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Особенности структуры частиц CO₂-асфальтенов гудрона, осажденных с использованием различных органических разбавителей

Методом просвечивающей электронной микроскопии проведено исследование структуры частиц CO₂-асфальтенов, выделенных из образца гудрона в процессе GAS (gas anti-solvent) с использованием гептана, толуола и их смеси (гептола) в качестве разбавителей. Показано, что CO₂-асфальтены, несмотря на меньшую ароматичность и полярность по сравнению с C₇-асфальтенами, имеют схожую с ними нерегулярную слоистую внутреннюю структуру, а также близкое распределение числа ароматических слоев и расстояние между слоями в упаковках образующихся кристаллитов. Тип используемого разбавителя гудрона влияет не только на выход и состав осаждаемых в их присутствии CO₂-асфальтенов, но и на степень упорядоченности и размеры слоев полициклических ароматических фрагментов молекул, формирующих их структуру. В этой связи толуол в качестве разбавителя обеспечивает получение CO₂-асфальтенов, которые по своей молекулярной структуре и структурным параметрам сопоставимы с частицами C₇-асфальтенов.

Ключевые слова: асфальтены, гудрон, сверхкритический диоксид углерода, анти-растворитель, просвечивающая электронная микроскопия.

R. N. Magomedov, A. V. Pripakhaylo, D. I. Panyukova, L. S. Foteeva, T. A. Maryutina.

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Structural Features of CO₂-Asphaltene Particles Precipitated from Vacuum Residue Using Various Organic Diluents

The method of transmission electron microscopy (TEM) was used to study the structure of particles of CO₂-asphaltenes precipitated from a vacuum residue sample in the gas anti-solvent (GAS) process using heptane, toluene and their mixture (heptol) as diluents. It has been shown that CO₂-asphaltenes, despite less aromaticity and polarity compared to C₇-asphaltenes, have a similar irregular layered internal structure, as well as a close distribution of the stacking number and the interlayer spacing. The type of the diluent used affects not only the yield and composition of the precipitated CO₂-asphaltenes, but also the degree of order and the size of layers of aromatic cores in the molecules forming their structure. In this regard, toluene as a diluent provides the formation of CO₂-asphaltenes, which in their molecular structure and structural parameters are comparable to C₇-asphaltenes particles.

Key words: *asphaltenes, vacuum residue, carbon dioxide anti-solvent, transmission electron microscopy (TEM).*

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Гидровисбрекинг мазута на инертной насадке ячеистой структуры

Исследован процесс гидровисбрекинга прямогонного мазута в реакторе с восходящим потоком сырья в присутствии инертной насадки-турбулизатора с ячеистой структурой, свободный объем которой составляет 65%. При умеренных для такого процесса условиях (температура — 450°C, давление 5 МПа) была достигнута конверсия сырья 55,1%. Конверсия нелетучего остатка, выкипающего выше 540°C составила 90%, глубина деметаллизации — 96%, конверсия смол и асфальтенов достигла 76%.

Основной получаемый в процессе гидровисбрекинга продукт — керосино-газойлевая фракция, выход которой составил 43,6%. Дистиллятные продукты исследованного процесса гидровисбрекинга по качеству схожи с дистиллятами процесса замедленного коксования, за исключением более низкого содержания серы и полного отсутствия кремния. Неконвертированный остаток гидровисбрекинга, полученный после удаления светлых дистиллятов при атмосферном давлении, имеет низкую вязкость, низкую температуру застывания и может использоваться в качестве сырья процесса гидроочистки, направленного на получение малосернистого судового топлива

Ключевые слова: гидровисбрекинг, тяжелая нефть, тяжелое сырье, тяжелый остаток, мазут, судовое топливо, инертный материал.

R. E. Boldushevskii^{1,2}, R. F. Iuzmukhametova², S. A. Antonov^{1,2}, A. I. Matveeva², P. P. Minaev^{1,2}, A. V. Iusovskii^{1,2}, A. I. Guseva^{1,2}, P. A. Nikulshin^{1,2}.

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Hydrovisbreaking of Atmospheric Residue under Cellular-Structured Inert

The non-catalytic hydrovisbreaking of straight-run atmospheric residue in an upflow reactor filled with cellular-structured inert with free reactor volume about 65% was investigated. Feed conversion up to 55.1 % was observed at moderate for such type of process reaction condition: temperature of 450°C and hydrogen pressure of 5 MPa. Conversion of non-volatile hydrocarbons, boiling higher than 540°C, was up to 90 %, demetallization rate was up to 96 % with asphaltenes and resins conversion was up to 76%. The preliminary product of atmospheric residue conversion is gasoil. Distillate hydrovisbreaking products are similar to coker products, except lower sulfur content and silicon absence. Unconverted residue is low viscous, has a low pour point, and ready for direct hydrotreating for marine fuel production.

Key words: hydrovisbreaking, heavy crude, atmospheric heavy residue, atmospheric residue, marine fuel, inert materia.

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Прогнозирование выходов низших олефинов при пиролизе углеводородного сырья

На основе проведенных исследований и литературных данных по процессу пиролиза различного углеводородного сырья разработан метод прогнозирования выхода непредельных углеводородов при пиролизе индивидуальных углеводородов алканового ряда, а также

смешанного углеводородного сырья. Предлагаемый метод является универсальным для любого типа сырья и позволяет предварительно оценить максимально возможный выход целевых продуктов пиролиза как перед началом экспериментальных исследований, так и в ходе промышленной эксплуатации установок пиролиза.

Ключевые слова: пиролиз, олефины, этилен, пропилен, прогнозирование выхода, сырье процесса, равновесные выходы.

R. G. Khasanov, F. R. Mutazin.

Ufa State Petroleum Technical University, Branch of the University in the city of Salavat

Prediction of Yields of the Lower Olefins during Pyrolysis of Hydrocarbon Raw Materials

A method for predicting the yield of unsaturated hydrocarbons during pyrolysis of individual alkane hydrocarbons and mixed hydrocarbons based on the conducted research and on literature data was developed. The proposed method is universal for any type of raw material and allows us to pre-evaluate the maximum possible yield of the target pyrolysis products both before starting experimental researches and during industrial operation of pyrolysis plants.

Key words: *pyrolysis, olefins, ethylene, propylene, yield prediction, process raw materials, equilibrium yields.*

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Удаление продуктов старения из работающих моторных масел без их слива из картеров двигателей машин

Установлены закономерности изменения содержания загрязнений и щелочного числа моторного масла в процессе его очистки. Определено, что внесение в работающее в двигателе моторное масло смеси гидроксида аммония с карбамидом 1% способствует укрупнению мелкодиспергированных частиц загрязнений. Последующее центрифугирование встроенными в систему смазки средствами очистки позволяет удалить из масла практически все загрязнения. Установлена зависимость содержания нерастворимого осадка и щелочного числа от продолжительности работы в двигателе моторного масла с введенным реагентом. Определено, что периодическая очистка моторного масла предложенным способом позволяет продлить срок его службы до замены и повысить эксплуатационные характеристики двигателя внутреннего сгорания.

Ключевые слова: моторное масло, загрязнения, коагулянт, реагент, очистка, двигатель.

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Results of Research on Removal of Aging Products from Operating Motor Oils without Their Drain from Car Engine Carters

The dependences of changes in the content of contaminants and the alkaline number of motor oil in the process of refining it are established. It was determined that the introduction of a mixture of ammonium hydroxide with urea 1% into a working engine oil promotes the enlargement of finely dispersed particles of contaminants. Subsequent centrifugation with cleaning agents built into the lubrication system allows you to remove almost all contaminants from the oil. The dependences of changes in the content of insoluble precipitate and alkaline number on the time of its operation in the engine under the action of a reagent are established. It is determined that periodic cleaning of engine oil by the proposed method allows to extend its service life until replacement and to increase the operational characteristics of the internal combustion engine.

Key words: engine oil, pollution, coagulant, reagent, cleaning, engine.

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на основе активированного гидроксидом калия нефтяного кокса

Предложена методика получения формованного углеродного адсорбента на основе активированного гидроксидом калия сырого нефтяного кокса и нефтяного пека в качестве связующего материала.

На основе приготовленной в различных соотношениях смеси были сформованы гранулы и карбонизованы при температуре около 800 °С. Установлено, что готовый продукт при количестве добавленного пека 30% сохраняет величину эффективной удельной поверхности на уровне 60–65% от поверхности используемого наполнителя (активированного кокса). С учетом прочности гранул на раздавливание рекомендуется количество связующего принимать от 20 до 30%, удельная поверхность гранул при этом составит 600–1100 м²/г.

Ключевые слова: активный уголь, активированный уголь, щелочная активация, гидроксид калия.

P. V. Kugatova, B. S. Zhirnov .

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The Pelletized Carbon Adsorbent from KOH-Activated Petroleum Coke

A method for producing a pelletized carbon adsorbent based on crude petroleum coke activated by potassium hydroxide and petroleum pitch as a binder is proposed. On the basis of the mixture prepared in various ratios, granules were formed and carbonized at a temperature of about 800°C. It was found that the finished product with an added pitch of 30% retains the effective BET specific surface area at the level of 60–65% of the surface of the used filler (activated coke). Taking into account the crushing strength of granules, it is recommended that the amount of binder be taken from 20 to 30%, the specific surface of granules will be 600–1100 м²/g.

Key words: activated carbon, alkalina activation, potassium hydroxide.

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Оптимизация процесса выделения диоксида углерода из дымовых газов

Изучены кинетические закономерности процесса выделения диоксида углерода из дымовых газов.

Разработана математическая модель для регулирования температуры нестационарных турбулентных течений в процессе абсорбции при гомогенном горении. Определено также влияние различных гидродинамических и физико-химических факторов на процесс выделения диоксида углерода из дымовых газов при использовании в качестве абсорбента ДЭА. На основе разработанной математической модели проведена оптимизация процесса выделения диоксида углерода из дымовых газов. В результате найден оптимальный технологический режим проведения процесса. Математическая модель позволяет оптимизировать процесс абсорбции и уменьшить концентрацию диоксида углерода в дымовых газах с 1,2–2,6 до 0,011–0,014%.

Ключевые слова: дымовые газы, диоксид углерода, абсорбция, модель, оптимизация.

F. V. Yusubov, E. F. Mansurov.

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Optimization of Carbon Dioxide Emission from Flue Gases

The kinetic dependence of the absorption process of carbon dioxide emission from flue gases were studied. A mathematical model has been developed to control the temperature of unsteady turbulent flows, in the presence of homogeneous combustion and the absorption process, the emission of carbon dioxide from flue gases. The influence of various hydrodynamic and physico-chemical factors on the emission process of carbon dioxide from flue gases with diethanolamine, was also determined. Based on the developed mathematical model, the process of carbon dioxide evolution from flue gases was optimized. As a result, the optimal technological regime of the process was found. After the development of a complete mathematical model and the optimization process of the emission of carbon dioxide from flue gases on its basis, the concentration of CO₂ from 1.2–2.6% decreases in the range of 0.011–0.014%.

Key words: flue gases, carbon dioxide, absorption, model, optimization.

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Исследование экологической безопасности антикоррозионных агентов с различной длиной гидрофобного радикала

В данной работе экспериментальными методами погружения и линейного расширения исследованы антикоррозионные свойства алкилдиаминов. Результаты экспериментов показали, что алкилдиамины обладают высокими антикоррозионными свойствами, однако при увеличении количества атомов углерода растворимость алкилдиаминов падает и эффект ингибирования выражен слабее. Результаты измерений

показали, что показатель биоразлагаемости алкилдиаминов в качестве антикоррозионных добавок к буровым растворам постепенно увеличивается при увеличении числа атомов углерода, в то время как растворимость и биотоксичность уменьшаются. Таким образом, чем больше длина углеводородной цепочки алифатического радикала диамина, тем лучше экологические характеристики антикоррозионного агента. Результаты исследования могут быть полезны для разработки и синтеза новых антикоррозионных агентов на основе органических аминов.

Ключевые слова: алкилдиамин, длина углеводородной цепочки, антикоррозионный, биоразлагаемость, биотоксичность.

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Study on Environmental Protection Performance of Anti-collapse Agents with Different Hydrophobic Chain Lengths

Organic amines are commonly used as anti-collapse agents because of their good anti-collapse properties, in this paper, alkali diamines have been selected as research objects to evaluate the anti-collapse abilities by immersion experiments and linear expansion experiments. The experimental results showed that the alkyl diamines have good anti-collapse abilities. However, with the increase of the number of carbon atoms, the solubility of alkyl diamines decreased, and the inhibition effects became worse. At the same time, The values of COD, BOD, and biotoxic EC50 were detected by the potassium dichromate method, dilution and inoculation method, and luminescent bacteria method. The results showed that the biodegradability of the alkyl diamine anti-collapse agents increased gently as the number of carbon atoms increased, while the solubility and biotoxicity were decreased. Therefore, the longer the alkyl diamine carbon chain length is, the better environmental performance shows. Hence, this research provided a guideline for synthesizing new organic amine anti-collapse agents.

Key words: *alkyl diamine, carbon chain length, anti-collapse, biodegradability, biotoxicity.*

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Технологии получения экологически безопасных масел-пластификаторов различных типов

Рассмотрены технологии производства экологически безопасных масел-пластификаторов типа TDAE, TRAE, MES, NAP для резинотехнической и шинной промышленности, представлены их основные физико-химические свойства и конкретные примеры применения. Описано влияние типов масел-пластификаторов на эксплуатационные свойства резинотехнических изделий и шин.

Ключевые слова: масло-пластификатор, экстракт селективной очистки, полициклические ароматические углеводороды, сольват слабой очистки

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Technologies for Producing Environmentally Friendly Plasticizer Oils of Various Types

The production technologies of environmentally friendly plasticizer oils such as TDAE, TRAE, MES, NAP for the rubber and tire industries are considered. Their basic physicochemical properties and specific application examples are presented. The influence of the types of plasticizer oils on the performance properties of rubber products and tires is described.

Key words: process oil, solvent extract, polycyclic aromatic hydrocarbons, mild extract solvate.

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Влияние тяжелых металлов на экосистемы

Проблема загрязнения окружающей среды является одной из важнейших в области экологии.

Стремительная индустриализация, открытие и разработка новых нефтяных месторождений, современная сельскохозяйственная практика и другие виды антропогенной деятельности вносят в окружающую среду значительное количество токсичных тяжелых металлов. Тяжелые металлы являются одними из основных веществ, которые загрязняют почву, воду и воздух. Загрязнение тяжелыми металлами непрерывно растет и вызывает тяжелое токсическое воздействие на все формы живых организмов, изменяет свойства почвы и ее биологическую активность. Чрезмерное накопление тяжелых металлов в растительных продуктах может серьезно сказаться на качестве и безопасности пищевых продуктов. Потребление таких продуктов представляет собой потенциальный риск для глобальной продовольственной безопасности и здорового образа жизни. В данной статье рассмотрено влияние тяжелых металлов на растения и их ферментативные и метаболические процессы, которое в конечном итоге приводит к снижению общей продуктивности растений.

Ключевые слова: тяжелые металлы, загрязнение, растения, продуктивность, экология.

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Impact of Heavy Metals on Ecosystems

The Problem of environmental pollution is one of the most important in the field of ecology. Rapid industrialization, the discovery and development of new oil fields, modern agricultural practices, and other anthropogenic activities contribute significant amounts of toxic heavy metals to the environment. Heavy metals are one of the main substances that pollute the soil, water and air. Heavy metal pollution is constantly growing and causes severe toxic effects on all forms of living organisms, changes the properties of the soil and its biological activity. Excessive accumulation of heavy metals in plant products can seriously affect the quality and safety of food. Consumption of such products poses a potential risk to global food security and healthy lifestyles. This article examines the influence of heavy metals on

plants and their enzymatic and metabolic processes, which ultimately leads to a decrease in the overall productivity of plants.

Key words: *heavy metals, pollution, plants, productivity, ecology.*

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Основные проблемы газопереработки в России

Газопереработка — самостоятельная, динамично развивающаяся отрасль, роль которой постоянно растет в связи с разведкой и разработкой новых газовых и нефтяных месторождений, увеличением объемов добываемых углеводородов, направляемых на переработку. Для дальнейшего развития отрасли необходимо совершенствование существующих технологий и оборудования, что невозможно без анализа и решения существующих проблем. В статье рассмотрены основные проблемы газоперерабатывающей промышленности России на современном этапе ее развития, предложены пути их решения.

Ключевые слова: *газопереработка, природные газы, газовая сера, аминовая очистка, гелий.*

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Problems of Gas Processing in Russia

Gas processing is an independent, dynamically developing industry, the role of which is constantly growing in connection with the exploration and development of new gas and oil fields, the volume of produced hydrocarbons for processing is increasing. For further development of the industry it is necessary to improve existing technologies and equipment, which is impossible without solving existing problems. In this regard, the article discusses the main problems of the gas processing industry in Russia at the present stage of its development. The ways of their solutions are proposed.

Key words: *natural gas processing, natural gas, gas sulfur, amine purification, helium.*

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Investigation on Fracture Propagation Characteristics in Horizontal Wells

According to the requirements of horizontal wells fracturing operations, this paper simulates the law of horizontal well fracturing in low-porosity and low-permeability sand-shale formation by large-mold fracturing test, and analyzes crack initiation and extension. The two completion methods of open-hole completion and casing perforation completion are considered, and the maximum and minimum horizontal principal stress difference is 10 and 4 MPa. The horizontal wellbore azimuth angle changes from 0 to 90 °. The test results show that the principal stress

difference has a great influence on fracture initiation. The smaller the stress difference is, the higher the fracture initiation pressure is and the more complicated the fracture initiation and extension is. The fracture propagates along the axial direction of the wellbore, and then at both ends of the wellbore the fracture turns to the direction perpendicular to the direction of the minimum horizontal principal stress. The horizontal wellbore can form a transverse fracture by drilling along the direction of the minimum horizontal principal stress. This study is of great significance for understanding the fracture initiation and propagation law of horizontal well fracturing and can provide guidance for multi-stage fracturing operations of horizontal wells in unconventional reservoirs.

Key words: *horizontal wellbore, hydraulic fracture, fracture propagation, multistage fracturing.*

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Well Testing Technology and Production Dynamics Analysis

of Condensate Gas Reservoir

Based on the actual production of the condensate gas reservoir of Yingtai Fault Depression, we analyze the fluid phase characteristics and distribution law of the gas reservoir in this paper. Through the investigation of the preferred well test model, the well test interpretation analysis is carried out for the typical well. According to the system well test data, a one-point formula suitable for Yingtai area is established to predict the production capacity, and the production dynamics of the condensate gas reservoir is analyzed. This study can provide a theoretical basis for the rational development of condensate gas reservoirs.

Key words: *condensate gas reservoir, field example, well testing technology, productivity forecast, production dynamics.*

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The Influence of Various Hydrocarbon Groups on the Effectiveness and Environmental Characteristics of Anti-Collapse Agent for Drilling Fluids

This paper studies the effect of different types of groups on the anti-collapse and environmental protection of anti-collapse agents. The core immersion test and linear expansion test were used to evaluate the anti-collapse properties of different groups. The experimental results show that the anti-collapse properties of different groups under the same carbon chain length: amino group > amide group > hydroxy group > carboxyl group. The anti-collapse properties of different amino groups of organic amines: primary amine > secondary amine > tertiary amine. At the same time, the potassium dichromate method, the dilution and inoculation method and the luminescent bacteria method were used to test the COD value, BOD value and EC50 value of the anti-collapse agent of different groups, the experimental results show that the size of different groups of biodegradability: hydroxyl group > carboxyl group >

amide group > amino group. Biological toxicity: hydroxyl group > amide group > carboxy group > amino group. The size of biodegradability of different amino groups of organic amines: primary amine < secondary amine < tertiary amine, biological toxicity: primary amine > secondary amine > tertiary amine.

Key words: *group, anti-collapse, biodegradability, biotoxicity.*

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Study on Water Vapor Adsorption Experiment and Main Controlling Factors of Deep Shale

In this paper, deep soft rock samples from three strata are selected, and the stratigraphic characteristics such as stratum physical property, mineral composition and pore structure are systematically analyzed. The characteristics of water vapor adsorption curves of deep soft rock strata are obtained by water vapor adsorption experiments, and the influence of soft rock water is analyzed. The main controlling factor of steam adsorption capacity. The results of soft rock water vapor adsorption experiments show that the water vapor adsorption capacity of soft rock increases with the increase of humidity. When the humidity exceeds 0.8, the adsorption of water vapor by soft rock increases rapidly. In soft rock samples, the water vapor adsorption capacity of shale is significantly different from that of glutenite, the strongest shale, and the difference between coarse conglomerate and fine conglomerate. There is a positive correlation between water vapor and clay mineral content, especially the presence of high specific surface area of montmorillonite and Imon mixed layer minerals, which can greatly improve the adsorption capacity of water vapor. Under low humidity, the temperature has little effect on the adsorption of soft rock water vapor. As the humidity increases, increasing the temperature can significantly increase the water vapor adsorption capacity. In addition, the soft rock water vapor adsorption capacity is negatively correlated with initial moisture content, porosity and permeability. This study is of great significance for understanding the hydrological characteristics and catastrophic processes of deep strata soft rock.

Key words: *shale, water vapor adsorption, pore structure, clay.*

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Application of Well pattern Adjustment for Offshore Polymer Flooding Oilfield:

A macroscopic and microscopic Study

In this paper, we simulated the development effect of well pattern adjustment technology during polymer flooding through laboratory experiments, and analyzed the development effect of oil displacement and the distribution of remaining oil from macroscopic and microscopic aspects. Changing the well pattern system was conducive to the uniform displacement of the polymer, improving and enhancing the displacement effect of the polymer flooding and

subsequent water flooding, especially improving the displacement effect of the low permeability layer. In this experiment, the oil recovery of well pattern adjustment was increased by 4.77%. Through experimental research, we believe that the polymer flooding with well pattern adjustment can not only expand the flow area by changing the flow field, but also further play the role of polymer profile control. The two mechanisms complement each other, effectively improving the unevenness of displacement and enhancing the oil recovery. The experimental results can provide new ideas and technical support for further improving the development effect of offshore polymer flooding oilfields.

Key words: *polymer flooding, well network adjustment, microelectrode technology, nuclear magnetic resonance technology, residual oil distribution.*

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Nitrogen Injection Controlling Bottom Water Coning Mechanism

Visualized Experimental Study

In this paper, a visualized model experiment was carried out on the mechanism of nitrogen injection suppression of bottom water coning based on full diameter core with developed fracture using X-ray imaging technology and an oilfield tests were conducted. The research results show that the nitrogen injection has a certain effect on suppressing the bottom water coning, Nitrogen can block the high-permeability water flow channel to a certain extent and enter the low-permeability area to improve the fluidity of the crude oil. The timing of nitrogen injection is the main controlling factor affecting gas injection development. Gas injection after long-term high water cut period is the main reason for the poor effect of the suppression of bottom water coning in the oilfield. When the water cut is relatively low, the bottom water suppression effect is better. When the water-cut is 70%~80%, the gas injection effect is the best. Moreover, the greater the nitrogen injection pressure is and the longer the soak time is, the better effect of the suppression of bottom water coning will be. In this paper, a reasonable development strategy of nitrogen injection to suppress bottom water coning is proposed through the experimental study, which is of great significance for guiding the development of volcanic reservoirs in the oilfield.

Key words: *volcanic reservoir, bottom water coning, visual experiment, nitrogen injection development strategy.*

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Microscopic Mechanism of Water Vapor Adsorption Experiments on Deep Soft Rock Water Vapor

At present, the research on influence of water on the physical properties of rocks is mostly focused on the macroscopic angle. The studies on nanoscale pore structure changes caused by water in the are few. The shale is characterized by good pore structure and high content of hydrophilic clay minerals, susceptible to water. Based on this, in this paper the shale samples were obtained from underground layer 3000 meters deep in Songliao Basin, Jilin Province, China. The sample parameters are measured by steam adsorption and nitrogen adsorption experiments under different soaking time conditions. The study shows that the pore structure of shale depends mainly on mineral composition and soaking time. With the increase in soaking time, the amount of water vapor adsorption first decreases by 10%, and then gradually increases. With water migration in the rock some pore structures are filled with shale particles. As the bubble time increases, the ion diffusion causes development of new pores and micro-cracks, and the adsorbed water vapor amount increases. At the microscopic scale, it is of great practical significance to study the nanoscale pore structure and adsorption characteristics of water vapor in the soft for different soaking time, and to further explore the stress characteristics, adsorption law and gas migration in shale.

Key words: shale, water vapor adsorption, soaking time, pore structure.

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Effects of Earth Rotation on Wellbore Trajectory and Correcting Method

This paper explains how the earth rotation causes the apparent gravity action line to deviate from the ground plumb line through mechanical modeling and formula derivation. In view of the compass pendulum, three-accelerometer and three-magnetometer survey methods, this paper analyzes the principle that the earth rotation causes the well inclination error and azimuth error. Based on the constructed simulated drilling trajectory, the actual measured inclination angle, azimuth angle and measured depth that have errors are calculated. This paper presents correcting methods for correcting the deviation error of the compass pendulum survey method, and deviation and azimuth error of the while-drilling survey method. Finally, the correcting method is applied to the actual measured data, and the corrected survey data can be gotten. Through comparing the corrected data and actual data, the correctness of the proposed error correcting method is verified.

Key words: earth rotation, compass pendulum, MWD, error correction.

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Unsteady Pressure Dynamics of Polymer Flooding Reservoirs

Considering Concentration Changes

This paper establishes an unstable seepage model with polymer concentration and pressure diffusion coupling considering the effects of polymer molecular diffusion, adsorption and viscoelasticity of polymer solution in the formation. The factors are closer to the actual seepage of the injecting reservoir. For the nonlinear adsorption, the combined variable and the analytical iterative method are used to obtain the approximate analytical solution of the model. According to the concentration model, the relationship between concentration and position is obtained. Based on this, the pressure distribution and variation in the reservoir are given. Using the model theory curve to fit the well test data, the seepage parameters of the formation are obtained, and the reflection characteristics of the unstable wellbore pressure derivative curve are analyzed.

Key words: *molecular diffusion, nonlinear adsorption, viscoelasticity, combined variables, analytical solutions.*

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Study on Reasonable Formation Pressure Maintenance Degree

in Low Permeability Reservoirs

By applying material balance equation, we deduce the theoretical formula of future cumulative oil production with different formation pressure. In view of the contradictory relationship between cumulative oil production and water cut increasing rate, we construct a bi-objective function to evaluate the reasonable formation pressure. Results show that: during the process from current formation pressure to reasonable formation pressure, when the reservoir formation pressure maintenance degree is 0.88, it can ensure that future cumulative oil production is relatively large and water cut increasing rate is relatively low. Under the condition of same formation pressure maintenance degree, as threshold pressure gradient grows, the impact on cumulative oil production is gradually increasing. In order to keep a good development result, the formation pressure should be recovered as early as possible before it drops significantly. This method can be used to calculate reasonable formation pressure quantitatively and provide a reference for high efficiency development in low permeability reservoirs.

Key words: *low permeability reservoir, reasonable formation pressure, cumulative oil production, water cut increasing rate, pressure recovery.*

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Monitoring and Control Model for Coal Mine Gas and Coal Dust

In order to provide production safety and determine the optimal ventilation scheme in coal mining, the mines should be classified by their gas emission and mine security rank. In this paper the three models of mine classification, mine insecurity, and the optimal ventilation required by the mine are established and solved by MatLab and Lingo software. Firstly, the daily absolute gas emission amount and relative gas are evaluated by average values of absolute and relative gas emission rates. It is shown that average values distribution complies with the normal distribution and fluctuation around the stable value. Finally, according to the standard requirements, the mine is classified as a high gas mine. The relationship is established between the gas concentration and the lower limit of coal dust explosion concentration, and a specific function relationship between gas concentration and coal dust explosion concentration is obtained by logarithmic fitting. The fuzzy membership function is derived, and the fuzzy statistical evaluation model is established to evaluate the mine safely. The probability safety value calculated by MatLab software is 4.63%. According to the relationship between gas concentration, coal dust concentration and ventilation speed, the minimum air volume actually required by the coal mining face under the condition of safe production is established. Through MatLab programming calculation, the minimum air volume of coal mining face 1 and face 2 is 385.1 and 531.08 m³/min, respectively. According to the diversion of the air volume of each working zone and the specific requirements for ventilation speed in each zone, a ventilation optimization model is established and solved by Lingo software. The calculated air volume of the local ventilator and the optimal (total) air volume required by the mine are 150 and 1491.18 m³/min, respectively. Through the solution and analysis of the model, it is shown that the simulation method of is reasonable and can produce reliable guidance for management of high-risk coal mining enterprises.

Key words: *data mining, mean test, fuzzy statistical method, optimization model.*