Chemistry and Technology of Fuels and Oils

3(643)'2024

Publisher— ICST «TUMA Group» LLC

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Генезис глубинных абиогенных нефтегазовых систем

Образование глубинных нефтегазовых систем происходит в результате процессов преобразования высокотемпературных глубинных флюидов, представляющих собой смеси различных летучих соединений, что приводит к формированию элементного и группового состава нефти и газа. Согласно имеющимся данным глубинные флюиды представляют собой смеси метана, водорода, воды, диоксида углерода, углерода, сероводорода, элементной серы, NO_2, а также металлосодержащих структур. Основным компонентом глубинных флюидов является метан, в огромных количествах генерируемый в недрах Земли. Исходя из того, что некоторые составляющие этих смесей обладают каталитической активностью в процессах полимеризации углеводородов, можно полагать, что глубинные флюиды представляют собой природную каталитическую систему. Указанными каталитическими свойствами обладает, прежде всего, имеющаяся в глубинных флюидах элементная сера, способная инициировать полимеризационные процессы, приводящие к образованию высокомолекулярных углеводородных и сераорганических структур. Металлы глубинных флюидов, в частности, ванадий как катализатор, также инициирует процессы образования высокомолекулярных комплексов – порфиринов. В результате вхождения серы и ванадия в состав нефтей они становятся крупнейшими концентраторами этих элементов. Вариабильность соотношения количества этих элементов во флюидах, их окислительно-восстановительного характера и, как следствие, интенсивностей протекания процессов полимеризации углеводородов, образования сероорганических соединений и металло-комплексов приводят к формированию нефтей с различными тяжестью сернистостью, металлоносностью или газовых систем.

Ключевые слова: состав глубинных флюидов, ресурсы нефтяных компонентов,
формирование состава нефтяных и газовых систем.
DOI: 10.32935/0023-1169-2024-643-3-3-10

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Genesis of Deep Abiogenic Oil and Gas Systems

The formation of deep oil and gas systems occurs as a result of transformation processes of high-temperature deep fluids, which are mixtures of various volatile compounds, which leads to the formation of the elemental and group composition of oil and gas. According to available data, deep fluids are mixtures of CH_4, H_2, H_2O, CO_2, C0, H_2S, SO, NO_2, as well as metal-containing structures. The main component of deep fluids is CH_4, which is generated in huge quantities in the bowels of the Earth. Based on the fact that some components of these mixtures have catalytic activity in the processes of polymerization of hydrocarbons, it can be assumed that deep fluids represent a natural catalytic system. These catalytic properties are possessed, first of all, by S^0, present in deep fluids, which is capable of initiating polymerization processes leading to the formation of high-molecular hydrocarbon and organosulfur structures. Metals of deep fluids, in particular vanadium as a catalyst, also initiate the formation of high-molecular complexes - porphyrins. As a result of the inclusion of sulfur and vanadium in the composition of oils, they become the largest concentrators of these elements. The variability of the amount of these elements in fluids, their redox nature and, as a

consequence, the intensities of hydrocarbon polymerization processes, the formation of organosulfur compounds and metal complexes lead to the formation of oils with different sulfur content, metal content or gas systems.

Key words: *composition of deep fluids, resources of petroleum components, formation of the composition of oil and gas systems.*

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Исследование процесса обезмасливания петролатумов для получения нефтяных церезинов

В работе исследован процесс получения нефтяных церезинов путем обезмасливания остаточных рафинатов депарафинизации растворителями. Изучены взаимосвязи основных показателей качества церезинов и параметров процесса обезмасливания: состава и кратности растворителя к сырью, температуры конечного охлаждения и фильтрации, количества стадий обезмасливания. Показано влияние увеличения стадий обезмасливания на основные качественные характеристики и выход нефтяных церезинов.

Ключевые слова: депарафинизация, обезмасливание, петролатум, церезин.

DOI: 10.32935/0023-1169-2024-643-3-11-14

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Research of the Process of De-Oiling of Residual Raffinaates for Obtaining Petroleum Ceresines

The paper investigates the process of obtaining petroleum ceresines by deoiling residual refineries with dewaxing solvents. The results of the study of the relationship between the main indicators of ceresin quality andprocess parameters have been studed: the composition and multiplicity of the solvent to the raw material, the temperature of final cooling and filtration, the number of stages of deoiling. The influence of the deoiling process stage numbers on ceresines quality and input are presented.

Key words: *dewaxing, deoiling, petrolatum, ceresin.*

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Модификация и исследование каталитической активности угольной добавки процесса Veba Combi Cracking (VCC)

Исследована модификация угольной добавки никелем и железом. Представлена морфология поверхности и порового пространства угольной добавки, импрегнированной никелем и железом. Рассмотрен микроэлементный состав добавки и показано её сходство с бурыми углями. Проведена сравнительная оценка текстурных свойств исходной и модифицированной угольной добавки. Показана связь между составом угольной добавки и конечными продуктами крекинга тяжелого нефтяного остатка в присутствии водорода в интервале температур 435–460°С и давлении 17 МПа. Показано влияние наличия в составе угольной добавки каталитически активных металлов на степень превращения смолисто-асфальтеновых компонентов, образования коксообразных веществ и выход светлых дистиллятных фракций. Установлено проявление каталитической активности в процессе термического крекинга гудрона в атмосфере водорода угольной добавки, модифицированной никелем и железом. Результаты исследования показывают положительный эффект от импрегнирования угольной добавки каталитически активными центрами, заключающийся в увеличении степени превращения высокомолекулярных компонентов тяжелого остаточного нефтяного сырья и свидетельствуют о значительном потенциале технологии Veba Combi Cracking.

Ключевые слова: гудрон, гидрокрекинг, асфальтены, уголь, адсорбенты, катализаторы, удельная поверхность, распределение объема пор по размерам.

DOI: 10.32935/0023-1169-2024-643-3-15-22

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Modification and Investigation Catalytic Activity of Coal Additive of Veba Combi Cracking (VCC)

Modifications of coal additives with a mixed oxide phase have been studied. The microelement composition of the additive is considered and its similarity with brown coal is shown. The morphology of the surface and pore space of coal additives impregnated with metals Ni and Fe is presented. A comparative assessment of the textural properties of the original and modified coal additive was carried out. The relationship between the composition of the coal additive and the final products of cracking of heavy oil residue in the presence of hydrogen in the temperature range of 435–460°C and an elevated pressure of 17 MPa is shown. The influence of the presence of catalytically active metals in the composition of the coal additive on the degree of conversion of resinous-asphaltene components, the formation of coke-like substances, and the yield of light distillate fractions is shown. The manifestation of the catalytic activity of a modified coal additive with metal oxides Ni and Fe during thermal cracking of tar in the presence of hydrogen has been established. The results of a study of the possibility of impregnation of carbon additives with catalytically active centers in order to increase the degree of conversion of high-molecular components of heavy residual petroleum feedstock indicate the significant potential of the Veba Combi Cracking technology.

Key words: *vacuum residue, hydrocracking, asphaltenes, coal, adsorbents, catalysts, specific surface area, volume size distribution.*

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Исследование активности триметаллических катализаторов в процессе гидроочистки смесевой дизельной фракции

В работе изучено влияние природы носителя, состава активной фазы и условий термообработки на активность триметаллических катализаторов Ni-Co-Mo в гидроочистке смесевой дизельной фракции. С помощью метода температурно-программируемой десорбции показано влияние количества и силы кислотных центров носителя на активность катализаторов одинакового элементного состава. Установлено соотношение никеля и кобальта, а также фосфора к молибдену в составе триметаллического катализатора гидроочистки, отвечающее максимальной степени обессеривания и минимальному содержанию полициклических ароматических углеводородов в гидрогенизате.

Ключевые слова: триметаллические катализаторы гидроочистки, кислотные центры, пропиточный раствор, гетерополианионы, спектр комбинационного рассеяния, обессеривание.
DOI: 10.32935/0023-1169-2024-643-3-23-29

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Study of Trimetallic Catalysts Activity in Hydrotreating of a Mixed Diesel Fraction

In this paper, the influence of carrier nature, active phase composition and heat treatment conditions on the activity of trimetallic Ni-Co-Mo catalysts in the hydrotreating of a mixed diesel fraction has been studied. The method of temperature-programmable desorption was used to prove the effect of the number and strength of the acid centers of the carrier on the activity of catalysts of the same elemental composition. The ratio of nickel and cobalt, as well as phosphorus to molybdenum in the composition of a trimetallic hydrotreating catalyst, corresponding to the maximum degree of desulfurization and the minimum content of polycyclic aromatic hydrocarbons in the hydrogenate, has been established.

Key words: *trimetallic hydrotreating catalysts, acid centers, impregnation solution, heteropolyanions, Raman spectrum, desulfurization.*

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Переработка поливинилхлорида в компоненты топливных фракций на сульфидных катализаторах

Исследован процесс термической и гидротермальной переработки отходов поливинилхлорида. При гидротермальной переработке поливинилхлорида в 10%-ном водном растворе NaOH получаемый жидкий

продукт содержит наименьшее количество хлорароматических углеводородов по сравнению с термической переработкой без добавления воды. Предложена схема двухступенчатой переработки поливинилхлорида, при которой на первой ступени осуществляется гидротермальная или термическая переработка, а на второй — гидрооблагораживание получаемого жидкого продукта на сульфидных катализаторах. В процессе гидрооблагораживания хлорсодержащей смеси исследованы промышленные сульфидные и синтезированные авторами наногетерогенные катализаторы NiWS и NiMoS. Наибольшую активность в процессе гидродехлорирования проявил ненанесенный NiWS катализатор, синтезированный ex situ.
Ключевые слова: поливинилхлорид, ненанесённые сульфидные катализаторы, пиролиз, гидродехлорирование, полимерные отходы.

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Polyvinyl Chloride Processing into Fuel Fraction Components
on Sulphide Catalysts
The thermal and hydrothermal processing of polyvinyl chloride waste has been the subject of study. The results of hydrothermal processing of polyvinyl chloride in a 10% aqueous NaOH solution indicate that the liquid product contains the least amount of chloraromatic hydrocarbons in comparison with thermal processing without water addition. A two-stage processing scheme for polyvinyl chloride is proposed, in which the first stage involves hydrothermal or thermal processing, and the second stage involves hydrodehydration of the obtained liquid product on sulphide catalysts. In the process of hydrodehydrogenation of chlorine-containing mixtures, industrial sulfide and nanoheterogeneous NiWS and NiMoS catalysts synthesised by the authors were studied. The unapplied NiWS catalyst, synthesised ex situ, exhibited the highest activity in the process of hydrodechlorination.
Key words: *polyvinyl chloride, unapplied sulfide catalysts, pyrolysis, hydrodechlorination, polymer wastes.*

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Многомерные характеристики изменчивости эксплуатационных свойств горюче-смазочных материалов
Предложены многомерные характеристики изменчивости эксплуатационных свойств горюче-смазочных материалов (ГСМ), основанные на простых физических аналогиях, позволяющие путем свертки данных о результатах исследования свойств ГСМ получать новую количественную информацию о поведении ГСМ в технике. Сформулированы условия сохранения свойств ГСМ, которые отражают непрерывность и взаимообусловленность изменений эксплуатационных свойств и условий применения ГСМ. Приведены примеры использования характеристик изменчивости при изучении эксплуатационных свойств моторных топлив и гидравлических жидкостей.
Ключевые слова: горюче-смазочные материалы, эксплуатационное свойство, эксперимент, химмотологический процесс, исследование, испытание, моделирование.

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Multidimensional Variability Characteristics of Fuels
and Lubricants Performance Properties

Variability characteristics partly based on physical analogies with application to fuels and lubricants properties are proposed. Characteristics obtained by multidimensional convolution of fuels and lubricants properties experimental data provide new quantitative information on performance of fuels and lubricants in equipment. Conditions of fuels and lubricants properties conservation that reflect continuity and interdependence of changes between performance properties and operating behavior of fuels and lubricants in equipment are formulated. Examples that illustrate the application of multidimensional variability characteristics for investigation of performance properties of motor fuels and hydraulic fluids are provided and briefly discussed.

Key words: *fuels and lubricants, performance property, equipment, experiment, chemmotological process, variability, conservation, modeling.*

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К вопросу об эффективности действия многофункциональных присадок
в смазочных маслах

В работе исследованы бензилалкоксикарбонилметилдисульфиды в качестве многофункциональных присадок к смазочным маслам. В работе приведены результаты исследования антикоррозионных, противоизносных, противозадирных и антимикробных свойств ранее синтезированных бензилалкоксикарбонилметилдисульфидов, в которых содержатся несколько функциональных групп. Показана эффективность ряда бензилалкоксикарбонилметилдисульфидов. В зависимости от состава и структуры эти соединения улучшают противоизносные, противозадирные и антимикробные свойства масел. Антимикробные свойства исследуемых соединений изучали в составе масла М-11. Синтезированные соединения в концентрации 0,5–1,5% обеспечивают устойчивость нефтяного масла к биоповреждениям, проявляют антимикробную и антигрибковую активность. Эти соединения по эффективности превосходят применяемый на практике биоцид — пентахлорфенолят натрия. Исследование на четырехшариковой машине трения показало, что эти соединения обладают противоизносной эффективностью. Данные, полученные при изучении термической стабильности присадок на дериватографе, согласуются с результатами термоаналитических исследований товарных присадок.

Ключевые слова: многофункциональные присадки, смазочные масла, антиокислительные, антикоррозионные, антимикробные свойства, функциональные группы.

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On the Issue of the Effectiveness of Multifunctional Additives in Lubricating Oils

The purpose of this work is to study benzyl alkoxycarbonyl methyl disulfides as multifunctional additives for lubricating oils, depending on its structure and composition. It has been shown that these compounds can be proposed as effective and multifunctional oil additives. The paper describes the results of studies of anticorrosion, anti-wear, extreme pressure and antimicrobial properties of previously synthesized benzyl alkoxycarbonyl methyl disulfides, which contain several functional groups. A number of benzylalkoxycarbonylmethyl disulfides have previously been shown to be effective. Depending on the composition and structure, these compounds improve the anti-wear, extreme pressure and antimicrobial properties of oils. The antimicrobial properties of the studied compounds were studied in the composition of M-11 oil. Synthesized compounds at a concentration of 0.5-1.5% ensure the resistance of mineral oil to biodamage, exhibit antimicrobial, more antifungal activity. These compounds are superior in efficiency to the biocide used in practice - sodium pentachlorophenolate. A study of anti-wear and extreme pressure properties conducted on a four-ball machine showed that these compounds also have anti-wear effectiveness. The data obtained during the study of the thermal stability of additives on a derivatograph are consistent with the results of thermoanalytical studies of additives.
Key words: *multifunctional additives, lubricating oils, antioxidant, anticorrosive, antimicrobial properties, functional groups.*

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Разработка и адаптация ингибитора коррозии для защиты металлического оборудования в условиях углекислотной коррозии

Разработан состав ингибитора коррозии для условий углекислотной среды и его адаптация под требования по дозировке, защитной способности, температурным характеристикам и совместимости с другими реагентами. Приведено поэтапное описание процесса разработки и основные требования, соблюдение которых контролируется. Результатом проведенных исследований являются две марки ингибитора углекислотной коррозии, в основе которых производное имидазолина. Различие разработанных композиций заключается в типе растворителя, и, соответственно, в температурных характеристиках – температурах вспышки и застывания. Оценено влияние количества активной основы на эффективность композиции, найдено оптимальное содержание компонентов в составе ингибитора коррозии. Подчеркнута важность показателей температуры вспышки и застывания для ингибиторов коррозии и предложен путь регулирования данных показателей состава.
Ключевые слова: ингибитор коррозии, углекислотная коррозия, производные имидазолина, защитный эффект.

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Development and Adaptation of a Corrosion Inhibitor
to Protect Metal Equipment in Conditions
of Carbon Dioxide Corrosion

The composition of a corrosion inhibitor for carbon dioxide conditions was developed and adapted to the requirements for dosage, protective ability, temperature characteristics and compatibility with other reagents. A step-by-step description of the development process and the main requirements, compliance with which is monitored, are provided. The result of the conducted research are two brands of carbon dioxide corrosion inhibitor, based on an imidazoline derivative. The difference between the developed compositions lies in the type of solvent, and, accordingly, in the temperature characteristics – flash and solidification temperatures. The effect of the amount of active base on the effectiveness of the composition was evaluated, and the optimal content of components in the composition of the corrosion inhibitor was found, namely, the active base, additives and solvent. The problem of the importance of flash and solidification temperature indicators for corrosion inhibitors is revealed and a way to regulate these composition indicators is proposed.
Key words: *corrosion inhibitor, carbon dioxide corrosion, imidazoline derivatives, protective effect.*

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Окисление сераорганических соединений масляных дистиллятов и деасфальтизата в присутствии растительных масел

Представлена технология получения базового масла путем окисления сераорганических соединений, содержащихся в нефтяных дистиллятах и деасфальтизатах пероксидом водорода в присутствии растительных (рапсового и касторового) масел с последующей экстракцией оксидатов и депарафинизацией рафинатов. Экстракцию полученной смеси после окисления – оксидата проводили N-метилпирролидном. Определено количественное содержание рапсового масла в рафинате и экстракте. Путем охлаждения экстрактного раствора от средневязкого масляного дистиллята получен вторичный рафинат, представляющий собой концентрат сульфоксидов, который использовался в качестве базового масла для смазочного материала с высокими трибологическими свойствами, используемого в тяжело нагруженных узлах трения. В свою очередь рапсовое масло, оставшееся в рафинате улучшает индекс вязкости и смазывающие свойства последнего. Проведен анализ показателей сырья и полученных рафинатов, характеризующие физико-химические и трибологические свойства.
Ключевые слова: базовое масло, пероксид водорода, растительное масло, оксидат, рафинат, смазка.

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Oxidation of Organosulfur Compounds of Vacuum Distillates and Deasphalted Oil in The Presence of Vegetable Oils

A technology for producing base oil is presented by oxidation of organosulfur compounds contained in petroleum distillates and deasphalted oils with hydrogen peroxide in the presence of vegetable (rapeseed and castor) oils, followed by extraction of oxidates and dewaxing of raffinates. Extraction of the obtained mixture after oxidation of the oxidate was carried out with N-methylpyrrolidone. The quantitative content of rapeseed oil in the raffinate and extract was determined. By cooling the extract solution from a medium-viscosity oil distillate, a secondary raffinate

was obtained, which is a concentrate of sulfoxides, which was used as a base oil for a lubricant with high tribological properties used in heavily loaded friction units. In turn, the rapeseed oil remaining in the raffinate improves the viscosity index and lubricating properties of the latter. An analysis of the indicators of raw materials and obtained raffinates, characterizing the physicochemical and tribological properties, was carried out.

Key words: *base oil, vacuum distillates, hydrogen peroxide, vegetable oil, oxidate, raffinate, lubricant.*

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Cracking of Resinous-Asphaltene Extra-Heavy Oil Compounds

on the Highly Developed Surface of a Coal Additive

The paper presents the results of cracking of extra-heavy oil in the pore space of a coal additive in a nitrogen atmosphere and in a subcritical aqueous fluid at a temperature of 365°C and a pressure of 17 MPa. The coal additive consisted of an amorphous carbon phase forming a developed microporous structure. An analysis using scanning electron microscopy and adsorption porometry established that a vapor-air modification of the coal additive changes its surface relief and leads to the development of a micro- and mesopore structure. The intrapore space of the modified coal additive contains 38.6 vol % mesopores with a specific surface area of 172 m^2/g. The final products of extra-heavy oil cracking with the proposed coal additive are characterized by an increase in the content of saturated and aromatic hydrocarbons, as well as by an almost complete absence of asphaltenes. The largest hydrocarbon yield was observed during extra-heavy oil cracking in a nitrogen atmosphere. In experiments, asphaltene conversion processes are observed due to the destruction of C–C, C–N, and C–O bonds with the formation of low-boiling compounds and high-carbon substances. The largest yield of aromatic hydrocarbons is observed during cracking in a subcritical aqueous fluid, with the yield of liquid products being reduced due to intensive gas formation. The hydrocarbon composition of gases is dominated by lower alkanes, which indicates the destruction of C–C bonds.

Keywords: *extra-heavy oil, cracking, coal additive, adsorption/desorption isotherms, SARA, gas chromatography.*

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Styrene Adsortion from Styrene–Water System with Carbon Sorbents

The asorption properties of carbon materials for purification of petrochemical systems were predicted digitally. The mechanism of styrene adsorption in pores of various sizes was clarified more precisely and the styrene adsorption energies were calculated with and without taking account of the aqueous medium. The "structure-adsorption activity" relationship was established and the characteristics responsible for increase in adsorption capacity of carbon sorbents were identified: the expedient pore size of the carbon material of the adsorbent was determined to ensure sufficient effectiveness of styrene adsorption from aqueous medium. The experimental studies of styrene adsorption

from aqueous medium using commercial AG-3 and BAU carbon sorbents confirm the validity of the established mechanisms.

Keywords: *styrene, adsorption, aqueous media, carbon sorbents, modeling, Monte Carlo method, nanotube, structure-property relationship, digital prediction.*

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Silicoaluminophosphate Molecular Sieves with Different Silica Contents
and Their Catalytic Properties in the Oligomerization Of α-Methylstyrene

Silicoaluminophosphate molecular sieves SAPO-11 were obtained from gels with different silica contents. Silicoaluminophosphates as cubic crystals with 0.5 mm diameter were obtained from gels with SiO_2/Al_2O_3 ratio equal to 0.1, while samples with the ratio SiO_2/Al_2O_3 = 0.5 were obtained as extended prisms with 1-2 mm diameter. Increasing the SiO_2/Al_2O_3 ratio from 0.1 to 0.4 leads a greater amount of acid sites and a decrease in the specific surface. The conversion of a-methylstyrene as well as the yield of linear dimers and cyclic trimers both increase with an increasing amount of acid sites and greater external surface.

Keywords: *molecular sieves, silicoaluminophosphate SAPO-11, olefin oligomerization catalysts.*

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How to Improve The Efficiency of Kinetic Hydrate Inhibitors
Based on Nanofibrillar Cellulose?

This research discovered that carboxylated cellulose nanofibrils (CNF) with cations of various structures can significantly reduce the number of nucleation sites for methane hydrate formation when compared to distilled water. The electrokinetic potential of CNF in water slightly affects the concentration of hydrate crystallization centers, but it does alter the work of their formation. The energy barrier increases as the absolute value of the electrokinetic potential of nanoparticles decreases. The study of the effect of various CNF salts on the kinetics of methane hydrate formation expands our understanding of the inhibition mechanism of hydrate formation. It's assumed that a significant negative charge prevents the adsorption of like-charged hydrate nucleation centers on CNF. A decrease in the absolute value of zeta potential of CNF due to a change in cation facilitates this process. As a result, nuclei sorbed on colloidal CNF particles are stabilized on the surface, complicating their coalescence and crystal growth. The design of cellulose-based nanoparticles with varying zeta potential will allow the development of a colloid theory for controlling the formation of gas hydrates.

Keywords: *methane hydrate, cellulose-based kinetic hydrate inhibitors, nucleation, subcooling.*

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Catalytic Vacuum Gas Oil Oxycracking in Presence of Metal Zeolite Catalysts

The results of study of catalytic vacuum gas oil oxycracking process in presence of metal zeolite catalysts are presented. Screening of oxides of 10 modifying transition metals (Cu, Ti, V, Cr, Fe, Co, Ni, Cd, Mo, and W) made it possible to disclose the basic differences in the behavior of the catalytic systems. Based on the data obtained, an activity series were constructed (based on the total yield of light fractions): Mo > Ti > Cr > Ni > Fe >W > V > Cd > Co > Cu. Best results for the target fractions were obtained in the presence of molybdenum, titanium, and vanadium zeolite systems (for 195/200-300°C fractions) and for tungsten-containing system (for hydrocarbon gas). Comparison of vacuum gas oil conversion data obtained under catalytic oxycracking conditions with bond strength of the surface oxygen of the metal oxides made it possible to establish their correspondence and to recommend this criterion for choosing catalysts for the process.

Keywords: *vacuum gas oil, catalytic oxycracking, oxidative cracking, transition metal oxides, metal zeolite catalysts, surface oxygen bond strength.*

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Study on the Geochemical Properties of Oil Shale and Its Mineralization Potential

With the gradual depletion of conventional petroleum resources, oil shale, as an important unconventional oil and gas resource, is of great significance to alleviate the global energy crisis and optimize the energy structure. In this study, we comprehensively assessed the organic matter abundance, type, maturity, and trace element characteristics of oil shale by collecting and analyzing oil shale samples from the Lower Permian region in the western part of the southern margin of the Junggar Basin, and by applying pyrolysis analysis and rock pyrolysis analysis. The study showed that the average value of total organic carbon (TOC) of the oil shale in the study area was 10.26%, of which 41.67% was medium-grade oil shale and 58.33% was low-grade oil shale, reflecting the overall abundance of medium-low organic matter. The average value of hydrocarbon potential was 40.83 mg/g. The hydrogen index of the oil shale samples ranged from 77 to 861.06 mg/g, with an average value of 405.56 mg/g. The organic matter type was mainly of the II_1 type (humic-sapropelic type), which accounted for 75% of the total, and the analysis of the highest pyrolysis peak temperature showed that 83.33% of the samples were in the low maturity-mature stage. Trace element analyses revealed that the oil shales in the study area were formed in a terrestrial-weakly reduced depositional environment. Especially, the analysis of Sr/Ba, Th/U and B/Ga ratios indicated that the oil shale was mainly formed in freshwater-semi-saline environment. In addition, the analysis of V/(V+Ni) and U/Th ratios supports the reduced

environment in which the oil shale was formed. The shale in the Dalongkou area has greater salinity values and higher organic matter productivity in the water body at the time of formation compared to the oil shale in the Cangfanggou area. The results of this study are important for understanding the geochemical properties and mineralization potential of the Lower Permian oil shales in the western part of the southern margin of the Junggar Basin.

Keywords: *Junggar Basin, oil shale, geochemical properties, mineralization potential.*

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Research on Shale Fracture Characteristics and Developmental Controlling Factors

This study focuses on the shale fracture characteristics and their developmental master factors in the southeastern Sichuan Basin, aiming to gain a deeper understanding of the fracture network in shale gas reservoirs and its impact on hydrocarbon exploration. Through geological investigation and core sample analysis of Longmaxi Formation shales within the Dingshan-Dongxi and Songkan formations, the characteristics and main controlling factors of shale fractures were deeply studied by using fracture measurements, chi-square projection method and electron microscopy. The results show that: the inclination of cracks is mainly dominated by high-angle cracks and upright cracks, with the upright cracks of the Silurian system accounting for 57.35%, and the high-angle cracks of the Triassic system accounting for 43.85%. The fracture filler is mainly calcite and pyrite, in which the calcite and the analysis of fracture density shows that the density of Silurian fracture lines is mainly 3-8 lines/m, accounting for 70.5% of the total number; the development of microfractures also plays an important role in shale gas storage and transportation, and there are various types of microfractures, including open and filled seams, which provide an important storage space for shale gas exploration; the degree of development of shale fractures is related to the mineral components, organic carbon content and thickness of the rock formation. The degree of shale fracture development is closely related to the mineral fraction, organic carbon content and formation thickness. Shales with high brittle mineral content and organic carbon content have a higher degree of fracture development, while the greater the thickness of the formation, the lower the fracture density. These findings indicate that the development degree and types of shale fractures vary significantly among different geological periods and tectonic blocks, and that their complexity and diversity have important implications for shale gas storage and transportation.

Keywords: *Sichuan Basin, shale, fracture characteristics, main control factors.*

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A Promising Device Based on Step Stage Theory for Highly Effective Treatment of Oil Field Wastewater

This study proposed a solar thermal electrochemical photo (STEP) theory-based integrated device for highly efficient oilfield-produced wastewater (OPW) purification, combining photothermal and electric technologies. The major oil fields in China reaching the mid-to-late stage of high-water content extraction have substantially increased the amount of OPW, the complex composition of which makes degradation challenging. This research aimed to improve OPW treatment efficiency and reduce energy consumption and mining costs via innovative processes and integrated experimental devices. A solar five-field demulsification model was developed by combining filtration, distillation, condensation, and other processes using the solar STEP theory and incorporating the photocatalytic oxidation, thermal effect, electro-oxidation, air flotation, and flocculation derived from solar energy. The model enables the utilization of photocatalysts to harness solar power.and get the full spectrum energy hierarchical conversion utilization. The results showed that petroleum hydrocarbon removal was positively correlated with the environmental temperature and voltage. The device significantly improved the petroleum hydrocarbon removal rate at an optimized temperature and voltage. At 100°C and 3 V, the petroleum hydrocarbon removal rate reached 93%, confirming the efficiency and feasibility of the device in improving OPW treatment efficacy and environmental protection.
Keywords: *solar STEP theory, solar five-field demulsification model, integrated device, solar full spectrum energy graded conversion and utilization.*

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Study on The Simulation Law of Two-Phase Seepage in Gravel
Based on Phase Field Simulation

Tight glutenite reservoir structure is complex, mineral types are multi-seepage, and most of them are non-Darcy's law flows Based on the finite element COMSOL simulation of seepage flow in glutenite water flooding, this chapter mainly explores the influence of several related factors on displacement recovery. With the increase of wetting angle, the wettability makes the porous state of solids and fluids in glutenite stable, so that water can easily push oil out, which leads to the increase of water flooding recovery The higher the injection rate, the higher the water cut in a short time, which makes the oil-water two-phase displacement accelerate and the higher the displacement recovery With the increase of gravel diameter, the oil saturation decreases less and more crude oil is bound by the pore structure surrounded by large particles, which is not conducive to displacement Small gravel particles have little influence on the front of water drive, and there is no obvious dominant channel, which leads to the recovery effect.
Keywords:

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DEEPWATER OIL AND GAS WELL ANNULUS PRESSURE MANAGEMENT STRATEGY

Deepwater oil and gas wells have complex well body structure, and the multi-layer closed annulus structure formed by free section and sealed section tubing column is easy to absorb heat and generate expansion pressure. In deepwater drilling operation, the rise in temperature of the closed casing annulus is easy to produce the phenomenon of rising annulus pressure, and due to the special characteristics of the underwater wellhead device, it is not possible to release the annulus pressure between the casing, and the high annulus pressure will lead to casing extrusion and deformation, which will seriously threaten the safety and integrity of the wellbore. In order to ensure the smooth progress of deepwater drilling operations and reduce operational risks, corresponding methods and strategies are proposed for the management of annulus pressure in deepwater oil and gas wells. A variety of measures and products have been developed worldwide for engineering measures of annulus pressure management, including optimization of well structure and cementing design, use of rupture discs, foam casing and vacuum tubing, and other measures. This paper analyzes five major categories of prevention methods and control techniques for deepwater oil and gas wells well annulus confinement pressure, which are increasing casing strength (stiffness level, wall thickness), eliminating expanding fluid, blocking heat transfer, balancing fluid thermal expansion and releasing annulus confinement pressure management strategies. Measures to control annulus pressure by increasing casing strength (stiffness level, wall thickness), fully sealing the annulus, vacuum insulated tubing, foam casing, nitrogen foam isolation fluid, non-circumferential pipe shoes and rupture disc casing tools and analyzing their engineering advantages and disadvantages. According to the engineering application experience, the use of rupture disk casing tool to alleviate the annular pressure is currently the most widely used and stable and reliable means in the world. And according to the theoretical knowledge and engineering practice of annular pressure management, the basic strategy of annular pressure management is summarized when rupture disk is adopted as the main means of annular pressure management.

Keywords: *deepwater oil and gas wells, annular pressure, annular trap pressure rise (APB), management strategy.*

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FOSSIL FUEL DEMAND SCENARIOS FORECAST
UNDER THE CARBON EMISSIONS REDUCTION TARGET

Restructuring energy supply and demand is one of the essential measures to realize the carbon emissions reduction target. To explore the impact of the restructuring of energy supply and demand on fossil fuel demand under the carbon emissions reduction target, takes China as an example, obtains a data set, and utilizes the elasticity analysis, incremental contribution method, weighted moving average method and scenario analysis to forecast the structure of

energy demand and the consumption of fossil fuels. The study results show that the projected values of China's total energy consumption demand in 2030 and 2035 will be 6300.19-6419.82 million tons of standard coal and 6955.92-7175.29 million tons of traditional coal, respectively. The shares of coal, oil, and natural gas in total energy consumption in 2030 will be 45.68-46.35%, 17.95-18.27%, and 10.71-10.89% respectively; by 2035 the energy structure will be further optimized, and the shares of coal, oil, and natural gas in the total energy consumption will be 39.71-40.53%, 18.07-18.56% and 11.86-12.15%, respectively. Further forecasts of gasoline, kerosene, diesel, and fuel oil consumption in 2030 and 2035 are analyzed in this study.
Keywords: *energy structure, fossil fuels, energy demand, forecast, carbon emissions reduction.*

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SIMULATION ANALYSIS OF WELLBORE INSTABILITY CONSIDERING THE INFLUENCE OF HYDRATION EFFECT ON THE PHYSICAL PROPERTIES OF BRITTLE SHALE

Shale gas, as an important unconventional oil and gas resource, its efficient development can alleviate the current severe energy demand situation. However, the water absorption and expansion characteristics and hydration effects of shale pose a great threat to the drilling safety of shale, mainly wellbore stability. Therefore, based on mechanical property experiments, the influence of hydration expansion on the mechanical property parameters of brittle shale was analyzed, and an evolution model of the mechanical property parameters of shale with hydration expansion was constructed. In addition, a finite element model for numerical simulation of wellbore stability in shale formations was established, and the effects of factors such as the addition of hydration inhibitors in drilling fluid on wellbore collapse were analyzed. Research has shown that the hydration and expansion of shale can reduce its elastic modulus and cohesive force, but the effect of hydration and expansion on Poisson's ratio and internal friction angle shows the opposite pattern. After being immersed in drilling fluid for 12 hours, the elastic modulus of shale decreased from 5.3 GPa to 3.9 GPa, and the cohesion decreased from 4.6 MPa to 3.0 MPa. In addition, wellbore collapse and instability in shale mainly occur in the early stages of drilling operations, while wellbore collapse will significantly slow down in the later stages. The wellbore enlargement rate increased to 40% within the first three hours of drilling operations. Moreover, the addition of hydration inhibitors in drilling fluids will prevent further collapse of the wellbore by inhibiting the invasion of water. When the hydration inhibitor in the drilling fluid was increased from 0 to 45 g/m3, the wellbore enlargement rate decreased from 66.2% to 27.8%. This study can provide theoretical reference for maintaining wellbore stability and drilling safety during shale drilling.
Keywords: *brittle shale, hydration expansion, wellbore instability, numerical simulation.*

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GEOCHEMICAL CHARACTERISTICS AND GAS SOURCE COMPARISON ANALYSIS
OF FAULT ADJUSTED TIGHT GAS RESERVOIRS

Tight gas is an extremely important unconventional oil and gas resource, and its efficient development can effectively alleviate the current tense energy situation. However, the geochemical characteristics and gas source analysis of fault adjusted tight gas reservoirs are currently insufficient. Therefore, based on experimental methods such as tight gas composition and hydrocarbon isotope determination, the geochemical characteristics of typical tight gas reservoirs were analyzed, and discussions were conducted on the genesis of tight gas and source rock properties in the study area. The research results found that the tight gas in the study area is mainly composed of light hydrocarbons, and the tight gas reservoir is an ideal geological body for carbon dioxide geological storage, with an estimated CO_2 burial value of up to $3.43 \cdot 10^9$ tons. Meanwhile, high-temperature and high-pressure trapping environments can easily cause heavy hydrocarbons in the trap to break down into light hydrocarbons, resulting in a much higher δ^{13}-C_1 value in the carbon isotopes of tight gas compared to other carbon isotopes. The light hydrocarbon components of typical tight gas reservoirs are mainly oil associated gas types, while the heavy hydrocarbon components are mainly coal derived gas types. Moreover, the average organic carbon content in the tight gas in the study area is 6.67%, indicating that its source rocks are type I and II-1 kerogen, derived from underlying humic source rocks. Finally, the study found that the δ^{13}-CO_2 values of all dense gas samples ranged from 7.85% to 15.3%, and the carbon dioxide concentration was all below 6%, indicating that the source of carbon dioxide in dense gas is a mixed mode.

Keywords: *tight gas, geochemical characteristics, source rocks, fractured reservoir, inhance oil recovery.*

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DESIGN AND DEVELOPMENT OF OILFIELD EXPLORATION
AND DEVELOPMENT DATA EXCHANGE MANAGEMENT PLATFORM

As the information age progresses and oilfield production deepens, information technology plays an increasingly pivotal role in oilfield production, scientific research, and management. Data quality and integrity have become key issues in both research and production. This study analyzes the architecture of data quality control methods based on the technical system of the OSDU (Open Subsurface Data Universe) sharing center. A virtual data layer (VDB) is introduced, and the overall architecture of the exploration and development data exchange management platform is constructed through collaborative technology. Employing a systematic design concept, all applications within the data exchange management architecture are organically combined, forming an integrated and cohesive design and development strategy. This research presents a novel approach where the system application is distinctly separated from the database management. This strategy effectively resolves the challenges associated with managing metadata in oilfield exploration. By designing the database and coding specifications, the development and deployment of the system are completed efficiently. The implemented system offers comprehensive functionalities to all oilfield levels, including data storage, auditing, querying, statistical analysis, and data exchange management. It facilitates the seamless exchange of diverse exploration and development data, ensuring scientific data management and

establishing a foundation for shared scientific data. This enhances service quality and the level of exploration and development in the field. This paper focuses on the design and development of a data exchange management platform for oilfield exploration and development, using the oil and gas industry as a case study. The analysis of industry demands and technology supply within this context is crucial for advancing the exploration and development capabilities in oilfields.
Keywords: *oilfield, exploration and development, OSDU standard, VDB, data exchange management system.*

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NUMERICAL SIMULATION INVESTIGATION OF VERTICAL BEARING CHARACTERISTICS OF DEEP WATER EXPANDABLE SURFACE CONDUCTOR

Deep water areas with soft subsea soils, conventional surface conductor into the mud depth is too deep, long waiting time for resting, prone to surface conductor sinking and submerged wellhead instability. In this paper, based on the basic principles of mechanics and the understanding of the structure of the surface conductor, a mechanical model of the bearing capacity of the surface conductor is established. Three types of expandable surface conductors were designed by changing the distribution of the expansion material, in contrast to conventional surface conductors. The bearing characteristics of different structural surface conductors are also investigated by changing the soil parameters from the strength of the submarine soil. The study has obtained: the load-bearing capacity comparison graph between conventional surface conductor and expandable surface conductor; the load-bearing capacity change of expandable surface conductor under the change of soil parameters and the change of expansion material section; and the load-bearing capacity improvement effect of the three expandable surface conductors designed in the paper compared with conventional surface conductors, using stress as the evaluation criterion. This paper provides technical support for the design of expandable surface conductors and provides a basis for numerical simulation of surface well construction.

Keywords: *drilling, deepwater drilling, surface conductor, expandable conductor, bearing characteristics.*

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A NEW METHOD FOR THE EVALUATION OF PRODUCTIVITY
OF WATER-PRODUCING GAS WELLS IN SPECIFIC TIGHT SANDSTONE RESERVOIRS

The tight sandstone reservoirs in the Sulige Gas Field have complex pore structures and gas-water distribution, and the water production law in the complex gas-water distribution areas has not been clarified. The water production of gas wells in different regions varies greatly, and the water production of gas wells seriously affects the efficient development of natural gas. In order to improve the benefit of gas field development, this study takes stress-sensitive effects, gas-water immiscibility, and constant production conditions of gas wells under a certain gas-water ratio Rgw as constraints, and considers the fluid seepage as an isothermal seepage process, an evaluation model of the productivity of a theoretical water-producing gas well and a relative permeability model of the gas phase are constructed. Moreover, the influence of water production on the degree of pressure drop, gas well productivity, and gas well recovery was systematically analyzed. This study shows that when the water-gas ratio of gas wells is less than 1, 1-2, 2-3, 3-4, 4-5, and greater than 5, its influence on productivity is less than 40%, 52%, 50%, 58%, 61%, 65% and greater than 65%, respectively. The average water-gas ratio of the water-producing gas wells in the Sulige Gas Field is 1.27 $m^3/10^4$ m^3. The effect of water production on recovery is compared with the case of no water production: for water-producing gas wells, the recovery rate of Type I wells is reduced by 8.45%, that of Type II wells is reduced by 9.58%, and that of Type III wells is reduced by 11.54%.

Keywords: *productivity calculation; dynamic analysis; water production impact assessment; tight sandstone.*

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STUDYING THE ACCUMULATION CHARACTERISTICS OF CRUDE OIL
IN AN OIL FORMATION IN THE ASPECT OF PREDICTING THE EFFECTIVENESS
OF CRUDE OIL EXPLORATION

The development of tight oil sandstones in the Extension Formation in the southwestern Ordos Basin and the mode of crude oil migration is a hotspot. A large number of geochemical experiments and computational methods were used to systematically study the crude oil transport characteristics of the Yanchang Formation in the Huaqing area. The results show that four typical types of inclusions are developed in the Yanchang Formation: inclusions in quartz fissures, inclusions in quartz colluvium and large rims, inclusions in calcareous colluvium, and inclusions in sodium feldspar. There are two peaks in the homogenization temperature of the inclusions: 80-100°C and 120-130°C. The Chang 6 and Chang 8 reservoirs in the Huaqing area have experienced the process of densification while forming reservoirs, and the physical properties of the sand body reservoirs during the maximum hydrocarbon discharge period are good, which is an effective channel for oil and gas transportation. The minimum oil column heights for oil and gas transportation in Chang 6 and Chang 8 Members are 7.48m and 15.68m, respectively. Proximity vertical transportation is an important mode of crude oil transportation and aggregation in the Yanchang oil group in the Huaqing area. The physical properties of crude oil in Huaqing area are good, showing low density, low viscosity, low freezing point and good fluidity. The hydrocarbon source rocks of the Chang 7 Member were transported under

excess pressure and buoyancy along channels such as cheese root networks, connected sands and microfractures, and thus large composite lithologic reservoirs were formed in the Chang 6 and Chang 8 Members.

Keywords: *crude oil, hydrocarbon aggregation, inclusions, accumulation characteristics.*

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CHARACTERIZATION OF PORE STRUCTURE AND OIL-WATER
TWO-PHASE SEEPAGE PROPERTIES IN SANDSTONE RESERVOIRS

In this study, the pore structure and oil-water phase seepage characteristics of sandstone reservoirs of the Yanchang Formation in the Ordos Basin were deeply analyzed. Through scanning electron microscopy observation, oil-water phase percolation experiments and nuclear magnetic resonance (NMR) experiments on 30 core samples, the pore structure was categorized into uniform macroporous, striated, microfractured and dense types. The experimental results show that the uniform macroporous type pore structure shows the strongest seepage capacity, and its ratio of liquid-measured to gas-measured permeability is 0.724 on average, while the dense type pore structure has the weakest seepage capacity, and the ratio is 0.091 on average; NMR T2 spectral analysis reveals that the cores with different types of pore structure show significant characteristic differences in the water-driven oil drive process, especially in the substitution of oil in the macroporous and micrometer pore In particular, the oil substitution in large pores and micron pores is remarkable, that is, the oil-water seepage process and the response of seepage and suction of cores with different types of pore structure are obviously different, which is a better way to study the characteristics of oil-water seepage and distribution of oil and water; the uniform macroporous type and the strip-type pore structure are more effective in oil-water two-phase seepage, and the microfracture type and the dense type are relatively poor. This paper provides a basis for the exploitation of tight reservoirs in the study area, which is of great theoretical and practical significance for optimizing the oilfield development strategy and improving the efficiency of oil and gas exploitation.

Keywords: *sandstone, tight reservoir, pore structure, oil-water permeability.*

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DIAGENESIS AND GENETIC MODEL OF CALCAREOUS INTERBEDS
IN MARINE STRATA

The installation of a surface conductor in deepwater jet drilling is crucial for offshore oil and gas development. This study investigates the interaction between the surface conductor and subsea soil during injection drilling. A simplified model using ABAQUS finite element software analyzes the damage effect of the water jet on the soil and simulates the mechanism of soil body damage under different parameters. The mechanical behavior of the soil and conductor

during installation is examined, and the load-bearing characteristics of the soil are analyzed. Sensitivity analysis of factors such as injection displacement and bit extension reveals their significant influence on conductor installation. The findings provide insights into the drilling process and contribute to ensuring the stability of the wellhead in deepwater drilling operations.
Keywords: *Zjet drilling, surface catheter, stability mechanism, finite element analysis.*

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CHARACTERIZATION OF PORE STRUCTURE AND TWO-PHASE SEEPAGE PATTERN
IN SANDSTONE CONGLOMERATE BASED ON CT SCANNING

Oil and gas occurrence characteristics and seepage characteristics of tight reservoirs are the key to production. CT technology can monitor displacement and advance seepage front in time In this chapter, NMR experiments of spontaneous imbibition and CT monitoring experiments of differential pressure displacement are carried out for dense conglomerate to clarify the law of two-phase seepage. The results show that in spontaneous imbibition, the fluid circulation in the pore of tight glutenite is high, and there is no micro-fracture The pore volume of clay minerals with high content increases when exposed to water, which improves the imbibition recovery ratio However, the highly heterogeneous gravel distribution increases the complexity of seepage path and thus enhances the imbibition recovery ratio. The strong heterogeneity of sandy conglomerate leads to the formation of preponderant passages in seepage In the early stage of displacement, the water flooding effect is poor and a large amount of water accumulates With the increase of displacement time, there is no obvious change in oil saturation at both ends of the middle part of a large number of water rock samples The oil saturation is lower at both ends and higher in the middle.
Keywords:

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FEASIBILITY ANALYSIS OF WATER INJECTION DEVELOPMENT
BASED ON GEOLOGICAL RESERVOIR CHARACTERISTICS

The characteristics of geological reservoirs are an important means to evaluate the feasibility of water injection development. The differences in reservoir characteristics in different regions make it difficult to scale up the promotion of water injection development parameters. A more effective way is to establish efficient water injection development methods and strategies suitable for the region. Therefore, based on the geological characteristics of the Wucangbao Chang 6 and Chang 9 oil reservoirs, the feasibility of water injection development in Wucangbao

reservoir is analyzed from several aspects such as interstitial material content, reservoir hydrophilicity, and stress sensitivity. The water injection parameters of Wucangbao Chang 6 and Chang 9 single wells are calculated using methods such as apparent flow rate method, permeability and single well productivity regression method, and stratigraphic series curve regression method, respectively. The water injection parameters are obtained based on the single well production. The results show that the Wucangbao Chang 6 and Chang 9 reservoirs have good water injection feasibility and prospects in terms of sandstone cement, reservoir fluid properties, wettability, and water flooding efficiency; And the production of single well Chang 6 is 1.5-4.0 t/d, while the production of single well Chang 9 is 2.0-4.5 t/d; According to the injection production balance, the initial single well injection volume of the Wucangbao Chang 6 layer is 10 m^3, and the initial single well injection volume of the Chang 9 layer is 20 m^3, in order to maximize the recovery rate of the reservoir during the dry or low water cut period.
Keywords: *water injection development, low permeability oil fields, single well production; recovery ratio.*

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PETROLOGY AND PHYSICAL CHARACTERIZATION OF SANDSTONE RESERVOIRS

The aim of this study is to investigate the petrological characteristics of the Jurassic Sangonghe Formation reservoirs in the Junggar Basin, Northwest China, and their physical characteristics in order to optimize the strategy of oil and gas exploration and development. Through the collection and analysis of core samples, this study systematically investigated the types, structural characteristics and pore-permeability relationships of the reservoir sandstones by using rock cast thin section analysis, pore structure delineation test by piezomercury method and experimental analysis by scanning electron microscopy. The results show that the sandstones in the reservoir of the Sangonghe Formation are dominated by feldspathic feldspathic sandstones and clastic feldspathic sandstones, and the maturity of the compositions is on the low side. The analysis of the rounding degree and cementation degree of the reservoir particles reveals its non-homogeneous characteristics, and the porosity and permeability show obvious positive correlation. Characterization of the pore structure of the reservoir shows that the size and distribution of the pore throat radius significantly affects the permeability, and the change of the throat has a more significant effect on the permeability. The porosity of the upper reservoir in the second section of the Sangonghe Formation ranges from 10.9% to 26.1%, with an average value of 17.6%, and the permeability ranges from 0.13 mD to 159 mD, with an average value of 24.43 mD. The characterization of the phase permeability analysis shows that the relative permeability of the oil phase decreases with the increase of the water saturation, and the relative permeability of the water phase increases, and the bound water saturation of the reservoirs in the study area is generally higher, with a range of 35.6% to 50.2%. 35.6% to 50.2%, with an average value of 41.6%, showing strong hydrophilicity. In summary, the petrological and physical characteristics of the Jurassic Sangonghe Formation reservoirs in the Junggar Basin are analyzed in detail in this study, which provides important geological data and theoretical basis for the exploration and development of oil and gas in this area.

Keywords: *Junggar Basin, Sangonghe Formation, reservoir petrological characteristics, physical characteristics, pore-permeability relationship.*

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PILE PENETRATION ANALYSIS AND SUGGESTIONS

OF JACKET PLATFORM SKIRT PILE SINKING

When the pile driving operation of the jacket platform is carried out, the depth of the steel pile into the mud is not enough or the maximum penetration depth of the steel pile is not the expected bearing layer, which will make the bearing capacity of the platform pile foundation insufficient, cause the platform to be unstable and cause safety accidents. In this paper, the energy conservation relationship in the process of pile sinking is analyzed and discussed from the calculation theory of hammering work and internal force work. Combined with the soil data of field engineering, the penetration of pile sinking of jacket platform is calculated and theoretically demonstrated. Through the above in-depth calculation and analysis, the variation law of penetration with formation depth is obtained. Finally, the control suggestions of pile sinking operation of jacket platform are obtained, in order to provide reference for engineering operation.

Keywords: *jacket platform, pile penetration, hammer power, bearing capacity of pile foundation, control suggestions.*

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RESEARCH ON SHALE RESERVOIR CHARACTERIZATION AND CONTROL FACTORS

This study focuses on the characterization of shale gas reservoirs in the Longmaxi Formation and their controlling factors in the east Sichuan Basin. Detailed mineralogical and reservoir characterization of shale samples in the region was carried out by various methods, including X-ray diffraction analysis and nitrogen adsorption experiments. The results show that the shale is mainly composed of clay minerals (illite content ranges from 34.9% to 55.7%), quartz and calcite. In terms of reservoir characteristics, the shale mesopore morphology is mainly "slit-type", with BET specific surface area ranging from 7.12-25.63 m^2/g and BJH pore volume from 0.0095-0.0262 mL/g. These reservoir characteristics show a significant positive correlation with the organic carbon content (1.82-3.87%). correlation. Petrographic analysis further reveals that the brittle mineral content has a significant effect on the brittleness, pore development and fracturing effectiveness of the rocks. In addition, diagenesis (including compaction, cementation, dissolution, and thermal evolution of organic matter) had a significant impact on the formation and

characterization of shale pores. These findings provide a key scientific basis for understanding the geological characteristics and development potential of shale gas reservoirs in the Longmaxi Formation in the Sichuan Basin.
Keywords: *Sichuan Basin, shale gas, brittle minerals, reservoir characteristics, controlling factors.*

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APPLICATION OF GEOLOGICAL ENGINEERING INTEGRATION
IN TIGHT SANDY CONGLOMERATE HORIZONTAL WELL

In order to improve the recovery rate of tight glutenite horizontal wells in the Baikouquan Formation in Mahu Sag, geological models were constructed through three aspects: structural modeling, lithofacies modeling, and attribute modeling; through rock mechanics parameters, in-situ stress direction, and vertical direction. Stress, pore fluid pressure, maximum horizontal principal stress, minimum horizontal principal stress to construct a one-dimensional in-situ stress model, combined with imaging logging wellbore wall caving and induced fractures to determine the in-situ stress direction to simulate the three-dimensional stress direction in the study area, using finite element method to simulate and The objective function fits and inverses the distribution of the three-dimensional in-situ stress field. Finally, comprehensive reservoir parameter characteristics and engineering parameter characteristics are used to predict the "sweet spot" of the study area. The results show that there are three types of sweet spots in the glutenite in the Mahu Depression: Type I sweet spots are good reservoirs with good oil content, high oil well production, and good reservoir engineering compressibility; Type II sweet spots are followed by oiliness and oil well production; Type III The sweet reservoirs have just reached the lower limit of the oil layer standard, mainly poor oil layers. The research results provide a reference for the development of Baikouquan tight glutenite in Mahu Sag.
Keywords: *geological integration; three-dimensional model; recovery factor; fracture network parameters; engineering parameters.*

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RESEARCH ON OIL PRODUCTION FORECASTING METHOD
OF TIGHT OIL RESERVOIR BASED ON GREY CORRELATION METHOD

Horizontal well fracturing technology is an important way to improve the oil recovery efficiency of low-permeability reservoirs. Aiming at a certain test area on the edge of Daqing oilfield, a simulation conceptual model is established using CMG reservoir numerical simulation software. The influence of engineering parameters such as the number of fracture clusters, fracture half-length, fracture permeability, production pressure difference on the peak daily oil

production is analyzed. Moreover, the gray correlation method is used to analyze the influence of the above factors on the peak daily oil production. Using key factors as variables in the regression model, a mathematical prediction model for daily oil production peak is established. The findings should make an important contribution to the oil production peak prediction.
Keywords: *oil production prediction, fracturing technology, horizontal well, tight oil reservoirs.*

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STUDY ON THE INFLUENCING FACTORS OF HYDRAULIC FRACTURE PROPAGATION IN DEEP UNCONVENTIONAL GAS RESERVOIRS

To fully understand the factors influencing hydraulic fracture propagation in deep unconventional gas reservoirs, this study takes a block in China as an example. Firstly, a comprehensive geological mechanics model of the reservoir is constructed. From the perspectives of discrete natural fracture modeling, hydraulic fracture propagation analysis, and hydraulic fracturing numerical modeling, an analysis model of the influencing factors of hydraulic fracture propagation in the reservoir is established. This model is then used to conduct an analysis of the influencing factors, laying the foundation for optimizing fracturing design and improving fracturing effectiveness. The study shows that among factors such as cluster spacing, fluid intensity, natural fracture line density, and horizontal stress difference, cluster spacing has the greatest impact on hydraulic fracture propagation in the reservoir, followed by fluid intensity, while horizontal stress difference has the least impact. Under the condition of gradually increasing cluster spacing, the modified reservoir volume will initially increase and then decrease. As fluid intensity gradually increases, the modified reservoir volume will also increase, but due to economic constraints, fluid intensity should not be excessively high. When the natural fracture line density is low, the rate of increase in modified reservoir volume is relatively fast as it increases. However, when the natural fracture line density is high, the rate of increase in modified reservoir volume slows down as it continues to increase. As the horizontal principal stress difference gradually increases, the modified reservoir volume will gradually decrease.

Keywords: *deep unconventional gas, horizontal fracturing fractures, fracture propagation, influencing factors, modified reservoir volume.*