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Проблемы и направления развития системы исследований и испытаний в химмотологии

Дана характеристика противоречий, сопровождающих на современном этапе развитие системы исследований (испытаний) и оценки соответствия горюче-смазочных материалов (ГСМ) требованиям техники. Предложены направления и отдельные примеры научно-технических решений, демонстрирующие возможности повышения эффективности исследований (испытаний), на основе совершенствования методологии моделирования химмотологических процессов и прогнозирования эксплуатационных свойств перспективных ГСМ для их ускоренной разработки, оценки соответствия и внедрения в технике.

Ключевые слова: горюче-смазочные материалы, эксплуатационное свойство, химмотологический процесс, моделирование, определяющие факторы, информативность, интегральная оценка, прогнозирование, принятие решений.
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Chemmotology Problematic Aspects and Development Lines of Research and Testing System

The characteristics of contradictions following at the present stage the development of system for research (testing) and compliance assessment of fuels and lubricants (FL) meeting the technical requirements have been provided. There were proposed the lines and individual examples of scientific and technical solutions, demonstrating opportunities to increase the efficiency of research (testing) based on improving the methodology for simulation of chemmotology processes and operational properties' forecasting for the perspective fuels and lubricants so that to push on their development, compliance assessment and insertion into equipment.

Key words*: fuel and lubrication materials, operational property, chemmotology process, simulation, determining factors, informative content, integral assessment, forecasting, decision making.*

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Методы оценки склонности к образованию отложений и сохраняемости топлив для реактивных двигателей

Представлено краткое описание методов исследования термоокислительных превращений топлив для реактивных двигателей, протекающих при их применении. Методы оценки

термоокислительной стабильности в динамических условиях и склонности к образованию отложений моделируют различные процессы образования отложений в топливной системе газотурбинного двигателя. Метод оценки химической стабильности позволяет исследовать жидкофазное окисление при хранении топлива в резервуарах.
Ключевые слова: топлива для реактивных двигателей, склонность к образованию отложений, сохраняемость,
термоокислительная стабильность, химическая стабильность, метод испытания.
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Methods for Assessing Propensity to Deposit and Storage Ability of Aviation Turbine Fuels
A brief description of a set of methods aimed at a comprehensive assessment of the propensity of aviation turbine fuels to deposit formation is presented. Methods for assessing thermal oxidative stability under dynamic conditions and the tendency to deposit formation simulate various conditions for the formation of deposits in the fuel system of a gas turbine engine. The chemical stability assessment method simulates the conditions of liquid-phase oxidation during fuel storage in tanks.
Key words*: aviation turbine fuels, deposition tendency, oxidation stability, chemical stability, test method.*

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Оперативное определение примесей биодизельных топлив в углеводородных топливах методом тонкослойной хроматографии
Представлен метод оперативного детектирования и определения содержания примесей биодизельных топлив различного происхождения в углеводородных топливах различных групп (подгрупп). Метод основан на разделении компонентов анализируемых проб в тонком слое сорбента на пластинах для тонкослойной хроматографии при элюировании смесями полярного и неполярных растворителей. Детектирование концентраций биодизельных топлив проводят обработкой пластины с хроматограммой смесью растворов соединений железа. С учетом простоты выполнения аналитических операций и отсутствия необходимости использования сложного аналитического оборудования метод может быть рекомендован к применению как в стационарных лабораториях, так и во внелабораторных условиях.
Ключевые слова: биодизельные топлива, углеводородные топлива, тонкослойная хроматография, детектирование, количественное определение.
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Quick Determination of Biodiesel Impurities in Hydrocarbon Fuels
by Thin-Layer Chromatography Method
A method used for quick detection and determination of the impurities' content in biodiesel fuels (BF) of various origins in hydrocarbon fuels of various groups (subgroups) has been presented. The method is based on the separation of the analyzed samples' components in a thin layer of sorbent on plates for thin-layer chromatography during elution with mixtures of polar and non-polar solvents. BF detection is carried out by treating a plate with a chromatogram with a mixture of solutions containing iron salts. The range of determined BF concentrations is from 0.1 to 100% vol., the relative standard deviation of the determination results is from 0.07 to 0.2. Considering that performing analytical operations is simple and the need to use complicated analytical equipment is absent, the method can be recommended for application both in stationary laboratories and in non-laboratory conditions.
Key words*: biodiesel, hydrocarbon fuels, thin layer chromatography, detection, quantitative determination.*

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Химмотология жидких синтетических топлив нового поколения
Проанализированы современные достижения отечественной науки в области разработки синтетических топлив назначения. Представлено сравнение наработок с мировыми аналогами. Выделены перспективное сырье и технологии синтеза топливных композиций. Сформулированы основные требования к соответствующим топливам, перечень контролируемых свойств и характеристик полного жизненного цикла: приготовление, хранение, транспортировка, распыление, горение, нейтрализация антропогенных выбросов. Определены рациональные методики и этапы тестирования топлив нового поколения с учетом ограниченных объемов производства. Сформулированы рекомендации по совершенствованию системы научно-исследовательских и опытно-конструкторских работ с целью получения синтетических жидких топлив.
Ключевые слова: синтетические жидкие топлива, авиационное топливо, биотопливо, полный жизненный цикл.
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New Generation Liquid Synthetic Fuels

The paper analyzes modern achievements of domestic science in the synthetic fuels development. A comparison of world analogues is presented. Promising raw materials and technologies for the synthesis of fuel compositions are identified. The main requirements for the corresponding fuels, a list of controlled properties and characteristics of the full life cycle are formulated: preparation, storage, transportation, spraying, combustion, neutralization of anthropogenic emissions. Rational methods and stages of testing new generation fuels are determined taking into account limited production volumes. Recommendations are formulated for improving the system of research and development work in order to obtain synthetic liquid fuels.

Key words*: synthetic liquid fuels, aviation fuel, biofuels, full life cycle, testing.*

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Simulation Analysis of Contact Stress Variation

of PDC Tooth Surface at Different Rotational Speeds

When drilling in deep hard-rock formation, polycrystalline diamond compact (PDC) drill bit has the phenomenon of fracture of PDC tooth due to high stress on tooth surface, while the current research on PDC tooth breaking focuses on the efficiency of PDC tooth breaking, and less on the change of contact stress on tooth surface when breaking rock. The rotational speed is an important mechanical parameter in oil drilling operation, in order to deeply study the influence of rotational speed on the contact stress of the tooth surface when PDC tooth breaks the rock, we established the PDC single-tooth rock-breaking model, investigated the rock-breaking process of the PDC tooth under different rotational speeds, and analyzed the change of the stresses of the rock and the PDC tooth when the PDC tooth breaks the rock. The results show that in the process of rock cutting by PDC teeth, the destruction of rock is gradual, the size and position of the contact surface between rock section and PDC teeth change constantly, resulting in the existence of stress concentration and impact on the surface of PDC teeth, the maximum value of the stress can reach 1194 MPa when the rotational speed is 100 RMP, and as the rotational speed increases, the speed of rock being broken is accelerated, and when the rotational speed is greater than 90 RMP, the The increase of rotational speed will cause more

violent impact creation on the PDC teeth when breaking the rock, which is not favorable to the service life of the drill bit. The relevant findings can help to reveal the intermediate damage mechanism of PDC teeth under different rotational speeds when drilling in deep hard-rock formations and provide a reference for the scientific selection of rotational speeds.
Keywords: *rotational speed, hard rock formation, PDC cutter teeth, rock-breaking stress, drill bit longevity.*

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Quantitative Evaluation of Tight Shale's Pore Configuration:

Mathematics and Experiments

The pore configuration of shale has always been a contentious topic in shale gas exploration research due to its complexity, aperture size and dispersion varies from nanometers to millimeters. To investigate the pore configuration of shale, this study selected the Longmaxi Formation shale in the Sichuan Basin as the research subject and conducted high-pressure mercury, cryogenic liquid nitrogen and cryogenic carbon dioxide adsorption experiments. By employing a combination of characterization methods and fractal dimension analysis, the study delved deeply into the nano-level pore features of the Longmaxi Formation shale. The experimental results demonstrated that the pores of the Longmaxi Formation shale samples could be classified into three types, of which the first and second types indicated good pore connectivity, while the third type showed poor connectivity. Moreover, the capacity and particular surface area of the minuscule pores were predominantly distributed at pore sizes of 0.3~0.5 nm. Additionally, mesopores could provide a substantial amount of pore volume, while micropores played a crucial role in controlling the total specific surface area and serving as the key location for gas adsorption and storage. Furthermore, the pore configuration of the Longmaxi Formation shale adhered to fractal laws, and the fractal dimension of pores larger than 50 nm was 2.9176, indicating that larger pores were more complex than medium and small pores. In conclusion, this study offered valuable insights into the pore architecture of the Longmaxi Formation shale and underscored the significance of considering pore configuration in shale gas exploration.

Keywords: *tight shale, nanopores, fractal theory, microstructure.*

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Experimental Study on the Characteristics and Diagenetic Processes of Typical Tight Oil Reservoirs

The southern part of the Ordos Basin, in the Fuxian area, where the Yanchang Formation's Chang 7 Member is a new stratigraphic unit for tight oil development, and there has been little research on its pore structure and diagenetic processes. This paper takes the Chang 7 Member in the Fuxian area as an example and systematically conducted a micro-scale reservoir property study of the Chang 7 tight oil using a large number of thin sections, scanning electron microscopy, physical properties, and CT scanning experiments. The results show that the sandstone types in the Chang 7 Member of the study area are mainly lithic arkose, followed by lithic arkose and sublithic arkose. The quartz content in the Chang 7 Member sandstones is relatively high, ranging from 15% to 47%, with an average of 31%. The types of pores developed include intergranular pores, intercrystalline pores, intragranular dissolution pores, intergranular dissolution pores, organic matter pores, and micro-fractures. Compaction, cementation (silica cementation, carbonate cementation, clay mineral cementation), and metasomatism have a destructive effect on reservoir quality; constructive diagenetic processes mainly include chlorite cementation and dissolution. Diagenetic sequence analysis indicates that the Ro value of the Chang 7 Member in the study area is between 0.79-0.91%, belonging to the late diagenetic stage A period. Early calcite is mostly pore-filling, and late calcite precipitates to fill dissolution pores. Clay minerals are mainly illite-smectite mixed layers, with the content of smectite in the mixed layers being less than 41%, and some less than 15%.

Keywords: *Ordos Basin, Chang 7 Member, tight oil reservoir, pore structure, diagenetic processes.*

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Sedimentary Microphase Characterization of Sandstone Reservoirs and Analysis of Reservoir Physical Properties

This paper takes the Chang8 reservoir of Yanchang Group in Yanchi area as the research object, aiming at revealing its sedimentary microphase and reservoir characteristics, and providing scientific basis for oil and gas exploration and development. The distribution characteristics of the sedimentary microphase and the physical characteristics of the reservoir are systematically studied by using field geological profile, drilling core, well logging and experimental analysis. The results show that the sedimentary microphase of the reservoir of Long 8 Formation Group mainly includes submerged diversion channel, submerged natural dyke and diversion interbay, etc. The average thickness of seepage sand layer of submerged diversion channel phase is 20.3 m, and the average value of sand-ground ratio is 0.53, among which, the type of sand formation of the submerged diversion channel phase is a double-segment II type curve characterized by the combination of heavy jumping component and fine-grained suspended component, showing good pore connectivity. In terms of reservoir characteristics, the Chang8 oil formation shows low porosity (10.83% on average) and extra-low to ultra-low permeability ($0.776 \cdot 10^{-3}$ μm^2 on average), with intergranular pores and feldspathic pores dominating the pore structure, and feldspathic pores accounting for 55.42% of the total pores, and there are a small number of clastic pores, intergranular pores, intergranular pores, and microcracks, which reflect the influence of diagenesis on the reservoir material. These characteristics reflect the significant influence of diagenesis on the physical properties of the reservoir. This study provides an important geological basis for the exploration and development of Yanchi Yanchang Group Long 8 reservoir, and helps to optimize the reservoir development plan and improve the recovery rate.

Keywords: *Yanchi area, Yanchang Formation Long 8 reservoir, sedimentary microphase, reservoir characterization; diagenesis.*

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Exploration and Practice of Geological Drilling Technology in the Field of Oil and Gas

In recent years, the domestic geological prospecting field attaches great importance to and promotes green exploration work, and strengthening the research on green exploration technology and methods is the target requirement for the healthy and sustainable development of geological prospecting work in the field of oil and gas. In this paper, green drilling work carried out in typical geological landscape areas of northwest China is studied, drilling equipment is selected scientifically according to local conditions, and drilling engineering technology and methods are studied, including implementing drilling methods of "multi-holes from one position" and "drilling instead of trenching", innovating drilling technology, optimizing coring bit and applying environment-friendly flushing fluid, etc., site control and protection are strengthened during construction, environmental recovery and treatment are implemented after construction, production guarantee measures for green drilling construction are explored, effectively reducing the intensity of environmental damage caused by engineering activities and the cost of environmental recovery and treatment, Drilling work has achieved the goal of improving quality and increasing efficiency, and achieved a win-win situation in economic benefits and environmental protection.

Keywords: *green exploration, oil and gas, portable full hydraulic rig, drilling technology, northwest China, geological landscape.*

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Key Drilling Technology of Well in Exploration Block

In order to serve the gas clean energy exploration in Beijing, Tianjin and Hebei, Institute of Exploration Techniques (CAS) undertook the drilling task of gas exploration well D22 in Xiong'An New Area. This paper analyzes the engineering situation and construction difficulties of well D22, and introduces the drilling technology of each drilling operation. In the construction process, according to the characteristics of dolomite thermal reservoir, bit optimization, coring technology, plugging technology and borehole trajectory control technology are studied.

Keywords: *Xiong'an New Area, gas drilling, coring, plugging, directional drilling.*

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Effect Ofcontinuous Circulation Technology on Cutting Bed in Extended-Reach Drilling

Continuous circulation technology can realize the continuous circulation of continuous pumping during drilling, which can be used to improve borehole cleanliness in extended-reach drilling and prevent cutting bed accumulation from adversely affecting downhole operations. This paper describes the mechanism of continuous circulation technology and the advantages and disadvantages of its supporting equipment, analyzes the theoretical model of cutting bed migration in extended-reach drilling, studies the distribution, thickness and migration law of cutting bed when continuous circulation technology is used, and optimizes and recommends the flowrate, ROP and drillstring rotation speed of well Panyu A in eastern part of the South China Sea. The results show that the cutting bed of the extended-reach drilling has wavy distribution and dynamic migration with time, and the migration velocity of the cutting bed is inversely proportional to the hole size. The migration direction is from the bottom of the well to the head of the well. The thickness of the cutting bed is the largest at the beginning of the horizontal section, and the thickness near the bottom of the well is the smallest. The research results provide a theoretical reference for borehole cleaning control in extended-reach well.

Keywords: *extended-reach drilling, continuous circulation technology; cutting bed, borehole cleaning, drilling parameter.*

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Study on ECD During the Construction of Extended Reach Wells

The vertical depth and horizontal length of extended reach wells vary greatly, leading to significant pressure losses along the wellbore. Improper downhole pressure control during drilling, tripping, casing running, cementing, and completion operations can result in wellbore collapse, well instability, and other related issues. By researching the downhole ECD model during well construction, the ECD calculation methods were established, which was suitable for drilling, tripping, casing running, cementing, and gravel packing operations. The computation of ECD data across diverse operational scenarios, when coupled with the analysis of three pressure profiles, enables the precise identification of potential hazards for each operation. By implementing suitable mitigation measures, the risks associated with these operations can be significantly reduced. Utilizing an extended reach well as a case study, this paper aims to provide a comprehensive analysis of the process of identifying and

mitigating risks through ECD data across various operations. The insights gained from this study will serve as a valuable resource for similar extended reach well projects.
Keywords: *extended reach well, ECD, three pressure profile, drilling, cementing, completion.*

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Research on Desliming Pretreatment and Electroflocculation Settlement Process of High Ash Coal Slurry Water and Oily Wastewater

In this study, the treatment method of high ash coal mud water and oily wastewater was systematically optimized by combining desliming pretreatment with electroflocculation and sedimentation process. The experiments used gravity settling method for desliming pretreatment and combined with electroflocculation settling process under different settling time, temperature and current density conditions, respectively. The results showed that after the desliming pretreatment, the concentration of suspended solids in the coal slurry water and the oily wastewater was reduced, and the removal rates reached 59.1% and 55.6%, respectively. Under the conditions of electroflocculation treatment with a current density of 3 mA/cm^2 and a treatment time of 20 min, the suspended solids concentrations of coal slurry water and oily wastewater were further reduced to 200.8 mg/L and 230.1 mg/L with removal rates of 61.0% and 48.9%, respectively. After the application of the combined process, the suspended solids removal rate of coal slurry water and oily wastewater increased to 71.4% and 68.5%, respectively, and the concentration of suspended solids decreased to 145.8 mg/L and 170.2 mg/L, respectively. With regard to the comprehensive indexes of water quality, the combined process significantly reduced the turbidity of coal slurry water and oily wastewater from 314.5 NTU and 344.4 NTU to 90.7 NTU and 105.8 NTU, respectively; electrical conductivity and conductivity of coal slurry water and oil wastewater were further decreased to 200.8 mg/L and 230.1 mg/L, respectively; the removal rate was 61% and 48.9%, respectively. 105.8 NTU; conductivity decreased from 1238.1 μS/cm and 1343.2 μS/cm to 1120.4 μS/cm and 1215.9 μS/cm, respectively; and pH remained relatively stable with small changes. This study provides a set of efficient, low-cost and environmentally friendly treatment technology for coal and oil industries, which significantly improves the production efficiency and product quality of coal preparation plants and oil fields, and has important practical application value.

Keywords: *high ash coal slurry water, oily wastewater, desliming pretreatment, electroflocculation and sedimentation, water quality improvement, suspended solids removal rate.*

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Reservoir Permeability Prediction Method Based on Fuzzy Clustering and Machine Learning

With the in-depth development of oil and gas exploration technology and the development of low permeability reservoirs, the permeability prediction method represented by machine learning technology has been widely applied. However, it is limited by data distribution, data heterogeneity, and model complexity. Traditional machine learning methods are not accurate, and the results are not stable when predicting permeability. Aiming at some problems encountered by traditional machine learning algorithms in predicting permeability, this paper takes carbonate rocks in Region X as the research object, comprehensively analyzes the geological characteristics of carbonate rocks, analyzes the importance of input features by XGBoost built-in module, and selects seven logging curves as the inputs of the network model combined with actual conditions. A Fuzzy C-means algorithm based on fuzzy logic is used to cluster the data. According to the clustering results, the data is divided into several subsets, and the SVR or LSTM model is trained for each subset. The predictions of all subsets are then combined to get the final prediction. The performance of the model is evaluated using evaluation indicators (such as mean square error, determination coefficient) and compared with direct prediction methods without clustering. The results show that the coefficient of determination (R^2) of prediction after FCM clustering reaches 0.86, and the average absolute error is 0.068. The determination coefficients (R^2) of LSTM and SVR algorithms for direct prediction are 0.75 and 0.73, respectively. It is proved that fuzzy logic combined with machine learning technology can better characterize the nonlinear mapping relationship between data, and explore more potential relationships between parameters to improve the prediction effect.

Keywords: *permeability prediction, fuzzy logic, machine learning, support vector machine, LSTM neural network.*

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Research on the Management Method of New Integrated Energy System Considering Carbon Emission Reduction

Low carbon and environmental protection are becoming increasingly important in the development and utilization of oil and gas resources, so it is crucial to effectively improve the efficiency of low-carbon management. Aiming at the operational requirements of the integrated energy system containing a large number of uncertain resources under the low-carbonization goal, this paper establishes a novel management method. Firstly, a low-carbonization synergistic operation model of carbon capture-P2G is constructed to promote the efficient interaction of the integrated energy system through the multimodal synergistic utilization of carbon cycle and hydrogen energy, and an optimal probabilistic energy flow model of the integrated energy system is established based on it. Then, to address the problem that it is difficult to balance the computational accuracy and solving efficiency of the existing solving methods, this paper proposes a new stochastic response surface (SRS) algorithm, which adopts Taylor series expansion to decouple and simplify the cross terms in the chaotic polynomials, so as to overcome the defects of the SRS that is difficult to deal with high-dimensional stochastic variables. Finally, the accuracy and adaptability of the proposed model and method are verified based on the test systems.

Keywords: *new power system, integrated energy, carbon emission reduction, renewable energy.*

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Experimental Study on CO_2 Injection to Enhance Recovery and Its Storage Characteristics in Low Permeability Gas Reservoirs

This study explores the effectiveness of CO_2 injection for enhancing methane (CH_4) recovery and its storage characteristics in low permeability gas reservoirs. Conducted under controlled conditions of 90°C and 10 MPa, experiments employed a CO_2 injection rate of 0.4 mL/min to assess displacement efficiency between dry cores and cores saturated with bound water. The results indicate that the presence of bound water significantly delays CO_2 breakthrough by approximately 0.15 PV compared to

dry cores, leading to a longer transition zone as CO_2 first dissolves in the bound water before effectively displacing CH_4. In wet cores, initial effective displacement of CO_2 is minimal, resulting in a lag in CH_4 recovery rates. However, the final CH_4 recovery rate in wet cores is slightly higher than that in dry cores due to the ability of bound water to occupy smaller pores, facilitating the displacement process. Additionally, CO_2 storage efficiency is evaluated through retention rates and storage ratios. The presence of bound water enhances CO_2 retention, significantly increasing retention rates during injection. The dissolved CO_2 in formation water accounts for a substantial portion of the pore volume, indicating improved solubility at higher pressures. In conclusion, this research demonstrates that CO_2 injection not only improves CH_4 recovery but also serves as a viable method for geological CO_2 storage in gas reservoirs, with recovery rates ranging from 88.37% to 96.29% and breakthrough times between 0.62 PV and 0.88 PV.

Keywords: *gas recovery, CO_2 injection, displacement efficiency, CO_2 storage, gas reservoirs.*

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Influence of Asphaltene Precipitation during CCUS Processes in Oil Reservoirs on Enhancing Recovery Rates

Reservoirs are ideal locations for CO_2 sequestration. During the development of oilfields, CO_2 is injected, where a portion of the gas dissolves or diffuses into the crude oil and formation water, while another portion reacts with the rock, precipitating within the reservoir. The study of the interactions between CO_2 and reservoir fluids (formation water and crude oil) during the CO_2 flooding process, as well as the resulting precipitation patterns and their impact on reservoir properties and recovery rates, is of significant importance. This paper analyzes the results of a core displacement study on the interactions among CO_2, formation water, and rock, revealing the mechanisms by which carbon dioxide interacts with highly saline formation water and crude oil. It advances the development of CO_2 flooding theory and numerical simulation methods, enhances the understanding of the applicability and development patterns of CO_2 enhanced oil recovery techniques in low permeability reservoirs, and provides strong guidance for the field application of CO_2 flooding technology in low permeability reservoirs containing highly saline formation water. The quantitative characterization is beneficial for informing the development strategies for CCUS in reservoirs.

Keywords: *CCUS, water alternating gas, flooding experiment, asphaltene, reservoir properties.*

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Research on the Rock Pore Structure and Porosity-Permeability Characteristics of Oilfield Saline Aquifer CCS

CCS (Carbon Capture and Geological Storage) is the single most likely technology to achieve industrialized emission reduction. CO_2 geological storage has undergone experimental demonstrations in many countries and is in the industrialization preparation stage. However, in terms of the application in oilfields, the two core issues of "injectivity" and "safety" have not been fundamentally resolved. In view of this, this paper focuses on exploring the influencing factors of the interaction between carbon dioxide - formation water - rock under different formation conditions in oilfields, as well as the injectivity of carbon dioxide in oilfield reservoirs, and the variation laws of reservoir physical properties after carbon dioxide injection into oilfield reservoirs. The aim is to provide theoretical support and practical guidance for the application of CCS technology in oilfields to achieve emission reduction and enhanced oil recovery.

Keywords: CO_2 geological storage, injectivity, pore structure, displacement experiment, water-gas alternation.

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In-situ Growing Polymer Particles on Carbon Fiber for Improving Interfacial Properties of Epoxy Composites

To greatly improve the interfacial adhesion between carbon fiber and epoxy matrix, herein, we report a rapid and efficient method of growing polymer microspheres on carbon fiber (CF) by in-situ thiol-isocyanate click dispersion polymerization with the presence of polyvinylpyrrolidone (PVP). The surface morphology observations of modified CF by scanning electron microscopy (SEM) indicated an obvious increase in surface roughness. Fourier-transform infrared (FT-IR) spectra, X-ray photoelectron spectra (XPS) and thermogravimetric analyses (TGA) confirmed the introduction of functional groups on CF. Dynamic contact angle and surface tension measurements displayed the enhancements of wettability and

surface energy of CF. Compared to the untreated carbon fiber, the transverse fiber bundle tensile strength (TFBT) and interfacial shear strength (IFSS) of modified carbon fiber/epoxy composites increased 150.97% and 68.47%. Simultaneously, the single fiber tensile strength of modified CF also showed an increase by 9.65%. Finally, schematic model of interphase reinforcing mechanism was analyzed.

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Analysis of Gas Reservoir Types and Main Controlling Factors of Enrichment and High Yield in Sichuan Basin

The formation of large and medium-sized gas fields in Sichuan basin is closely related to many main controlling factors, which have a significant control effect on oil and gas accumulation. Therefore, the analysis of gas reservoir types and main controlling factors of enrichment and high yield in Sichuan basin is put forward. Set up the basic framework of structural, stratigraphic, lithologic and fractured gas reservoirs, and analyze the geological background; The characteristics and main controlling factors of four gas reservoir types are explored, and on this basis, the concrete embodiment of sediment structure in the upper gas reservoir types in Sichuan Basin is analyzed, and the controlling effects of reservoir, structure and fracture are studied in the gentle fold area in central Sichuan. This paper analyzes the natural gas enrichment and high-yield models in western Sichuan thrust belt, northern Sichuan low-level fold belt and Xujiahe Formation. The experimental results show that this method can improve the analysis efficiency, effectively reduce the influence of data error and subjectivity on the analysis results, and the safety factor is high. With the passage of time, the permeability of gas reservoirs in different regions has decreased significantly.

Keywords: Sichuan basin, gas reservoir type, enrichment and high yield, main control factor analysis.

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Study on Gas Production Mechanism of Foam Drainage and Optimization of Technological Parameters

To enhance the recovery factor of gas fields, foam drainage is an ideal method, particularly when the gas well's production is not too low, the natural gas flow rate is sufficient, and the liquid accumulation is moderate. This study investigated the liquid carrying capacity of different foaming agents in salt solutions with varying temperatures and salinities through dynamic foam tests. By analyzing the gas quality, water quality, and process characteristics of low-yield gas wells, a new type of foaming agent was developed, which is resistant to high mineralization, oil, and methanol. The injection process parameters were then optimized to ensure effective performance. The results showed that the newly developed foaming agent could foam and carry liquid effectively under conditions with water mineralization of less than 150,000 mg/L and methanol content of less than 50%. Field tests of foam drainage gas production were conducted on-site, with significant improvements observed. During the test, the average differential pressure of the oil casing in a single well decreased by 2.9 MPa, while the average daily liquid production increased from 0.37 m³ to 0.9 m³, indicating a good drainage effect. As a result, the gas recovery rate of the well was significantly improved, with the comprehensive gas recovery rate increasing by 28.14% during the experimental period compared to the same period in previous operations. For the foam drainage process, the preferred injection method involved using an alcohol injection pump to add the foaming agent, combined with a pry-mounted foam discharge dosing truck and a foam discharge rod through a dosing cylinder.

Keywords: gas field, foam drainage, mineralization, gas recovery, carry liquid.

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Evaluation of Chemical Properties of Microemulsion and Experimental Study of Oil Displacement Mechanism

Polymer macromolecules are difficult to enter low permeability reservoirs due to the characteristics of narrow pore throat, serious reservoir heterogeneity and high injection pressure. At present, low permeability oil fields are mainly developed by water drive, and the recovery rate is low. Therefore, the microemulsion flooding technology of low permeability reservoir is studied in order to develop low permeability oilfield reasonably and efficiently. The results show that the interfacial tension of the three microemulsions can reach an ultra-low level, and the interfacial tension of the betaine microemulsion is the lowest, which is 0.0026mN/m. The three microemulsions have particle size peaks between 0.08μm and 0.1μm, and can easily pass through low-permeability core pores. The microemulsion viscosity is 7.2,8.5,7.4 mPa·s,respectively, which has a good ability to reduce the water-oil mobility ratio. In terms of solubilization capacity, MSDDS microemulsion had the strongest solubilization capacity, reaching 11.7mL/g, while TW-20 and ABSC-14 microemulsion solubilization parameters were 9.5mL/g and 10.6mL/g, respectively. When the temperature is higher than the turbidity point of nonionic surfactants, the microemulsions appear stratified turbidity. Due to its ultra-low interfacial tension and better solublization parameters, betaine microemulsion improved the recovery rate by 16.45%.
Key words: microemulsion, phase transformation mechanism, performance evaluation, application effect.

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Chemical Performance Evaluation and Economic Benefit Analysis of Corrosion Resistant Coatings for Oil and Gas Pipelines

In order to improve the corrosion resistance of oil and gas pipelines, this study conducted a chemical performance evaluation and economic benefit analysis of corrosion-resistant coatings for oil and gas pipelines. Prepare corrosion-resistant coatings for oil and gas pipelines, apply them onto steel plate specimens, prepare samples, conduct tests on heat resistance, electrochemical impedance, etc., and complete the chemical performance evaluation of the coatings. Based on cost analysis, conduct an economic benefit study on the corrosion-resistant coating. The experimental results show that the corrosion-resistant coating can maintain the stability of the structure in high temperature environments, with a high impedance value. It can effectively block the corrosion of the substrate by electrolyte solutions, significantly reduce the corrosion rate, and protect pipeline steel plates from corrosion damage. At the level of economic benefit analysis, taking into account the cost of coating preparation, construction, and maintenance saved due to reduced corrosion during long-term use, although the initial investment of this corrosion-resistant coating was relatively high, its excellent anti-corrosion performance effectively reduced pipeline maintenance costs and replacement frequency, demonstrating significant economic benefits in long-term operation. Meanwhile, its excellent weather resistance and durability reduce the downtime losses caused by frequent maintenance, further enhancing the overall economic benefits.

Keywords: oil and gas pipelines, corrosion resistance, coating, chemical properties, economic performance.

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Target Detection of High-Resolution Remote Sensing Images Based on Convolutional Neural Network with Salient Features

The processing technology of remote sensing images has attracted more and more attention. Since remote sensing image target detection technology has a wide range of applications in , terrain exploration and post-disaster reconstruction, etc. Remote sensing image target detection refers to finding the target of interest in the remote sensing image and giving the specific location, while remote sensing image target recognition is the further classification of a certain target, which is a long-term concern in the field of remote sensing image processing. Convolutional Neural Network CNN (Convolutional Neural Network) has achieved great success in the field of computer vision with its deep semantic features, and in recent years, it has been increasingly applied to remote sensing image target detection and recognition tasks. Aiming at the task of remote sensing image target detection, this paper proposes a new deep feature-based remote sensing image target detection method. The depth feature extracted by CNN is used to extract the region of interest, and the target confirmation of the region of interest is carried out through multiple scales of CNN. This method does not require bounding box data for training, and improves the detection accuracy and reduces the false alarm rate.

Keywords: remote sensing images; convolutional neural networks; deep features; convolutional feature fusion; object detection, leakage monitoring, pipeline corrosion, remote pressure and flow monitoring, geological disaster warning.

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Adaptability Study and Optimization Evaluation

of Encrypted Well Network in Low-Permeability Reservoirs

In this study, the adaptability of encrypted well network and the evaluation of well network optimization are discussed in depth for the characteristics of medium and low permeability fracture nature in the long 6 reservoir of Ansai Oilfield, in order to improve the development efficiency and economic benefits of the oilfield. By comprehensively analyzing the geological structure of the reservoir, the form of injection and extraction well network and the degree of water drive utilization, the influence of well spacing, row spacing and water injection pressure on the recovery rate was studied. The results show that increasing the water injection pressure from 35MPa to 40MPa can increase the degree of water drive utilization from 45% to 58%. In terms of well network configuration, when reducing the injection and recovery well spacing from the conventional 550 m to 150 m, the degree of reservoir mobilization can be significantly increased from about 60% to nearly 100%. In addition, by adjusting the spacing to 125m, the utilization of the formation can be further increased to more than 90%, which shows a significant improvement compared to 70% under the traditional spacing. In addition, the simulation of different combinations of spacing and injection/production well spacing shows that smaller combinations of well spacing and spacing can effectively improve the degree of water drive control and reservoir utilization efficiency. Comparison of well network encryption schemes shows that, while keeping the injection/extraction ratio and the number of wells unchanged, the inverse nine-point well network scheme with diagonally encrypted wells can significantly improve the development efficiency and economic benefits of the field, with Scheme 5 showing the best performance in terms of oil recovery and integrated water content. These results not only provide a scientific basis for the refined well network design and optimization of the long 6 reservoir in Ansei Oilfield, but also provide important theoretical support and practical guidance for the development of similar low-permeability fractured reservoirs. The study emphasizes the importance of maximizing the development effect by scientifically adjusting well network parameters, demonstrating clear theoretical value and practical significance.

Keywords: *fracturing fluid, hydrophobic binding thickener, high temperature resistance, thickening mechanism, performance evaluation.*

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Micro-Mechanism and Permeability of Wetting of Unsaturated Loesses

In this study, the wetting mechanism of loess microstructures is deeply investigated from the perspective of unsaturated soil theory. The research methodology includes the prediction of the permeability coefficient of unsaturated soils using Van Genuchten model and Fredlund model, and variable head permeability test. The experimental results showed that the increase of percussive water content led to a significant decrease in the saturated permeability coefficient of the soil samples, which decreased by nearly 100 times when the percussive energy was elevated from 590.3 kJ/m^3 to 2705.6 kJ/m^3. With the increase of soil matrix suction, the permeability difference gradually decreases. In addition, the variation of the permeability coefficient of unsaturated soil was significantly affected by the percussive water content and percussive work of the soil samples. The microstructural analysis showed that wet subsidence resulted in significant changes in the pore characteristics and particle structure of loess, with the porosity decreasing from 0.374 to 0.296, the equivalent diameter decreasing to 4.028 μm, the pore morphology ratio increasing to 2.113, and the fractal dimension rising from 1.5021 to 1.5467, reflecting the increase in the pore complexity of the soil samples after wet subsidence deformation. The wetting mechanism of unsaturated loess is mainly affected by microstructure and intergranular suction, and the increase of moisture leads to the weakening of structural suction and sliding of soil particles, which in turn triggers the collapse of microstructure to form wetting. In summary, this study not only provides a new perspective for understanding and predicting the wet subsidence of loess, but also provides an important scientific basis and practical guidance for related applications in soil engineering and environmental science.

Keywords: *loess, wet subsidence, microstructure, unsaturated theory, wet subsidence mechanism.*

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A Study of Newly Compound Impactor Aiming
to Mitigate Stick-Slip Vibration on Drill Bit for Deep Formations

Existing torsion impactor used in the oil field has obvious defects, especially the failure to effectively enhance bit weight. This paper elaborates a brand newly designed compound impactor, in addition, the hydraulic performance of drive unit-the mixed flow impeller is respectively analysed to demonstrate the feasibility of the impactor. This innovative scheme owns an integrated motion just using one independent mechanical device, resulting in an impact loading on the bit in the axial and circumferential simultaneously. However, the theoretical model of a single stage impeller is provided to show the ideal hydraulic characteristic curve. Numerical simulation is investigated to reveal the relationship between the output torque and relative factors, including the flow rate, rotation velocity, and the incident angle of the guide wheel. Compared with earlier single axial vibrator and current torsion impactor driven by a screw or turbine, the remarkable significance of this project is the realization of a high-frequency compound shock on rocks and the reduction of the tool length owing to the utilizing of the mixed flow impeller. Both theoretical analysis and numerical results indicate the new power device can achieve equivalent output torque with a smaller size in comparison to the turbine. The tool provides a revolutionary method to prevent stick-slip vibration on drill bit, Moreover, the composite motion of bit exert by the tool increases the rock fragmentation efficiency. Another characteristic of this tool is the replacement of multi-stages turbines with a single flow impeller, leading to an equivalent output torque with a shorter length.
Keywords: *compound impactor, stick-slip vibration, mixed flow impeller, CFD.*

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Prediction of Gas Field Reservoir Favorable Zone Exploration and Its Main Control Factors

Reservoir characteristics of Ordos Basin Jingbian gas field X area Ordovician Ma5 section carbonate rock, study its reservoir main control factors, and predict the favourable zones of reservoir. According to the current domestic and foreign oil and gas exploration data, carbonate reservoirs have very favourable geological conditions for oil and gas exploration, and the vast majority of oil and gas reservoirs exist here, which can be used as the key research object for oil and gas reservoir development. However, nowadays, China's research on marine carbonate reservoirs is not mature and has certain exploration difficulties, so it proves that the study of carbonate reservoirs has great significance for the development of oil and gas reservoirs in China. This paper takes the Ordovician weathered crust and the carbonate reservoir of Ma5 section in Area X of Jingbian gas field in Ordos

Basin as the research object, integrates the geological theory and exploration practice, and makes use of the drilling and logging data, cores, thin sections, as well as the analysis of physical properties, gas test and other data in the research area to carry out an in-depth study on the characteristics of Ordovician Ma5 section in Area X of Jingbian gas field in Ordos Basin, respectively. Through the stratigraphic division and comparison of the Ordovician Ma5 section, reservoir pore characteristics and spatial characteristics in the study area, we analyse the favourable development intervals of the reservoir and predict the favourable zones to be as follows: rolling favourable exploration zone of the Jingbian karst terrace; favourable exploration zone of the Jila-Zhaohuangmiao-Angsumiao karst saddle-valley belt; favourable exploration zone of the eastern part of the X zone's solifluction ping; favourable exploration zone of the southern part of the Yulin-Yanchuan karst plain.
Keywords: *Ordovician, Ma5 section, dolomite, carbonate reservoirs.*

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Improving the Efficiency of Oil Displacement by Filtration

of Fractured Carbonate Reservoirs and Nitrogen Flooding

In order to conduct in-depth research on fractured carbonate reservoirs and effectively promote the improvement of oil recovery efficiency, this study aims to improve oil recovery efficiency through filtration and nitrogen flooding in fractured carbonate reservoirs. An oil field is selected as the research object to carry out the research, elaborate its geological characteristics, establish fracture standards, and analyze the regional fracture analysis. The parameters of physical large-scale model are designed and prepared, and the fractured carbonate reservoir model is constructed. The core seepage experiment was designed and the seepage results of rock samples were analyzed. Design the water injection nitrogen displacement process, and complete the application test. The test results show that: in fractured carbonate reservoir, oil well location and fracture distribution have a significant impact on oil production effect. When waterflooding oil production, the oil wells far away from fractures perform better; However, due to the characteristics of nitrogen and the existence of fractures, the oil production time of nitrogen flooding is significantly different, and the oil wells near the fractures produce oil quickly at the initial stage, but the overall effect is limited.

Keywords: *oil and gas resources, fractured carbonate reservoir, seepage experiment, nitrogen flooding by water injection.*

CORRECTION

To the article “A Preview of the Subsea Christmas Tree Installation Procedure,” Vol. 60, No. 5, pp. 1289–1296, November, 2024.

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A Preview of the Subsea Christmas Tree Installation Procedure

In the process of deep-water gas field development, the deep-water production system plays a key role, and the deep-water production system has been widely used in the development of the world’s offshore gas fields. In this paper, the author uses the X gas field as an example to introduce the subsea christmas tree installation procedure and the reliability of subsea tree production stage by using fault tree analysis (FTA). The installation procedure of the subsea christmas tree is divided into three steps: preparatory work before going in; pulling out the retracted part of the protective leg; using the tree running tool (LTRT) to install the subsea christmas tree. In this paper, the author introduces the installation procedure of subsea christmas tree detailedly, which is important in ensuring the independent and efficient development of offshore gas fields. According to the FTA analysis of throttle module, wellhead connector module and tubing hanger module, the average failure probability of subsea christmas tree production stage is 25.82 times every 106 hours, and the average failure interval is 4.42 years.

Keywords: *offshore gas field, subsea christmas tree, installation procedures, tree run tool (LTRT).*