs Containing H₂S and CO₂

In view of the special geological characteristics of the complex carbonate reservoir in Asmari reservoir of Missan oilfield, in order to effectively control the damage of working fluid to the reservoir when drilling multi-pressure reservoir, and prevent the occurrence of well leakage, blowout and well collapse in long open hole reservoir. In this paper, a new temporary plugging drilling fluid formulation system for low permeability carbonate reservoir containing H₂S and CO₂ in target block is designed by using self-developed acid-soluble temporary plugging agent DSK-1 combined with HCOONa and modified biopolymer VS-A flow pattern regulator, modified starch water loss reducer and DSP antioxidant. The temperature resistance, formation water pollution resistance, inhibition and acid gas and fluid resistance of the system were evaluated. At the same time, The temporary plugging experiments on cores taken from the site show that the recovery rate of plugging removal of the formula system is up to 86.3%, which can effectively meet the target requirements, and provide some guidance and reference for the follow-up study of temporary plugging drilling fluid for acid low permeability carbonate rock.

Key words: low permeability; carbonate reservoir; drilling fluid; system, Missan Oilfield.

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Three-dimensional Numerical Simulation of Influence of Physical Parameters of Cement Sheath on the Stability of Separated Cementing Interfaces

The current research on the stability of the formation-cement sheath-casing combination is mainly based on the plane, and the established 3D model is just an example. There is no systematic study under the three-dimensional model and the triaxial ground stress, when the influence of the physical parameters on the stability of the composite cementing interfaces are separated. By establishing a three-dimensional formation-cement sheath-casing combination, the two cementing interfaces are separated under the action of triaxial ground stress, the effects of physical properties (Elastic Modulus, Poisson's ratio, density) of the cement sheath on the contact pressure and spacing of the cemented interfaces are studied. According to the established theoretical model, the influence of different physical parameters on well integrity after cementing in Qinghai Oilfield were analyzed, which provided theoretical support and guidance for the occurrence of out-of-tube turbulent flow and instability mechanism, and pointed out the direction for

subsequent construction operations such as profile control and water plugging. The physical properties of the cement sheath are preferred to ensure long-term sealing of the combination.

Key words: cementing; physical parameters; cement sheath; three-dimensional; formation; casing; crustal stress.

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Molecular Simulation on Competitive Adsorptions of CO₂, CH₄ and N₂ in Deep Coal Seams

We simulated the competitive adsorption of CO₂, CH₄ and N₂ in deep coal seams by building a graphite supercell structure and discussed the impact of pressure, pore size and multicomponent on CH₄ desorption. The results show that the adsorption capacity of a single component is in the order of CO₂ > CH₄ > N₂. For the CH₄/CO₂ competitive adsorption, absorbed CO₂ can reach saturation at low pressure. CO₂ has adsorptive advantage compared with CH₄, and CO₂ can promote the CH₄ desorption by means of displacement. For CH₄/N₂ competitive adsorption, the adsorption capacity of N₂ is weaker than that of CH₄ demonstrating that the improvement in coalbed methane (CBM) production by N₂ injection is achieved by reducing the partial pressure and creating flow channels. The presence of H₂O has a greater impact on the gas with a stronger adsorption capacity in the binary component system. For the CH₄/CO₂/N₂ competitive adsorption, the CO₂ adsorption is dominant at 1 nm slit pore, while CH₄ adsorption is dominant for 2 nm slit pores. This indicates that by increasing the pore diameter, CO₂/N₂ injection does not promote CH₄ desorption. H₂O also has a significant impact on the competitive adsorption in the ternary component system. The strong interaction between H₂O and CO₂ weakens the CO₂ adsorption capacity.

Key words: coalbed methane; competitive adsorption; pore diameter; moisture content; molecular modeling.

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Enhanced Thermal Oxidation Stability of Jet Fuel by Deoxygenation Treatment

Thermal oxidation stability is an important parameter for jet fuel practical application. In this work, the deoxygenated fuels (JP-10 and RP-3) by nitrogen purge underwent the accelerated thermal oxidation (180, 200 and 220°C) to evaluate the influence of deoxygenation on fuel stability, during which the hydroperoxide number, total acid number, the size distribution of insoluble oxidation species and the concentration of remaining antioxidant (butylated hydroxytoluene, BHT) were monitored and analyzed. The results show that the deoxygenation and the thermal oxidation have very little influence on the fuel physical properties (density, net heating value and kinematic viscosity). However for the accelerated thermal oxidation, the deoxygenation greatly reduces the hydroperoxide number and the

total acid number, with more BHT reserved in the fuel. Moreover, the deoxygenation treatment also inhibits the formation tendency of soluble macromolecular oxidatively reactive species (SMORS) and insoluble oxidation species such as gums and deposits.

Key words: fuel oxidation, deoxygenation treatment, hydroperoxide number, total acid number.

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Study on Production Decline Law of Junlian Coalbed Methane Development Test Well

For the production decline law of coal-bed methane wells, production decline can be divided into three types: exponential decline, hyperbolic decline and harmonic decline. The research of production decline law is very important for the evaluation of the CBM productivity. This paper has studied on the law of production decline in junlian region and got the production decline type of low, medium, high production wells. At last, this paper gave the dynamic reserves calculation and recovery evaluation methods and steps using FAST-CBM coal-bed methane reservoir analysis system software.

Key words: production decline, CBM, exponential, harmonic decline, hyperbolic decline.

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Preparation and Properties of Single-Channel Slim-Hole Fiber-Elastic Emulsion Cementing Slurry System

This paper is aimed at the problems of weak cement sheath, weak impact strength, low compressive strength, low bonding quality and so on in slim-hole cementing. The cement slurry system was improved by self-developing elastic emulsion combined with toughening fiber. And compared the influence of different toughened materials on the mechanical properties of cement stone. The evaluation results show that the cement slurry system exhibits good rheological properties through the combination of fiber and elastic emulsion. Pumping resistance is small, high temperature and high pressure filter loss is less than 30 mL, slurry is stable, no free liquid, but also shows good shrinkage resistance, thickening time can be adjusted for 3-5 hours. In addition, in terms of mechanical properties, the impact strength of cement stone under 0.3% carbon fiber +15% elastic emulsion is greater than 2.2KJ·m², the compressive strength at 24h is greater than 20MPa, the resistance to gas is 15.6MPa, and the shear strength is greater than 3.5MPa. The tensile strength is greater than 300KPa, which fully meets the needs of field applications.

Key words: single channel, slim-hole, cementing, fiber-elastic emulsion.

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Study on the Micro-Sweep Characteristic of CO₂ Flooding

Micro multi-phase flow equation is built based on the mechanism of multi-phase fluid flow in porous media in this paper. We considered the convection diffusion and the improved component mixing rule. In order to be more close to the low permeability reservoir, the micro model is not only simple pore throat but also complex pore throat. We predict the residual oil distribution characteristics of CO₂ flooding in low permeability reservoir by finite element micro simulation, and verify it by experiment. Furthermore, we analyzes the micro flow characteristics of CO₂ flooding for the different wettability. The results show that: compared to the high permeability reservoir, CO₂ flooding improving micro sweep volume by convective diffusion is more obvious in the low permeability reservoir; the mainly distribution patterns of residual oil are the prismatic residual oil, the wedge-shape residual oil and the membrane residual oil. With the wetting angle of fluid and rock decreased by the process of CO₂ flooding, Micro displacement efficiency further improved.

Key words: CO₂ flooding, microscopic flow characteristic, wettability.

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Oil Pipeline Network Evaluation Based on Multi-channel Convolution and H-Markov Model with Co-evolution Mechanism

With the development of oil pipeline transportation domain, the layout of regional oil pipeline transportation network is dually influenced by regional development and its own evolution, more than that, it is a dynamic concept. In order to get more reasonable evaluation results, it is necessary to improve the traditional evaluation method by the way of regarding the network layout behavior and regional space expansion behavior as interactive objects in this paper. On the basis of analyzing regional development characteristics and pipeline transportation network layout demands from the perspective of spatiotemporal, the co-evolution mechanism between them is dissected. Based on this, the multi-dimensional layout evaluation index system is constructed from four dimensions, a layout evaluation model of oil pipeline transportation network based on multi-channel convolution and Hidden-Markov model with co-evolution mechanism (i.e. CEM-MCNN-HMM) is proposed, which serve as a framework of co-evolutionary behavior recognition to use convolution kernel of different sizes to extract feature information of different granularity from data in different channels, effectively obtain the property features, behavior features and interactive features of the behavior objects, and then convert the behavior recognition problem into classification problem. Using Hidden-Markov model to excavate the status dependent relations with a certain span of time and modify the classification results to improve the robustness of the model. At last, take real data set as training data, test the performance of the proposed model from three aspects: the rationality test of using fractal dimension metrics and resetting fractal measured unit, model evaluation criteria based on confusion matrix analysis. The result shows that the performance of CEM-MCNN-HMM is best among all models and can improve the judgment level of transport network layout.

Key words: oil pipeline network layout evaluation model, co-evolution mechanism, coevolutionary behavior recognition, convolution kernel of different sizes, HMM.

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Comprehensive Transportation Network Planning Method Based on Energy Conservation Concept

Under the background of new urbanization, following the concept of "intensive, energy-saving and ecological", the idea of "interactive development of transportation and land use, minimum energy consumption and environmental damage" is put forward. Regional comprehensive transportation network with land use and travel demand as the main body will become the main trend of low-carbon ecological comprehensive transportation planning strategy. Based on the three-level programming model, this paper cooperates with the dynamic mutual feed relationship among the three at the planning level, and carries out comprehensive optimization design on them. Decision variables include not only the decision of land use change, but also the construction and renovation of traffic routes. In order to solve the complex mixed integer nonlinear model, the hybrid method of augmented dual algorithm and sequential average algorithm is adopted to solve the lower model and the heuristic algorithm is adopted to effectively solve the integrated model, thus obtaining the optimal comprehensive transportation network layout scheme and the optimal land use scheme. Finally, a multi-scale space is taken as a research unit to carry out an example analysis. The results verify the effectiveness of the proposed model and method, which can improve the scientificity and rationality of the planning.

Key words: low carbon ecology, regional integrated transportation distribution network, augmented dual algorithm, heuristic algorithm.

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Study on Adaptability of Polymer Molecular Coil Dimension in the Pore Structure of the Reservoir

A series of experiments were carried out to study the matching relationship between pore structure in reservoir and the molecular radius of gyration. The hydrodynamic radius D_h (molecular coil dimension) was tested by dynamic light scattering and it was used to characterize the crimping degree of polymer chains and molecular coil dimension. The storage modulus and loss modulus was studied through creep recovery. CT scan was used to get the parameters of pore throat structure in the reservoir. Finally, experiment of polymer injection has been carrying out to indicate the adaptability of polymer molecular coil dimension in reservoir pore structure. Comparing pore radius with the molecular radius of gyration, shows that the storage modulus ratio is the key critical factor of oil displacement efficiency and the range of 10-20. Also, stable pressure gradient at 0.05-0.3 MPa/s is good; stable pressure gradient at 0.3-0.6 MPa/s is medium; stable pressure gradient above 0.6 MPa/s or no stable pressure gradient is bad. Greater molecular weight and higher concentration of polymer in the core with low permeability has no stable pressure.

Key words: molecular weight, creep recovery, polymer viscosity, pore throat structure.

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Preparation and Performance Evaluation of Hydrophobically Associating Polymer as High-Strength Water-Swelling Temporary Plugging Material

The use of degradable polymer materials to control working fluid flow during hydraulic fracturing is an area of interest in stimulation technology. A temporary plugging agent with high compressive strength is used to block the pre-fracturing or natural old cracks, and then the new joints are pressed at different positions by repeated fracturing to increase the oil and gas passages, thereby realizing a stable production of oil and gas reservoirs. The temporary plugging agent temporarily blocks the particles or liquid from entering the pre-existing cracks, allowing the fracturing fluid to transfer to create new cracks within the reservoir and create a more complex network of fractures. In view of the needs of this technology, the temporary plugging agent not only has strong pressure resistance, but also has good water solubility, can lose the blocking ability in a certain time, and has good returning performance, which can make new and old cracks simultaneously effect. This method can achieve oiling effect. A new type of internal temporary plugging agent was developed, and the mechanism of temporary plugging of temporary plugging agent was evaluated through experiments, including temporary plugging material microstructure, particle size, water absorption, water absorption speed, temporary plugging effect and conductivity after dissolution. The research shows that the temporary plugging agent has a good temporary plugging effect, no pollution to the oil well, and can play a good protective role on the reservoir in repeated fracturing.

Key words: temporary plugging agent, water swelling, plugging strength, conductivity.

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Molecular Structure Design Principles for Clay Hydration Inhibitors

The crucial challenge associated with water-based drilling fluids for the extraction of shale gas is the inhibition of clay hydration in the drilling operation. In the design of efficient shale inhibitors, the selection of appropriate groups is important. In this report, three inhibitors with different amounts of amine and hydroxyl groups were used to study their inhibition performance, inhibition mechanism, and their environmental friendliness. Given that amine groups can replace cations and decrease basal spacing, unlike hydroxyl groups, the former exhibits superior inhibition performance. In terms of biodegradability, the amine group is better than the hydroxyl group. However, the hydroxyl group has better performance compared to the amine group with respect to toxicity. Thus, the design principle of the chemical groups is that the inhibitor should consist of both the amine and the hydroxyl groups. For proper inhibition,

the inhibitor should contain the amine as the basic group. By adjusting the number of hydroxyl groups, inhibitors with excellent biotoxicity can be designed.

Keywords: Shale gas, clay hydration, inhibitors, design principle, amine group, hydroxyl group.