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Коксование тяжелых смол пиролиза и их деасфальтизатов

В статье рассмотрен процесс коксования различных тяжелых смол пиролиза установки ЭП-300, а также выделенных из них деасфальтизатов. Приведены характеристики кокса и дистиллятов коксования, полученных при давлении 0,2 и 0,4 МПа.

Ключевые слова: *тяжелое нефтяное сырье, тяжелая смола пиролиза, замедленное коксование, нефтяной кокс.*

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Coking of Heavy Pyrolysis Resins and Their Deasphaltizates

The article discusses the coking process of various heavy pyrolysis resins of the EP-300 plant, as well as their deasphaltizates. The characteristics of coke and coking distillates obtained at pressures of 0.2 and 0.4 MPa are given.

Key words*: heavy oil raw materials, heavy pyrolysis resin, delayed coking, petroleum coke.*

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Оптимизация технологии процесса замедленного коксования при производстве премиальных нефтяных коксов

В статье рассмотрена вариативность эксплуатации промышленной технологической установки замедленного коксования проекта 21-10/3М. На основе лабораторных исследований и созданной модели процесса рассмотрены технологические режимы, позволяющие производить востребованные нефтяные коксы: анодные и премиальные (игольчатые). Наряду с выбором сырьевой базы при производстве игольчатых коксов определена основополагающая роль ректификации продуктов коксования, где важнейшей задачей является организация эффективного выделения и возврата в процесс непрореагировавшей части ценного ароматического сырья. Доказано лабораторно и подтверждено расчетом, что максимальный объем производства целевого игольчатого кокса на уровне 40% и более достижим

на промышленной установке замедленного коксования за счет полной конверсии дефицитного специфичного сырья.

Ключевые слова: *замедленное коксование, нефтяной кокс, анодный кокс, игольчатый кокс, анизотропный кокс, тяжелый газойль каталитического крекинга, коэффициент рециркуляции.*

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Optimization of Delayed Coking Process Technology in the Production of Premium Petroleum Cokes

The article considers the variability of operation of the industrial technological unit of delayed coking of the project 21-10/3M. Based on laboratory studies and the created process model, the mathematical modes allowing to produce popular petroleum cokes are considered: anode and premium (needle). Along with the choice of the raw material base in the production of needle cokes, the fundamental role of rectification of coking products is determined, where the most important task is to organize the effective separation and return to the process of the unreacted part of valuable aromatic raw materials. It has been established in the laboratory and confirmed by calculation that the maximum volume of production of target needle coke at a level of 40% or more is achievable in an industrial delayed coking plant due to the complete conversion of scarce specific raw materials.

Key words*: needle coke, anisotropic coke, delayed coking, catalytic cracking heavy gas oil, recyclin.*

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Сильнокислотный катализатор марки «КОБ» в процессах превращения прямогонных углеводородных фракций

В работе рассмотрены основные химические реакции, протекающие на цеолитном катализаторе марки КОБ в одностадийном процессе превращения прямогонной нафты. Анализ продуктов превращения, позволяет сделать вывод о протекании реакций крекинга, изомеризации, олигомеризации, димеризаии, дегидроциклизации и алкилирования с образованием сложных углеводородных смесей с высоким содержанием ароматических соединений, состав которых обусловлен условиями процесса и углеводородным составом прямогонной нафты.

Ключевые слова: *катализатор олигомеризации, бутан-бутиленовая фракция, бензиновая фракция.*
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Highly Acidic Strength Catalyst COB in Conversion Process
of Straight-Run Hydrocarbon Fraction

The paper discusses the main chemical reactions occurring on zeolite catalyst COB in a single-stage process of converting straight-run naphtha. The analysis of the transformation products allows us to conclude that the reactions of cracking, isomerization, oligomerization, dimerization, dehydrocyclization and alkylation occur to form complex hydrocarbon mixtures with a high content of aromatic compounds, the composition of which is determined by the process conditions and the hydrocarbon composition of straight-run naphtha.
Key words*: catalyst of oligomerization, butane-butylene fraction, gasoline fraction.*

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Исследование параметров аэрозольного нанесения пленок нановолокнистого углерода

Работа посвящена изучению влияния параметров нанесения на газочувствительные характеристики газового сенсора на базе нановолокнистого углерода. Параметрами нанесения являлись концентрация суспензии, выбор растворителя и толщина пленки газового сенсора. Нановолокнистый углерод наносился на подложку газового сенсора методом аэрозольного напыления. Газочувствительными характеристиками являлись отклик газового сенсора, степень восстановления, время отклика и отношение сигнал-шум.
Ключевые слова: *нановолокнистый углерод, газовый сенсор, аэрозольное напыление.*
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Investigation of the Parameters of Aerosol Spraying
of Films of Nanofibrous Carbon

This work is devoted to the study of application parameters on the gas-sensitive characteristics of a carbon nanofiber-based gas sensor. The deposition parameters were suspension concentration, solvent selection and film thickness of the gas sensor. Carbon nanofibers were applied to the gas sensor substrate by aerosol spraying. The gas-sensitive characteristics were gas sensor response, recovery rate, response time and signal-to-noise ratio.
Key words*: nanofibrous carbon, gas sensor, aerosol spraying.*

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Разработка подхода к количественному определению димеров жирных кислот

Рассмотрены наиболее распространенные хроматографические и спектрометрические методы анализа димеров жирных кислот. Показано, что наиболее перспективным методом рутинного анализа является газохроматографическое определение с прямым вводом в колонку. Установлено, что зависимость сигнала детектора от содержания как мономеров, так и димеров остаётся линейной в исследуемом диапазоне концентраций, при этом коэффициент относительной чувствительности по отношению к мономерам и димерам стабилен при изменении соотношения их мас. Разработанный подход может применяться для исследования состава противоизносных присадок к топливам для реактивных двигателей и создания оригинальной присадки.
Ключевые слова*: димеры жирных кислот, мономеры жирных кислот, противоизносные присадки.*
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Development of an Approach to Quantification of Fatty Acid Dimers

The most common chromatographic and spectrometric methods for the analysis of fatty acid dimers are considered. It has been shown that the most promising method for routine analysis is gas chromatographic determination with cool on-column injection. It was found that the dependence of the detector signal on the content of both monomers and dimers remains linear in the studied concentration range, while the relative sensitivity coefficient with respect to monomers and dimers is stable when their masses ratio changes. The developed approach can be used to study the composition of anti-wear additives
for jet engine fuels and create an original additive.
Key words*: fatty acids dimers, fatty acids monomers, anti-wear additives.*

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Применение комплексного методического подхода при анализе проб неизвестного состава в нефтегазовой отрасли

Предложен комплексный методический подход к физико-химическому исследованию проб неизвестного состава, описаны методы анализа, актуальные на каждом этапе исследования, рассмотрены процедуры проведения, достоинства и недостатки каждого метода. Рассматриваемый алгоритм исследований позволяет определять природу образцов, их качественный и количественный состав с применением современных методов анализа для решения как прикладных задач, связанных с эксплуатацией нефтегазового оборудования, так и научных вопросов происхождения и превращения тех или иных веществ.
Описанный подход является достаточно универсальным и разработан с учетом преимуществ и ограничений каждого из методов.

Ключевые слова: *физико-химические исследования, комплексный методический подход, хроматография, масс-спектрометрия, молекулярная спектроскопия, оптическая спектроскопия, элементный анализ, термогравиметрия, рентгенофлуоресцентный анализ.*
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Application of a Comprehensive Methodological Approach to the Analysis of Samples of Unknown Composition in the Oil And Gas Industry

A comprehensive methodological approach to the physicochemical study of samples of unknown composition is proposed, analysis methods that are relevant at each stage of the study are described, the procedures, advantages and disadvantages of each method are considered. The research algorithm under consideration makes it possible to determine the nature of samples, their qualitative and quantitative composition using modern methods of analysis to solve both applied problems associated with the operation of oil and gas equipment, and scientific issues of the origin and transformation of certain substances. The described approach is quite universal and was developed taking into account the advantages and limitations of each method.

Key words*: physicochemical studies, integrated methodological approach, chromatography, mass spectrometry, molecular spectroscopy, optical spectroscopy, elemental analysis, thermogravimetry, X-ray fluorescence analysis.*

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Перспективы производства молочной кислоты

В статье рассмотрены актуальные исследования в области микробиологического синтеза молочной кислоты. Рассмотрены наиболее применимые штаммы-продуценты, виды углеродных субстратов и фундаментальные направления исследований по оптимизации синтеза молочной кислоты.

Ключевые слова: *молочная кислота, продуценты, микробиологический синтез.*
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Prospects for the Production of Lactic Acid

The article reviews current research in the field of microbiological synthesis of lactic acid. The most applicable producer strains, types of carbon substrates and fundamental research areas for optimizing lactic acid synthesis are considered.

Key words*: lactic acid, producents, microbial fermentation.*

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Regulation of Effectiveness of Intensifying Compositions
Based on Carboxylic Acid and Alcohol in an Aromatic Solvent Media
for Bazhenov Formations' Rocks Treatment

This work presents the results of studying the dissolving ability of acetic acid in a non-polar aromatic solvent and water during the interaction with rock samples of bazhenov formation. It's classified as a difficult production zone and hard-to-recover reserves which has great potential for oil production. It has been shown that the dissolution processes of mineral and organic rock components extensively depend on the acetic acid concentration and the nature of solvents. Moreover, they are determined by the associated state of acetic acid. Using the method of IR-Fourier spectroscopy, the features of hydrocarbon solutions' effect on the extraction of organic matter components from rocks depending on content of reagents are considered. It was found that the addition of isopropanol to hydrocarbon and aqueous solutions of acetic acid significantly reduces the intensity of dissolution processes. Based on the determination of esterification degree, presence of the esterification reaction was confirmed. This reaction leads to partial binding of acid and alcohol during the ester formation and provides a significant retardation of dissolving effect of these compositions. Also, the possibility of regulating compositions' dissolving ability in a wide range between different values by introducing surfactants has been demonstrated. The studied compositions can be used as the base for intensifying surfactant-acid systems with prolonged action which can have a complex effect on the minerals and organic matter of the bazhenov formation rocks.

Keywords: *intensifying systems, bazhenov formation, dissolving ability, acetic acid, petroleum solvent, isopropanol, isopropyl acetate, surfactants, organic matter.*

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Rheological Models for Transporting and Processing Heavy Crude Oils

Using the hydrodynamics of flow, a new nonlinear differential equation for the rheology of highly viscous crude oils has been derived, reflecting the dependence of shear stress on relaxation time and shear rate. Various analytical solutions are presented, taking into account boundary conditions, allowing for the assessment of shear stress and the effective viscosity of highly viscous dispersed systems. A practical application of the rheology equation for evaluating the apparent viscosity of heavy crude oils is proposed. Additionally, a recirculation scheme for processing heavy crude oils is suggested, aimed at improving their rheological properties.

Keywords: *rheology, oil-based dispersion, highly viscous fluids, new rheology equation, apparent viscosity, shear stress, recirculation, crude oil processing.*

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Compressive Sensing-Based Spectral Inversion Algorithm
and Its Application in Detailed Fault Characterization

RThe relentless advancement and integration of mechanization and intelligence within the coal and oil and gas mining and oil and gas industry, combined with the increasing depths of mining operations, necessitate significantly higher safety standards. This necessity arises due to the increasingly complex geological and coal and oil and gas seam conditions encountered as mining operations delve deeper into the earth. Traditionally, 3D seismic exploration technology has been fundamental in ensuring both operational efficiency and safety in the coal and oil and gas mining sector. However, despite its critical role, this technology still has limitations in detecting and characterizing small-scale geological structures which can pose substantial risks if not accurately identified and mitigated. To address these challenges, this paper introduces a sparsity-constrained adaptive hard thresholding algorithm designed to tackle the spectral inversion optimization problem with an L_0 norm constraint for the enhanced retrieval of reflection coefficients, thereby establishing a comprehensive workflow for enhancing seismic data resolution through compressed sensing spectral inversion. Real data validation has demonstrated that this method significantly enhances the resolution of seismic data while maintaining the amplitude integrity and fidelity of the original signals. This improvement allows for a more detailed and accurate characterization of small-scale geological features, which are critical in identifying and mitigating potential hazards within coal and oil and gas mining operations, thus offering robust support for the implementation of more effective safety protocols and disaster prevention strategies in coal and oil and gas mines.

Keywords: *compressive sensing; fault characterization; spectral inversion; coal and oil and gas seismic exploration technology.*

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Study on the Temperature and Salt Resistance of Novel Surfactants

for Enhanced Oil Recovery

In recent years, enhanced oil recovery (EOR) techniques, such as surfactant flooding and polymer flooding, have demonstrated significant success in improving oil recovery rates in conventional reservoirs, achieving objectives like water control, increased oil production, and cost-effectiveness. However, high-temperature and high-salinity conditions in deep and ultra-deep reservoirs present substantial challenges to conventional EOR systems. Consequently, research on temperature- and salt-resistant EOR systems is critical for enhancing recovery in these challenging environments. This paper reviews the progress in the development of temperature- and salt-resistant EOR systems both domestically and internationally. By discussing the structure and properties of four key EOR systems, we analyze their mechanisms of action and effectiveness in enhancing oil recovery. The study reveals that the selected surfactant systems exhibit excellent temperature resistance, withstanding temperatures of up to 140-160°C, making them suitable for high-temperature reservoirs. Additionally, these surfactant systems show strong resistance to both monovalent and divalent salts, withstanding Na^+ concentrations of 15,000-50,000 mg/L and Ca^{2+} concentrations of 1,500-4,500 mg/L, which makes them effective for use in highly saline reservoirs.

Keywords: *deep reservoirs, temperature and salt resistance, enhanced oil recovery, improved oil recovery.*

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Near-Borehole Acoustic Velocity Model Inversion

Based on Finite-Difference Ray Tracing Tomography

In oil and gas well drilling engineering, a near-borehole acoustic velocity model could be used for quantifying the radial distance of drilling fluid intrude into the formation rocks. Therefore, for the high time cost drilling engineering projects, it is necessary to obtain the near-borehole velocity model as quickly as possible to evaluate the drilling fluid intrusion distance. In this paper, we propose a traveltime tomographic method to quickly build the velocity model around the borehole using the array acoustic logging data. The ray tracing process of the method is based on the finite-difference computational scheme of the fast sweeping method, which is much more efficient compared with the conventional two-point ray tracing methods because the proposed method considers contributions of all ray paths corresponding to the same source transducer simultaneously. Furthermore, this paper proposes to widen the ray path by rotating finite-differential directions, so as to enlarge the coverage area of the inversion gradient. The strategy significantly reduces the number of iterations needed for model convergence. Synthetic and field data tests prove that the proposed near-borehole acoustic velocity model inversion method has

high computational efficiency, and is applicable for quantifying the radial distance of drilling fluid intrude into the formation rocks in the time-sensitive drilling process.
Keywords: *borehole fluid intrusion, velocity model inversion, ray tracing, traveltime tomography, rotated grid.*

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Research on Fracturing Sweet Spot and Cluster Design Based
on Big Data Analysis and Intelligent Fusion Algorithms

This study addresses numerous issues in traditional fracturing sweet spot identification and segment cluster design by proposing a method based on big data analysis and intelligent fusion algorithms. First, based on the key influencing factors for sweet spot identification, a combined big data analysis method using K-Means and KNN is employed to perform clustering analysis, aiming to achieve the goal of identifying fracturing sweet spots. Secondly, an algorithm integrating expert experience, Self-Organizing Map (SOM) clustering, K-Means, and KNN is introduced to carry out segment cluster design, thereby realizing the objective of intelligent segment cluster design based on the comprehensive sweet spot index.The research demonstrates that in the sweet spot identification process, there are many influencing factors. The combination of K-Means and KNN for big data analysis can accurately identify geological sweet spots, engineering sweet spots, and the comprehensive sweet spot index. In the segment cluster design process, the expert experience model first integrates geological and engineering data from the block, forming design schemes through inductive analysis. Intelligent algorithms centered around SOM, K-Means, and KNN are capable of deeply analyzing geological and engineering data, achieving the goals of stratification and clustering.

Keywords: *big data analysis, sweet spot identification, expert experience, intelligent fusion algorithms, segment cluster design.*

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Effect of Liquid Invasion on Shale Microstructure and Permeability

In the process of shale gas development by multi-stage fracturing, a large amount of liquid invaded the shale and destruct the seepage space of shale, thus affecting the seepage capacity of shale. A better understanding of the mechanism of liquid invasion on shale is crucial for drilling and fracturing design. This paper presented a series of

experiments to comprehend the dynamic changes of microstructure and permeability after liquids invaded into shale. The results demonstrated that deionized water exhibits the highest infiltration volume, while slick water and kerosene exhibit similar levels of infiltration. Both deionized water and slick water exhibit an initial rapid decreased in shale permeability during the initial phase of liquid infiltration, followed by a fluctuation period where permeability initially increased and then decreased. The mechanism of liquid invasion on shale was discussed. Results show that the effect of liquid invasion on shale can be categorized into three stages. In stage 1, a limited number of micro-cracks formed in this stage and a lot of sticky flocculent minerals generated after immersed, leading to a significant decrease in the permeability of the shale samples. In stage 2, the uneven expansion caused by the hydration of clay minerals resulted in hydration stress directly applied to the tips of pre-existing micro-cracks, and lead to new cracks initiate and existing cracks propagate. In stage 3, over a certain period of hydration, isolated micro-cracks in localized regions of the shale merged and formed macroscopic cracks that traversed the shale. This study is helpful to understand the dynamic changes of shale microstructure and permeability after liquid invaded into shale.
Keywords: *microstructure, permeability, liquid invasion, shale gas, shale-liquid interaction.*

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Safety Risk Analysis of Well Control for Wellbore with Sustained Annular Pressure and Prospects for Technological Development

Sustained annular pressure (SAP) is a primary indicator and hazard of wellbore integrity failure, commonly observed in deep oil and gas wells, gas storage injection/production wells, CCUS wells, and shale gas horizontal wells. The wellbores with SAP are faced with significant well control risks, primarily manifested as high-pressure fluid leakage, secondary risks during well interventions, and challenges in post-event remediation. To handle these risks, advancements have been made in barrier enhancement and pressure management technologies, annular pressure detection and identification techniques, and safety control strategies. These developments enable scientific prevention, real-time monitoring, quantitative detection, and effective control of SCP. However, gaps remain in the integration of simulation, evaluation, and control capabilities within industrial simulation software for SCP scenarios. Challenges also persist in sealing wellbore leaks, including high injection difficulty, low pressure-bearing capacity, and unsatisfactory remediation outcomes. It is recommended to develop industrial simulation software, innovate new materials, techniques, and equipment, and conduct scientific evaluations of SCP wellbore service safety. These efforts aim to overcome wellbore leakage management challenges under various engineering contexts.

Keywords: *sustained annular pressure, safety risks, detection technology, management and control, simulation software, sealing technology.*

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Application of Amplitude Variation with Offset Analysis Technique

on Predicting the Gas Content of the Coalbed

Recent years, domestic and foreign scholars have done a lot of exploration and practice on seismic prediction methods of the gas content of the coalbed. Amplitude variation with offset (AVO) analysis technique can be applied to the coalbed gas, but it is different from the "established conclusion" of conventional natural gas. Take K area as an example, Modulus attributes and density of the coalbed are sensitive to coalbed gas through petro-physical analysis. That means the higher the gas content, the lower the modulus property and density value, moreover, the negative correlation between gas content and modulus attributes is more obvious. Through AVO forward modeling analysis, 8+9# coalbed in K area shows the type IV of AVO abnormal characteristics, and high gas content corresponds to strong abnormal, low gas content corresponds to weak abnormal. AVO attribute of "A-B" can predict the gas content of 8+9 coalbed in K area, which shows good application effect.

Keywords: *coalbed gas, AVO analysis technique, petro-physical analysis, AVO forward modeling.*

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Research on the Coalbed Methane Reservoir Characteristic

Identification Method Based on Seismic Attribute Analysis

This study addresses the problem of coalbed methane reservoir characteristic identification by introducing seismic attribute-based analysis methods. First, the characteristics of coalbed methane reservoirs and the seismic response mechanisms are analyzed. Then, a summary of seismic attribute analysis methods is presented. Based on this, the study explores methods for coalbed methane reservoir characteristic identification based on seismic attribute analysis. The research lays a foundation for the further development of coalbed methane exploration in China. The study shows that the optimized selection of seismic attributes plays a crucial role in coalbed methane reservoir identification. By selecting appropriate seismic attributes, the accuracy and reliability of reservoir identification can be improved, providing strong support for coalbed methane exploration and development. With the continuous development of technology, optimization selection methods are constantly evolving, from traditional manual selection to automated selection through machine learning. The technology of seismic attribute optimization selection is expected to play an increasingly important role in coalbed methane exploration. The application of machine learning and artificial intelligence technologies in coalbed methane reservoir identification not only improves the accuracy and efficiency of reservoir identification but also provides technical support for the intelligent and automated development of coalbed methane exploration.

Keywords: *seismic attributes, coalbed methane, reservoir characteristics, seismic response, identification methods.*

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Research on Chemical Properties of Anti-Corrosion Coatings
for Natural Gas Pipelines and Economic Evaluation of Interconnection

With the increase in the demand for long-lasting anti-corrosion technology for pipelines in oil and gas storage and transport projects, the research on the external anti-corrosion layer and internal coating technology of pipelines has received wide attention. For the natural gas pipeline anticorrosion coating materials in the pipeline corrosion research status quo, the preparation of dibasic acid as chain extender epoxy acrylate modified material coating materials, the study of its anti-corrosion effect on the chemical pipeline, examined the resin acid value, epoxy acrylate structure, water contact angle, water absorption, electrochemical impedance, salt spray resistance, dynamic mechanical heat, light curing coatings, and other basic properties. four dibasic acid epoxy The chemical impedance and salt spray resistance test results of the coating materials of the acrylate-modified material resins show that the corrosion resistance of the coating materials exhibits the change rule of gradual enhancement first and then gradual decrease with the increase of the carbon chain. At the same time, the article studied the feasible economic benefit evaluation method of the construction project of interconnected long-distance natural gas pipeline project, and the results showed that: the financial internal rate of return of the interconnected pipeline project under the three functions of gas supply, transferring and security are 10.61%, 11.87% and 1.69% respectively; the project financial internal rate of return for the overall function of the project is 6.49%, which is higher than the benchmark rate of return of 6%. The project as a whole is financially viable.

Keywords: *epoxy acrylate modified material resins, electrochemical impedance, salt spray resistance, natural gas interconnections, pipeline engineering, economic efficiency evaluation.*

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A New Oil-Based Drilling Fluid System for Enhancing the Stability
of Deep Well Settlement under High Temperature and High Pressure Conditions

In order to solve the technical problems of high temperature and high pressure drilling in deep wells, the rheological properties are difficult to control due to the high density of drilling fluid, insufficient temperature resistance caused by well depth, and frequent well leakage caused by the development of formation fractures. Based on the research and performance evaluation of high-temperature resistant emulsifiers for oil-based drilling fluids, a set of XZ high-efficiency oil-based drilling fluid system has been perfected through material optimization

and system formulation optimization. This system has good high-temperature stability, sealing effect, anti pollution ability, and settling stability, and can meet the needs of different formations; The developed oil-based drilling fluid anti high temperature flow regulator has solved the problem of settling stability in high-temperature and high-pressure deep well completion and oil testing operations, forming an XZ anti high temperature high-density oil-based completion fluid system with a density of 2.5 g/cm^3, temperature resistance of 220°C, and high temperature static settling stability of 15 days.
Keywords: *high temperature resistance, high-density, oil based drilling fluid, research and development of processing agents.*

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Classification and Segmental Construction
of Pseudo-Capillary Pressure Curve Using NMR T_2 Spectrum

Based on experimental results, a new construction method is proposed. Firstly, the mean throat diameter is calculated using the geometric mean of T_2 values extracted from nuclear magnetic resonance (NMR) T_2 spectra. Then, the reservoir types are divided into five categories based on the mean throat diameter. Categories I and II are constructed using a two-segment power function to build the capillary pressure curve, while categories III, IV, and V are constructed using a two-segment power function and a linear function in a three-segment approach. The values of the breakpoints in the relationship between P_c and $1/T_2$ are determined using the geometric mean of T_2 values. Finally, a model is developed to classify and segmentally construct the pseudo-capillary pressure curve for the entire region. The results obtained using this method show good agreement with the experimentally measured capillary pressure curve and accurately calculate the mean throat diameter. This method provides a technical foundation for expanding the application of nuclear magnetic resonance well logging.
Keywords: *NMR* T$_2$ *spectrum, pseudo-capillary pressure curve, pore structure, classification, segmentation.*

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Effect of Lubricating Oil Composition on Damage and Fouling of Sandstone Reservoirs in Natural Gas Production

During natural gas drilling and production, the use of lubricating oil causes damage and fouling to sandstone reservoirs, thereby hindering the migration, diffusion, and extraction of oil and gas. In addition, reservoir fouling caused by lubricating oil and natural gas can also cause drilling and production machinery to get stuck and other related obstacles, and petroleum workers are actively exploring the causes of sandstone reservoir damage and related solutions to alleviate reservoir damage. This study is based on the geological characteristics of sandstone reservoirs, and establishes adsorption and diffusion models for natural gas and lubricating oil molecules according to the natural gas occurrence law. At the same time, the influence of lubricating oil composition and reservoir conditions on sandstone reservoir damage is analyzed. In addition, the micro mechanism of sandstone reservoir damage was revealed based on molecular dynamics and adsorption theory. The research results indicate that natural gas and lubricating oil components have both adsorption and desorption effects on the surface of sandstone, and Langmuir monolayer adsorption is the main cause of sandstone reservoir damage. Raising the reservoir temperature will reduce the adsorption capacity of methane and lubricating oil molecules, and the adsorption capacity of the reservoir will decrease from 0.53 mg/m^3 at 40°C to 0.39 mg/m^3 at 80°C. The increase in reservoir pressure exhibits a higher reservoir damage rate and lower permeability, which may be due to the enhanced adsorption of microscopic molecules on the sandstone surface caused by reservoir pressure. In addition, the increase in the molecular chain and content of lubricating oil can also reduce the reservoir damage rate from 9% to 20%, which may be due to the increase in the molecular chain of lubricating oil promoting the adsorption of molecules on the surface of sandstone. By analyzing the impact of lubricant composition and reservoir conditions on sandstone reservoir damage, convenient conditions and theoretical support can be provided for natural gas and reservoir development in sandstone reservoirs.

Keywords: *natural gas extraction, sandstone reservoir damage, lubricating oil, reservoir fouling, molecular adsorption model.*

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Study and Analysis of Normalized Production Decline in Shale Oil

Continental shale oil is characterized by tight reservoirs, strong heterogeneity, high oil viscosity, and poor mobility. The "horizontal well + closely spaced volume fracturing" approach is the key to its efficient development. However, field production shows that due to the influence of geological, engineering, and production system factors, production and pressure frequently fluctuate. Conventional production decline prediction methods are highly sensitive to data variations, making it challenging to effectively predict the production dynamics in this region. Focusing on the production characteristics of Jimusar lacustrine mixed shale oil wells, this study employs a

normalized production decline model that simultaneously incorporates the effects of pressure and production (normalized production decline model) to analyze the production dynamics of shale oil wells in this area. The study also proposes a corresponding process for predicting the ultimate recoverable reserves (EUR) of single wells in Jimusar lacustrine mixed shale oil using this method. The findings demonstrate the feasibility and advantages of the normalized production decline method for such production wells, providing valuable insights and references for EUR prediction in similar production wells.
Keywords: *shale oil, dynamic analysis, production decline model, ultimate recoverable reserves (EUR).*

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Some Features Remediation of Organic Polluted Groundwater Sites via In-Situ Heating Enhanced and Circulation Well

By setting up in-situ heating wells within the radius of influence of groundwater circulation wells, the effectiveness of using circulation wells and heating enhanced circulation wells to remediate organic contaminated groundwater was compared and studied. The results showed that in the fine sand aquifer medium of the site, when the length of the groundwater circulation well was set to 6.00m and the aeration flow rate was 0.3 m^3/h, the influence radius was 5 m. After 48 hours of cumulative remediation, the total petroleum hydrocarbons in the circulation well reached the remediation target value; When the temperature of the four in-situ heating wells located 1 m away from the enhanced circulation well is set to 40°C, the total concentration of petroleum hydrocarbons in the circulation well reaches the target value after 24 hours of cumulative repair; After 48 hours of repair, the repair efficiency of the reinforced circulation well increased by 3.18% compared to the circulation well, and the repair efficiency of the working well 5 m away from the reinforced circulation well increased by 22.97% compared to the working well 5 m away from the circulation well; The influence radius of both the circulation well and the enhanced circulation well is about 5 m. In situ heating has improved the efficiency of remediation and provided a new approach for the application of groundwater circulation wells in the remediation of contaminated sites.
Keywords: *groundwater circulation well, in-situ heating, total petroleum hydrocarbons.*

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Research on the Distribution of Remaining Gas Based on the Dynamic Fine-grained K-means Recursive Algorithm

Due to the poor physical properties of tight sandstone gas reservoirs and complex reservoir space, the development is difficult and the final recovery is low. The main reason is that the local enrichment of residual gas is difficult to be accurately described. In this paper, the high dimensional index system affecting residual gas was established, and the main controlling factors affecting residual gas were obtained through the dimensional reduction of machine learning. Firstly, two machine learning algorithms are used to identify the main factors affecting the remaining gas. Then use it as input to perform unsupervised learning on the grid using K-means and label it. Finally, by integrating the spatial coordinate parameters of the grids, setting thresholds, and dynamically recursively searching each grid, resulting in the distribution of remaining gas types for each layer. The results show that the main factors affecting the residual gas are reserve abundance, effective thickness and pressure. In addition, the first and second layers are dominated by high residual gas reservoirs, the third layer has more high residual gas reservoirs, the fourth and fifth layers are dominated by medium residual gas reservoirs, and the sixth layer has very little residual gas.

Keywords: *distribution of remaining gas types, feature selection, unsupervised learning, dynamic fine-grained recursion.*

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Particle Migration and Blockage Characteristics of High Water Content Porous Sandstone Underground Gas Storage during the Injection and Production Processes

High water content porous sandstone underground gas storage often encounter the problem of pore throat blockage induced by particle migration, which significantly affects the injection and production capacities. To determine the characteristics and main controlling factors of particle migration blockage during the injection and production processes, a comprehensive study was conducted using particle migration visualization experiments and the coupled computational fluid dynamics-discrete element method (CFD-DEM) method. Results reveal that blockages begin when the particle diameter exceeds 1/3 of the pore throat diameter and is significantly affected by the differential pressure. When the particle diameter exceeds 2/3 of the pore throat diameter, severe blockage occurs, and the differential pressure has little influence on this blockage phenomenon. Notably, when the particle diameter is less than 2/3 of the pore throat diameter, some blockages formed during the injection process are broken and re-formed in other pore throats during the production process, which impacts both the injection and production capacities. However, when the particle diameter exceeds 2/3 of the pore throat diameter, blockages

formed during the injection process are not easily washed away during production, and new particles tend to accumulate and stack at the blocked locations, leading to a more significant decline in the production capacity. Additionally, in the initial stage of injection, blockages are mainly caused by single-particle obstructions. Over time, these blockages transition into multi-particle bridging and gradually accumulate to form a stable blockage region. During production, the direction and primary pathways of particle migration change, and new blockages rapidly appear in the form of multi-particle bridging. These findings are of great significance for understanding particle migration and blockage characteristics in high water content porous sandstone underground gas storage and for improving their injection and production capacities.
Keywords: *particle migration, pore structure, injection and production processes, laser etching, CFD-DEM.*

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On The Issue of Gas Leakage Evaluation in Section of Gas Field

In the process of long natural gas transmission, the pipeline leakage often occurs due to various reasons, the aperture of the leakage is large, small, the location of the leakage point is difficult to predict, causing pollution to the environment, waste of energy. Through the direct and indirect causes of natural gas pipeline leakage accident, the main factors of pipeline leakage are analyzed, and then through the CFD software to simulate the leakage time and dangerous area identification, and get the distribution of natural gas in the atmosphere after natural gas pipeline leakage. The study shows that: after this kind of pipeline leakage, the most important thing is to control the leakage time and dangerous area identification, at the same time, supporting the natural gas pipeline leakage monitoring system and pipeline leakage prevention management measures, to reduce the harm of pipeline leakage. At the same time, He8 solid waste of YA gas field was sampled, its performance characteristics and pollution characteristics were analyzed, and the solid waste of He8 well of the gas field was studied. Zero-price metal catalyst was selected by the experimental reduction method to decompose pollutants in the copper catalyst. It show that when the experimental conditions is T=45°C, pH=11, $Q_{Na_2S_2O_8}$=10%, $Q_{catalytic\ agentCuba}$= 10%, hydroxypropylguar gum, polyacrylamide (PAM), carboxymethyl cellulose (CMC) and other gas field polymers, after 4 hours of reaction, the COD removal rate reached more than 85%. At the same time, for the gas storage reservoir A of Yanchang gas field, combined with the geological development characteristics of the gas reservoir, the long-core cutting and changing test of different gas sources is carried out to complete the gas injection study.

Keywords: *gas field, natural gas leakage, solid waste, carbon dioxide gas injection.*

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Study on the Influence of Interlayer on the Exploitation Characteristics of Carbonate Bottom Water Gas Reservoir

Using the X bottom water gas reservoir as an example, this paper combines physical simulation and numerical simulation methods to conduct high-temperature and high-pressure water invasion core experiments and numerical simulation sensitivity analysis. The study divides the development stage of bottom water gas reservoir with interlayer, and clarifies the main controlling factors that affect the production effect of the reservoir. The research shows that the development of gas reservoirs with interbed bottom water can be divided into three stages: elastic gas drive, water supplement energy, and gas-water co-production; As the permeability of the interlayer decreases and the thickness increases, the pressure difference required for bottom water breakthrough rises, enhancing the sealing ability of the interlayer. This can delay water breakthrough in gas reservoirs and reduce water invasion intensity, which is conducive to gas reservoir production. When the interlayer is locally developed, the water phase will flow along the dominant channel, resulting no obvious elastic gas drive stage, which is similar to the water breakthrough pressure and production effect in reservoirs without interlayer; Dispersion, permeability and thickness of interlayer are the main factors influencing the recovery effect of bottom water gas reservoirs. Among these, the dispersion of interlayer is the key factor, followed by permeability of interlayer and thickness of interlayer. The findings of this paper can deepen the understanding of the main controlling factors affecting the production performance of bottom water gas reservoirs, and provide a mechanism understanding for guiding their efficient development.

Keywords: *carbonate rock, bottom water gas reservoir, interlayer, development stage, water invasion experiment, mechanism simulation.*

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Optimization of Multi-Cluster Fracturing in Offshore Low-Permeability Reservoirs

The development of hydraulic fracturing technology in offshore oil fields has lagged, constrained by operational conditions and environmental challenges. This study focuses on offshore low-permeability tight reservoirs, employing numerical simulations to investigate multi-cluster fracturing in horizontal wells under varying reservoir thickness and cluster spacings. The research explores the impact of different cluster spacings and reservoir thickness on stress shadow effects and fracture propagation behaviors. A detailed analysis was conducted to develop visual representations of how cluster spacing and reservoir thickness influence multi-cluster fracture extension. The study also optimizes perforation parameters to improve fracture initiation and propagation. Key findings indicate that in scenarios with small cluster spacing and thick reservoirs, significant stress shadow

interference occurs, impeding the extension of middle fractures due to pressure from outer fractures. By reducing perforation friction in the middle fractures and increasing friction in the outer fractures, balanced fracture propagation can be achieved, enhancing the overall efficiency of multi-cluster fracturing operations.
Keywords: *low permeability reservoir, horizontal well, fracture propagation, finite element.*

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Numerical Simulation Analysis of Parameters in an Artificial Gas Cap of CO_2 Enhanced Oil Recovery And Storage

The numerical simulation of parameters in an artificial gas cap for CO_2 enhanced oil recovery (EOR) and storage presents a promising avenue to improve oil recovery while mitigating carbon emissions through geological storage. This study investigates the optimization of key parameters of both geological and development such as gas injection pressure and purity, reservoir heterogeneity, permeability, porosity and operational strategies using numerical simulation software CMG-GEM. By analyzing the interplay between oil recovery rate and CO_2 trapping mechanisms, this work provides a comprehensive understanding of the CO_2-EOR system under varying conditions. The results reveal that certain set of geological parameters and operational parameters can significantly enhance oil recovery rate while ensuring effective CO_2 storage. Furthermore, the study models and evaluates the diffusion of CO_2 and storage mechanism under different development methods such as WAG and CO_2 injected continuously. These findings offer valuable insights into advancing sustainable energy practices and optimizing CO_2-EOR systems.

Keywords: *CO_2-EOR, carbon storage and utilization, numerical simulation.*

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Experimental Study of Petroleum Coke Ash in Concrete Applications

Petroleum coke is the product of delayed coking in oil refining industry, which contains high heat and has high utilization value. Circulating fluidized bed combustion technology has developed faster and better in recent years; with its wide application, the production of petroleum coke ash will also be greatly increased. At this stage, the utilization and research of petroleum coke ash is less, so the recycling of petroleum coke ash has great research significance. This paper focuses on the effect of petroleum coke ash on the workability, mechanical properties and durability of concrete. The test is done by adding coke ash or pre-dissolved coke ash, fly ash, mineral powder, and high efficient water reducing agent to study the application of petroleum coke ash in concrete. The study shows that: the reasonable use of petroleum coke ash can significantly reduce the amount of cement; the incorporation of pre-dissolved coke ash is more favorable to the performance of the concrete than the incorporation of the original coke ash; when the amount of coke ash, the total amount of cementitious material is the same, the mechanical properties of compounded coke ash and S95 mineral powder, the anti-carbonation properties and the anti-chloride

penetration properties are optimal; the anti-chloride penetration of the single mix of coke ash has the poorest capacity, and the mechanical properties and anti-carbonation properties of the compounded fly ash and coke ash are the worst. mechanical properties and the worst resistance to carbonation. The optimum ratio of petroleum coke ash in concrete is 15% pre-dissolved coke ash and 35% mineral powder.
Keywords: *petroleum coke ash, mineral powder, workability, mechanical properties, durability.*

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Determination of a Gas Field Production Pipeline Network
through Rolling Forecast Virtual Flow Metering
Based on a Surface and Subsurface Integrated Model

This study presents a novel integrated model combining surface and subsurface data with multiphase flow calculations to achieve rolling forecast virtual measurements for gas field production pipeline networks. Utilizing model splitting, first-order difference weighted moving average, Sequential Quadratic Programming (SQP) algorithm, and Kalman filter methods; we optimized flow data for enhanced accuracy and stability. The model addresses scenarios with both known and unknown reservoir Inflow Performance Relationship (IPR) curves. For unknown IPR curves, the model adapts by generating new curves using historical data or employing rolling calculations. Case studies from a gas field in China demonstrate the model's robust stability, broad applicability, and precision, fulfilling high engineering standards and significantly improving real-time flow safety simulations and production processes. Future work will integrate gas-oil ratio and water content variations to refine phase separation measurements, enhancing the model's versatility in diverse production scenarios.
Keywords: *virtual flow metering of gas fields, surface and subsurface integrated model, rolling forecast, sequential quadratic programming.*

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Sedimentation Stability of Paraffinic Gas Condensates

The paper discusses the problem of performing qualification sedimentation stability tests of paraffinic gas condensate aiming at selecting the most effective depressor-dispersing additive for transportation of raw materials by railroad transport in the cold season. It is shown that the methods of determination of low-temperature properties (pour point, sedimentation stability during cold storage) used for analysis of diesel fuels cannot be fully applied in testing the resistance to stratification of gas condensate mixtures in conditions of transportation by rail. The paper proposes a method for testing paraffin raw materials in railroad tank car simulators with estimation of

the volume of non-dissolved residue, under realistic conditions. Comparison of the results of laboratory tests of gas-condensate mixtures containing four different depressor-dispersing additives with the pilot-scale tests data showed satisfactory correlation.
Keywords: *paraffinic gas condensate, depressor-dispersing additives, sedimentation stability, sedimentation stability test method.*

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Silylation of Carboxylated Nanocellulose

A new hybrid material was created by chemical modification of carboxylated nanocellulose and tetraethoxysilane. According to FTIR spectroscopy and electron microscopy data, tetraethoxysilane reacts with hydroxyl groups of cellulose located on the surface of nanofibers/nanoparticles. It is important to note that the carboxyl groups are retained and can participate in ion exchange reactions. The obtained hybrid material demonstrates a number of valuable properties: it has a large adsorption capacity, it is stable in a wide temperature range and has good performance characteristics. Thus, this hybrid material is a promising candidate for application in systems of fresh water purification from various pollutants.
Keywords: *nanocellulose, NC, carboxylated, TEOS, hybrid material, water purification.*