Chemistry and Technology of Fuels and Oils

3(649)'2025

Publisher— ICST «TUMA Group» LLC

Редактор
В. С. Дмитриева

Ответственный секретарь
О. В. Любименко

Графика и верстка
В. В. Земсков

Подготовка материалов
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Формат 60 × 84 1/8.
Печать офсетная.
Усл. печ. л. 7.
Тираж 1000 экз.

Отпечатано в ООО ИПФ «СТРИНГ»
424006, Республика Марий Эл,
г. Йошкар-Ола, ул. Строителей, 95

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Опыт облагораживания фракций бензина каталитического крекинга с целью увеличения производства высокооктановых автомобильных бензинов

В работе описан опыт переработки бензина каталитического крекинга (БКК) на имеющихся установках вторичной переработки Куйбышевского НПЗ в условиях экспортных ограничений. Показаны основные качественные характеристики сырья и продуктов, а также параметры технологического режима гидроочистки БКК. Комплекс технологических решений позволил увеличить загрузку установок каталитического риформинга и изомеризации, предоставив дополнительный объем сырья для производства высокоэкологичных автомобильных бензинов.

Ключевые слова: *бензин каталитического крекинга, гидроочистка бензинов каталитического крекинга, гидрирование олефинов, каталитический риформинг, автомобильный бензин.*
DOI: 10.32935/0023-1169-2025-649-3-3-7

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Upgrading Catalytic Cracking Gasoline Fractions
to Increase Production of High-Octane Motor Gasolines

Upgrading Catalytic Cracking Gasoline Fractions to Increase Production of High-Octane Motor Gasolines
The article describes the experience of processing fluid catalytic cracking (FCC) gasoline at existing secondary processing units at the Kuibyshev Refinery under conditions of export restrictions. The main quality characteristic of feed and products also critical process parameters of FCC gasoline hydrotreating are presented. A set of technological solutions made it possible to increase catalytic reforming and isomerization units utilization, providing an additional resources for the production of highly environmentally friendly motor gasoline.

Key words*: fluid catalytic cracking (FCC) gasoline, FCC gasoline hydrotreating, hydrogenation of olefins, catalytic reforming, gasoline.*

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О групповом углеводородном составе жидких продуктов каталитического оксикрекинга вакуумного газойля

Изучено влияние температуры, продолжительности процесса, степени окисления и времени контакта на групповой углеводородный состав жидких продуктов каталитического оксикрекинга вакуумного газойля. Показано, что наибольшее влияние на качественный групповой состав фракции н.к.–195(200)°С оказывает температура и время контакта, наименьшее — продолжительность процесса. На выход и качественный

состав фракции 195(200)–300°С, помимо температуры и времени контакта существенное влияние оказывает степень окисления. Установлено, что усиление жесткости процесса (высокая температура, время контакта, большая продолжительность процесса) сопровождается образованием высокоароматизированного продукта. Выход алканов проходит через максимум при степени окисления 0. 5% и продолжительности 600–900 с; выход непредельных и ароматических углеводородов растет симбатно жесткости режима; выходу кислородсодержащих во фракции н.к.–195(200)°С способствуют повышенный температурный режим, малая продолжительность процесса, а во фракции 195(200)-300°С — напротив, низкая температура и высокая продолжительность. По результатам сравнительного анализа с образцом традиционного каталитического крекинга установлена значительно более низкая ароматичность фракции н.к.–195(200)°С и повышенная — для 195(200)–300°С. Это объясняется накоплением высокомолекулярных глубоконенасыщенных углеводородов, которые проявляют высокую активность в реакциях ароматизации и алкилирования.

Ключевые слова: *оксикрекинг, вакуумный газойль, цеолитсодержащий катализатор, групповой углеводородный состав, ароматические углеводороды, непредельные углеводороды, каталитический крекинг.*
DOI: 10.32935/0023-1169-2025-649-3-8-11

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On the Issue of the Group Hydrocarbonic Composition of Liquid Products of Catalytic Oxycracking of Vacuum Gas Oil

The effect of temperature, duration, oxidation state and contact time on the group hydrocarbon composition of liquid products of catalytic oxycracking of vacuum gas oil was studied. It was shown that the greatest effect on the qualitative group composition of the fraction b.s.-195(200)°C is provided by temperature and contact time, the least by duration. In addition to temperature and contact time, the yield and qualitative composition of the fraction 195(200)-300°C are significantly affected by the oxidation state. It was found that an increase in the severity of the process (high temperature, contact time, long process duration) is accompanied by the formation of a highly aromatic product. The yield of alkanes passes through a maximum at an oxidation state of 0.5% and a duration of 600-900 s; unsaturated and aromatic increases symbatically with the severity of the regime; oxygen-containing in the fraction b.s.-195(200)°C are promoted by an increased temperature regime, a short duration of the process, and in 195 (200)-300°C, on the contrary, by a low temperature and a long duration. According to the results of a comparative analysis with a sample of traditional catalytic cracking, a significantly lower aromaticity of the b.s.- 195 (200)°C fraction and an increased one for the 195 (200)-300°C fraction were established. This is explained by the accumulation of high-molecular deeply unsaturated hydrocarbons, which exhibit high activity in aromatization and alkylation reactions.

Key words*: oxycracking, vacuum gas oil, zeolite-containing catalyst, group hydrocarbon composition, aromatic hydrocarbons, unsaturated hydrocarbons, catalytic cracking.*

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К вопросу о корреляции углеводородного состава и низкотемпературных свойств базовых фракций дизельных топлив

В статье исследован углеводородный состав четырех образцов базовых фракций дизельных топлив методами газовой хромато-масс-спектрометрии, абсорбционной спектрометрии ультрафиолетового и видимого диапазонов и протонного магнитного резонанса. На основе результатов анализа установлены различия в качественном и количественном составе углеводородов, который определяющим образом влияет на низкотемпературные характеристики дизельных топлив. Полученные экспериментальные данные обработаны с помощью метода корреляционного анализа и рассчитаны коэффициенты корреляции параметров, показавшие прямые и обратные зависимости низкотемпературных характеристик от содержания различных групп углеводородов. Установлено, что определяющими факторами, положительно влияющими на низкотемпературные свойства, являются высокое содержание низкомолекулярных н-алканов C_9–C_{15} и нафтенов, низкое содержание высокомолекулярных н-парафинов C_{22+} и аренов. При этом среди аренов наибольшее отрицательное влияние оказывают алкилзамещенные ароматические углеводороды нафталинового и фенантренового рядов.

Ключевые слова: *дизельное топливо, углеводородный состав, молекулярно-массовое распределение, низкотемпературные свойства, хромато-масс-спектрометрия, ультрафиолетовая спектрометрия, протонный ядерный магнитный резонанс, корреляционный анализ.*
DOI: 10.32935/0023-1169-2025-649-3-12-19

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On the Issue of Correlation Of Hydrocarbon Composition and Low-Temperature Properties of Base Fractions of Diesel Fuels

The article studies the hydrocarbon composition of four samples of basic fractions of diesel fuels using gas chromatography-mass spectrometry, ultraviolet-visible absorption spectrometry and proton magnetic resonance. Based on the results of the analysis, differences in the qualitative and quantitative composition of hydrocarbons were established, which decisively affects the low-temperature characteristics of diesel fuels. The obtained experimental data were processed using the method of correlation analysis and the correlation coefficients of the parameters were calculated, showing direct and inverse dependencies of low-temperature characteristics on the content of various groups of hydrocarbons. Based on the obtained regularities, it was established that the determining factors that have a positive effect on low-temperature properties are: high content of low-molecular n-alkanes and naphthenes, low content of high-molecular n-paraffins C_{22+} and arenes. At the same time, among arenes, the greatest negative effect is exerted by alkyl-substituted aromatic hydrocarbons of the naphthalene and phenanthrene series.

Key words*: diesel fuel, hydrocarbon composition, molecular weight distribution, low-temperature properties, chromatograph mass spectrometry, UV spectrometry, nuclear magnetic resonance, correlation analysis.*

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Применение теории внутреннего энергосбережения при разделении нефтяных фракций на ректификационных тарелках

Представлена теория внутреннего энергосбережения в процессе ректификации. Приведены формулы количественной оценки внутреннего энергосбережения при различных энергетических потенциалах подаваемой в колонну исходной смеси. Анализ зависимости парового числа от флегмового при различных энергетических потенциалах подаваемой в колонну исходной смеси показал, что параметром, определяющим процесс ректификации (затраты теплоты в кипятильнике колонны, холода в конденсаторе, размеры и стоимость колонны и др.) является только флегмовое число. Доказано, что с увеличением внутреннего энергосбережения в колонне снижаются суммарные затраты на процесс разделения жидких смесей. Теория внутреннего энергосбережения подтверждает необходимость промежуточного циркуляционного орошения в сложных колоннах первичной переработки нефти и способна его улучшить.

Ключевые слова: *внутреннее энергосбережение, ректификация, флегмовое число, флегма, первичная переработка нефти.*
DOI: 10.32935/0023-1169-2025-649-3-20-25

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Application of the Theory of Internal Energy Saving in Separation of Petroleum Fractions on Distillation Column Trays

The paper presents internal energy saving theory in the distillation process. There are presented formulas for quantitative estimation of internal energy saving at various energy potentials of the feed mixture fed to the column. By analysis of the boilup ratio dependence on the reflux ratio at various energy potentials of the feed mixture fed into the column it is proved that the parameter determining the distillation process (heat consumption in the column boilers, cold consumption in the condenser, size and cost of the column, etc.) is only the reflux ratio. It is proved that as the internal energy saving in the column increases, the total cost of the liquid mixture separation process decreases. The theory of internal energy saving confirms the necessity of intermediate pump-around in complex columns of primary crude oil processing and is capable of its improving.

Key words*: internal energy saving, distillation, reflux ratio, crude oil, reflux, primary crude oil processing.*

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Низкотемпературный крекинг тяжелой нефти
в присутствии микрочастиц оксидов металлов

Выявлено влияние давления и наличия микрочастиц оксидов металлов на состав и реологические свойства жидких продуктов низкотемпературного крекинга тяжелой высоковязкой нефти Ашальчинского месторождения при температуре 360°С. Показано, что с ростом давления до 10 МПа, по сравнению с исходной нефтью, в продуктах увеличивается содержание смолисто-асфальтеновых веществ и снижается количество легкокипящей фракции н.к.–200°С, что свидетельствует о протекающих процессах конденсации. При низкотемпературном крекинге с участием микрочастиц Al_2O_3, ZnO и Fe_2O_3 при давлении 10 МПа в конечных продуктах содержание смол и легкокипящих фракций практически не меняется, снижается содержание асфальтенов, увеличивается количество насыщенных углеводородов. В процессе крекинга тяжелой нефти в условиях субкритического водного флюида под давлением 18 МПа с добавлением микрочастиц Fe_2O_3 увеличивается степень превращения асфальтенов до 30 %. Выявленные закономерности в составе продуктов крекинга приводят к значительному уменьшению индексов аномалии вязкости и снижению вязкости продуктов на 42–56 % по сравнению с исходной нефтью. Отличительные особенности состава, а также строения НДС продуктов низкотемпературного крекинга, влияющие на их реологические свойства, необходимо учитывать при разработке эффективных технологий подготовки тяжелой высоковязкой нефти к транспортировке и переработки.

Ключевые слова: *тяжелая нефть, оксиды металлов, асфальтены, крекинг, перегретый пар, групповой состав, бензиновая фракция.*
DOI: 10.32935/0023-1169-2025-649-3-26-30

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Low-Temperature Cracking of Heavy Oil in the Presence of Metal Oxide Microparticles

The influence of pressure and the presence of metal oxide microparticles on the composition and rheological properties of liquid products of low-temperature cracking of heavy high-viscosity oil of the Ashalchinsky field at a temperature of 360 °C is revealed. It is shown that with an increase in pressure up to 10 MPa, in comparison with the initial oil, the content of resinous-asphaltene substances in the products increases and the amount of low-boiling fraction decreases, which indicates ongoing condensation processes. During low-temperature cracking involving Al_2O_3, ZnO, and Fe_2O_3 microparticles at a pressure of 10 MPa, the content of resins and low-boiling fractions in the final products practically does not change, the content of asphaltenes decreases, and the amount of saturated hydrocarbons increases, which leads to an increase in the aromaticity of the nuclei of complex structural units and the aliphaticity of the dispersion medium. In the process of cracking in a subcritical aqueous fluid under a pressure of 18 MPa with the addition of Fe_2O_3 microparticles, supramolecular structures are destroyed with an increase in the degree of asphaltene conversion to 30 %. Changes in the composition of cracking products lead to a significant decrease in the viscosity anomaly indices and a 42–56% decrease in the viscosity of products compared to the initial oil. The identified distinctive features of the composition of low-temperature cracking products that affect their rheological properties should be taken into account when developing effective technologies for preparing heavy, high-viscosity oil for transportation and subsequent processing.

Key words*: heavy oil, metal oxides, asphaltenes, cracking, superheated steam, group composition, gasoline fraction.*

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Влияние способа модифицирования нанотрубок галлуазита на рутений-кобальтовые катализаторы Фишера — Тропша

Исследовано влияние способа модифицирования катализаторов на основе кобальта и рутения, нанесенных на галлуазит, на их каталитические свойства в процессе Фишера — Тропша. Установлено, что повышение кислотности способствует увеличению выхода олефинов, которые активно реадсорбируются на поверхности катализатора, что в свою очередь приводит к инициации роста углеводородных цепей.

Ключевые слова: *синтез Фишера — Тропша, кобальтовые катализаторы, линейные парафины.*
DOI: 10.32935/0023-1169-2025-649-3-31-36

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Effect of Halloysite Nanotube Modification Method on Ruthenium-Cobalt Fischer – Tropsch Catalysts

The effect of the modification method of catalysts based on cobalt and ruthenium applied to halloysite on their catalytic properties in the Fischer–Tropsch process was studied. It was found that increasing acidity promotes an increase in the yield of olefins, which are actively re-adsorbed on the catalyst surface, which in turn leads to the initiation of hydrocarbon chain growth.

Key words*: Fischer–Tropsch synthesis, cobalt catalysts, linear paraffins.*

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Получение железнодорожной смазки на основе солей органических ортофосфорных эфиров и веретенного масла

Разработана железнодорожной смазки на основе веретенного масла, солей органических ортофосфорных эфиров и сажи, предназначенной для снижения износа системы колесо – рельс. Проведены эксперименты по оптимизации соотношения компонентов, изучены реологические свойства и стабильность составов при различных температурах. Был подобран оптимальный состав смазочной композиции, соответствующей техническим требованиям и демонстрирующей высокую смазывающую способность.

Ключевые слова*: износ колес и рельсов, железнодорожная смазка, углеводородный гель, веретенное масло, гелирующий комплекс, реологические характеристики.*

DOI: 10.32935/0023-1169-2025-649-3-43-47

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Development of Railway Lubricant Based on Salts of Organic Orthophosphate Ester and Spindle Oil

The paper describes the stages of development of a railway lubricant based on spindle oil, salts of organic orthophosphate ester and soot, designed to reduce wear on the wheel-rail system. Experiments have been conducted to optimize the ratio of components, and the rheological properties and stability of the compositions at various temperatures were studied. The optimal composition of the lubricant was selected, which meets the technical requirements and demonstrates high lubricating ability.

Key words*: wheel and rail wear, railway lubricant, hydrocarbon gel, spindle oil, gelling complex, rheological characteristics.*

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Определение растворяющей способности комплексонов и кислот по отношению к сульфатным и карбонатным минералам

В работе изучена проблема присутствия неорганических солей в породе пласта. В работе были рассмотрены основные реагенты для удаления солей, методикой эксперимента был выбран гравиметрический метод анализа. Определена растворяющая способность комплексонов, органических кислот и составов по отношению к сульфатным и карбонатным минералам при различных температурах и за различные промежутки времени. Установлены эффективные концентрации растворяющих агентов и рассмотрено влияние различных температур на растворяющую способность.

Ключевые слова*: кислотные обработки, солеотложения, комплексоны, сульфаты, карбонаты.*
DOI: 10.32935/0023-1169-2025-649-3-48-52

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Determination of the Dissolving Capacity of Complexones and Acids in Relation to Sulfate and Carbonate Minerals

This article discusses the problem of the presence of inorganic salts in the reservoir rock. The main reagents for removing salts were considered in the work, and the gravimetric method of analysis was chosen as the experimental technique. During the experimental part, studies were conducted to determine the dissolving capacity of complexones, organic acids and compositions in relation to sulfate and carbonate minerals at different temperatures and for different periods of time. As part of the work, effective concentrations of dissolving agents were established and the effect of different temperatures on dissolving capacity was considered.

Key words*:* *acid treatments, salt deposits, complexones, sulfates, carbonat.*

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Разработка стабилизатора грунта для строительства дорог вблизи нефтегазовых месторождений

Рассмотрена проблема недолговечности дорожных покрытий вблизи нефтегазовых месторождений и возможность применения в дорожном строительстве на промысле стабилизаторов грунтов.
Для исследования эффективности полученных образцов стабилизаторов грунтов был взят грунт одной из восточных областей России и проанализированы его свойства: фракционный состав, число пластичности, оптимальная влажность. Разработаны композиции стабилизатора грунтов и предложена методика получения стабилизированного грунта.

Ключевые слова: *промысловые дороги, стабилизатор грунтов, предел прочности на сжатие, полимеры, поверхностно-активные вещества.*
DOI: 10.32935/0023-1169-2025-649-3-53-56

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Development of Soil Stabilizer for Road Construction near Oil and Gas Fields

The article addresses the issue of the short service life of road surfaces near oil and gas fields and explores the potential use of soil stabilizers in field road construction. To evaluate the effectiveness of the developed stabilizers, soil from one of the eastern regions of the Russia was analyzed for its properties, including grain-size distribution, plasticity index, and optimum moisture content. This paper proposes a method for obtaining stabilized soil, the use of which demonstrated an increase in the compressive strength of the soil when a soil stabilizer is introduced.

Key words*:* *field roads, soil stabilizer, compressive strength, polymers, surfactants.*

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Investigation of the Hydrocracking Stage in the Integrated Pyrolysis-Coking-Hydrocracking Process of Biomass for Aviation Fuel Component Production

Currently, the global aviation industry is focusing on the development of alternative fuel components for aircraft engines that reduce greenhouse gas emissions from the life cycle emissions. Of particular interest is the integration of bio-based materials processing technologies into existing oil refining facilities. This research aims to explore coprocessing of pretreated lignocellulosic feedstocks using pyrolysis and coke-making processes and conventional feed via hydrocracking. Optimal operating conditions were determined, and the products of hydrocracking of various coking biogasoils were investigated. A kerosene fraction with a yield exceeding 25% by mass, resulting from combined hydrocracking, has been obtained, meeting most critical of the specifications for jet fuel as outlined in regulatory standards.

Keywords:

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Thermodynamic Properties and Non-Isothermal Gas Flow
in the Bottom-Hole Zone of a Production Well in the Achimov Horizon

The study presents thermodynamic calculations of the properties of Achimov formation gas and its behavior during throttling (isenthalpic flow) in the near-wellbore zone (NWZ) for cases involving both mobile and immobile hydrocarbon condensate. The discussion covers non-isothermal effects over a wide range of reservoir pressures from 15 to 60 MPa and high-pressure drops across the reservoir. For an analytical description of gas flow in the NWZ, a nontraditional approach utilizing the calculation of two isenthalpic indices is employed. To process the results of the well's gas-dynamic studies, a complex index is proposed that simultaneously accounts for non-isothermal flow and the gas's high density (strong non-ideality). An assessment of the role of non-isothermal effects during short-term gas-dynamic studies of wells is also discussed.

Keywords: *gas throttling, Joule–Thomson effect, isenthalpic indices, bottomhole formation zone, methane, formation gas, gas-dynamic well testing.*

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Design of Electric Control Servo Catching Tool at Temporary Blocking Oil Casing Construction

In the process of temporary blocking oil/casing construction using traditional mechanical and hydraulic tools, problems such as low success rates, high accident rates, and low operational efficiency exist. This study designs an electric control servo catching tool. The tool is described in detail from the perspectives of mechanical structure, power system, electric control and debugging system, micro-hydraulic servo system, and execution system. Based on this, the study also explores the design of the process tubing structure and the field construction process, and

conducts research on pressurized electric control temporary blocking technology. The aim is to improve the success rate of oil/casing temporary blocking operations and reduce accident rates. The research shows that the electric control servo catching tool consists of two main parts: the deployment and sealing assembly and the catching assembly. The deployment assembly mainly consists of the power system, electric control and debugging system, micro-hydraulic servo system, and execution mechanisms. The application of the electric control servo catching tool in the pressurized electric control temporary blocking process requires a highly reliable and precisely designed process tubing. The structure of the tubing must fully consider multiple factors and use high-strength, high-temperature resistant, and corrosion-resistant materials to ensure that no failure occurs during operations in extreme environments.

Keywords: *electric control servo catching tool, design research, mechanical structure, pressurized electric control temporary blocking process, technical research.*

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Modification of Sand Clay with Silicate Cement to Improve

Compressive Properties in Oil and Gas Pipeline Foundations

This study investigates the mechanical and durability performance of silicate cement-modified sandy soil by evaluating the effects of varying cement content (5–15 wt%), temperature (25–125°C), salinity (0–12% NaCl), and external pressure (5–15 MPa) on compressive strength, shear strength, and permeability coefficient. Long-term immersion tests simulating oil and gas field environments were also conducted to assess the durability of the modified soil. The results demonstrate that, under ambient temperature conditions, increasing the cement content to 15 wt% significantly enhanced the compressive strength of sandy soil from 1.35 MPa to 5.75 MPa. When the temperature increased from 25°C to 125°C, the compressive strength of the modified soil improved by up to 37%. A salinity concentration of 6% NaCl further strengthened the cementitious matrix and reduced the permeability coefficient; however, excessive salinity weakened particle cohesion. Under high-temperature and high-pressure conditions (125°C, 10–15 MPa), the compressive strength reached a maximum of 6.10 MPa, accompanied by notable improvements in shear strength and durability. Field application results revealed that in pipeline installation areas with a salinity of approximately 5 wt% and a pH of 8.5, the use of 10 wt% silicate cement modification reduced ground settlement by approximately 51% compared to unmodified areas. Additionally, the compressive and shear strengths were increased by 58% and 50%, respectively, while the permeability coefficient was significantly reduced, demonstrating excellent load-bearing capacity and impermeability. In summary, silicate cement-modified sandy soil exhibits superior mechanical enhancement and durability under extreme conditions

encountered in oil and gas pipeline foundations. These findings provide critical technical support and theoretical insights for future engineering applications.

Keywords: *silicate cement, modified sandy soil, high temperature and pressure, high salt environment, oil and gas pipeline foundation.*

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Mechanism of Improving Oilfield Recovery

by High-Volume Water Injection without Proppant

This study used laboratory core experiments, combined with flow characteristics, oil displacement effect, oil-water interface effect and other aspects to systematically explore the effect of high-displacement water injection on oil field recovery under proppant-free conditions. The experimental results show that with the increase of water injection rate, the flow velocity and pressure gradient increase significantly. When the water injection rate increases from 5 L/min to 12 L/min, the flow velocity increases by 82% and the pressure gradient increases by 112%. In terms of oil-water interface optimization, after the water injection rate increases, the oil-water interface instability index increases from 0.45 to 0.79, and the emulsification degree increases to 25.3%, indicating that the shear force enhancement is conducive to improving oil displacement efficiency. High-displacement water injection also effectively promotes the utilization of residual oil. When the water injection rate is 12 L/min, the residual oil saturation in the core decreases by 15.3%. High-displacement proppant-free water injection can significantly improve the recovery of low permeability reservoirs, mainly by enhancing hydraulic drive, optimizing oil-water interface effect and improving the utilization of residual oil.

Keywords: *low permeability reservoir; high displacement water injection; proppant-free water injection; recovery factor; oil displacement mechanism.*

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Study on the Relationship between Faults and Hydrocarbon Formation

The western margin of the Ordos Basin is located in the western part of the Tianhuan Pass and the eastern edge of the western margin retrograde zone, with a special tectonic position. Due to the scarcity of drilling wells and the lack of high-quality seismic data, it is difficult to identify the tectonics of the study area, and the understanding of the characteristics of faults and rifts and the period of their activity is still unclear. Natural fractures are developed in various sections of the Mesozoic in the central western margin of the Ordos Basin, and the fracture

characteristics have spatial and temporal variability. This paper combines the regional tectonic stress environment background, analyses the causes of faults and fractures and clarifies the relationship between faults and fractures, analyses the relationship between faults and fractures and existing reservoirs, the distribution of well planes and profiles, and the production rate, etc. It analyses the period of oil and gas reservoirs and the period of fault and fracture activities, and explores the role of fault activities in the formation and enrichment of oil reservoirs. The faults in different periods are compared with the related well planes to analyse the relationship between the faults and reservoirs in different periods and to explore the role of fault activities in oil and gas formation. The results show that: the near-south-north faults are the largest in scale, with large fracture spacing and complex fault plane features; the north-west faults are small in scale, mainly developed in the Extension Formation, with geese-type features; the north-east-east faults are large in scale, with a late development period, and with a parallel distribution of nearly equidistant spacing. The formation of NEE- and NE-trending fractures is closely related to the NEE-trending faults. Faults and associated fractures had different controlling effects on oil reservoirs in different periods. Faults and fractures in the Indo-Chinese and Yanshan phases communicated between the long7 hydrocarbon source rocks and the upper and lower sandstone reservoirs, which provided a good channel for the upward petroleum transport, and at the same time, the faults and fractures improved the physical properties of the reservoirs, which contributed to the formation of the oil and gas reservoirs.

Keywords: *central part of the western margin of Ordos Basin, fault-rupture characteristics, period of activity, orogenic effect.*

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Characteristics and Main Controlling Factors of the Upper Triassic Oil and Gas Reservoirs

This study examines the characteristics and controlling factors of Upper Triassic oil and gas reservoirs in the Ordos Basin, employing a multidisciplinary approach that integrates geological, petrophysical, and statistical analyses. Utilizing data from the Geological Survey of China and PetroChina Company Limited, encompassing geological, geophysical, and petrophysical measurements from various wells, we analyzed core samples and well logs to gain detailed insights into reservoir properties such as porosity, permeability, grain size distribution, mineral composition, and hydrocarbon saturation. Geological analysis revealed distinct lithofacies, including sandstone, siltstone, and shale, with consistent stratigraphic layering. Petrophysical measurements indicated average porosity and permeability values of 14.2% and 2.1 mD for sandstone, 10.5% and 0.8 mD for siltstone, and 7.3% and 0.3 mD for shale. Grain size analysis showed mean grain sizes of 250 μm, 150 μm, and 100 μm for sandstone, siltstone, and shale, respectively. X-ray diffraction (XRD) analysis identified predominant minerals such as quartz, clay, and feldspar, with hydrocarbon saturation averaging 50% for sandstone, 40% for siltstone, and 30% for shale. Statistical analyses, including regression and principal component analysis (PCA), identified porosity, permeability, and mineral composition as primary factors influencing reservoir quality. Geostatistical modeling using kriging demonstrated spatial variability in porosity and permeability, with high-quality reservoir intervals localized in specific regions. Numerical simulations confirmed favorable hydrocarbon flow characteristics in these intervals.

This comprehensive analysis elucidates the key factors controlling reservoir quality and hydrocarbon distribution in Upper Triassic reservoirs of the Ordos Basin, thereby enhancing exploration and production strategies.

Keywords: *upper Triassic, Ordos Basin, reservoir characteristics, petrophysical properties, lithofacies, statistical analysis.*

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Sedimentary Evolution Characteristics of Jurassic in the Ordos Basin and Their Impact on Reservoirs

In the Ordos Basin, which has been explored for over a hundred years, there are still areas that have not been fully understood. Haotan New Area is a newly developed block in recent years, and the Yan'an Formation strata in the basin area have not been fully understood in the new area, which restricts the pace of oil and gas exploration and development in the region. On the basis of previous research, this article studies the sedimentary evolution characteristics of the new area from the aspects of sedimentary evolution and reservoir control factors. Yan 10 belongs to braided river sedimentation, and it is found that Yan 10+Fuxian period has braided river sedimentation characteristic.Yan 9-Yan 8 is greatly influenced by hydrodynamics and is characterized by the development of delta plain subfacies sedimentary environments, underwater distributary channels, and microfacies of inter distributary depressions. During the Yan 10 period, there were three main microfacies: floodplain, edge plain, and stagnant sediment in the river channel. In addition, the influence of sedimentary environment on reservoir development was analyzed and studied. Sedimentary environment, diagenesis, cementation and compaction play a role in the development of reservoir pores, and dissolution can improve reservoir space. Provide predictions and recommendations for the next steps of exploration and development.

Keywords: *Haotan New District, Yan'an Group, sedimentary evolution, sedimentary facies, reservoir.*

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Study on the Influence of High-Temperature Environment

on Dynamic Characteristics of Drill String in Ultra-Deep Wells

With the continuous exploitation of deep oil and gas resources, the drilling depth keeps increasing, the sensitivity of the dynamic characteristics of the drill string in the downhole is exacerbated, and the impact of the high-temperature environment in the downhole on the dynamic characteristics of the drill string has also become non-negligible. Firstly, the temperature field distribution of ultra-deep wells is initially calculated using the energy conservation equation. Secondly, the influence of high-temperature environments in ultra-deep wells on the physical and dynamic

parameters of drill strings is analyzed, and the finite element model for drill string dynamics in ultra-deep wells is improved and solved numerically. Finally, an example is used to compare and analyze the effect of underground high temperatures on the dynamic characteristics of drill strings. The results indicate that high temperatures significantly impact the movement characteristics of the drill string, while exerting minimal influence on dynamic load, particularly dynamic torque.

Keywords: *ultra-deep wells, drilling string, temperature field, dynamic characteristics, finite element method.*

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Application Analysis of Chemical Flooding Technology in the Development of Tight Oil

This study explores the application of chemical flooding technology in the southern Ordos Basin to enhance tight oil reservoir development. Employing a multidisciplinary approach, we integrated field data, laboratory experiments, literature reviews, and reservoir simulations to comprehensively assess the effectiveness and economic viability of this technique. Reservoir characterization identified porosity and permeability ranges, while fluid property analysis elucidated oil and water viscosities across different temperatures. The investigation focused on the mechanisms of chemical flooding, particularly interfacial tension reduction and viscosity enhancement. Utilizing Eclipse and CMG software for reservoir simulations, we predicted significant improvements in oil recovery and reductions in water cut. Economic evaluations, including net present value (NPV) and return on investment (ROI), confirmed the project's financial feasibility. Our findings demonstrate that chemical flooding substantially enhances oil recovery, reduces water cut, and offers a high economic return, positioning it as a promising strategy for tight oil development in the southern Ordos Basin.

Keywords: *chemical flooding, tight oil development, ordos basin, reservoir characterization, fluid properties, economic evaluation.*

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Variable Density Intermediate Stratum Gravity Correction Method

for Heterogeneous and Complex Surface

In the correction of Bouguer gravity anomaly data, the density of the intermediate stratum is the most important parameter for calculating the Bouguer gravity anomaly. Whether the selected density of the intermediate stratum is appropriate determines the degree of eliminating the influence of the intermediate stratum and the quality of the obtained Bouguer gravity anomaly data. This article focuses on the difficult problem of correcting the intermediate stratum of strongly heterogeneous surfaces under complex geological conditions. Starting from geological data and obtaining formation density data from logging data, a variable density intermediate stratum correction method for strongly heterogeneous surfaces is developed. The article explains the method of correcting the intermediate stratum of strongly heterogeneous surface. Based on the distribution of age strata in different surface areas in geological data, density zones are divided, and the density values for correcting the intermediate stratum are determined based on the density logging data corresponding to the age strata. The corrected Bouguer anomaly data removed the influence of inter-stratum heterogeneity. Through example verification, the removal of Bouguer anomalies affected by heterogeneous intermediate stratum provides reliable basic data for the separation of gravity anomaly information in the middle and deep stratum.

Keywords: *intermediate stratum, Bouguer, anis tropism surface, Chrono stratigraphy, density logging.*

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Machine Learning-Based Monitoring of Chemical Contamination from Drilling Leaks

With the increasing requirements for environmental protection in oil and gas field development, the leakage during drilling and the chemical pollution caused by it have become the key technical difficulties restricting sustainable development. In this study, a set of intelligent monitoring and risk assessment system integrating multi-source data is constructed, based on three uncertainty quantification methods, namely, Dropout Bayesian Approximation, Density Network Integration, and Mixed Density Network (MDN), to deeply mine and distribute the drilling parameter and chemical detection data of 17 wells. To address the limitations of the traditional methods, which are difficult to take into account the nonlinearity, multiple peaks and uncertainty, SHAP value and BPCA are introduced for feature selection and dimensionality reduction, and the MDN model is optimised based on maximum likelihood and entropy regularisation strategies. The experimental results show that the MDN outperforms other methods in terms of negative log-likelihood (NLL), mean square error (MSE) and confidence interval coverage (PICP), and achieves accurate fitting of the pollution concentration distribution and risk warning. Finally, combining the pollution probability distribution and well control scheduling rules output from the model, the parameter optimisation and operation recommendation scheme is proposed, which achieves an early warning accuracy of more than 93% in the field deployment, and provides strong support for green drilling and environmental protection.

Keywords: *drilling leakage, chemical contamination, machine learning, Bayesian neural network, hybrid density network.*

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Optimization of Drainage Indicators for High-Conductivity Fractured Gas Reservoirs Based on Embedded Discrete Fracture Models

Reservoir X has high-conductivity fractures developed in the gas-water reservoir. During development, severe edge and bottom water invasion occurs, and after water appears in gas wells, water production rapidly increases and even quickly floods the wells. Pilot experiments such as gas injection to block water in the reservoir have shown no significant effects. The discussion indicates that reservoir drainage has become the main research direction for the next phase of production. Since the reservoir shows no obvious patterns when studied using equivalent models, an embedded discrete fracture model was used to characterize and represent the high-conductivity fracture network in the eastern area of the reservoir based on the water production characteristics. Sensitivity analysis of the high-conductivity fracture network in the eastern area was conducted, and reasonable drainage indicators for the eastern area were optimized. The results show that the embedded discrete fracture model can effectively characterize the high-conductivity fracture network; The fracture length, aperture, and permeability of high-conductivity fractures significantly impact development effects. The greater the fracture length and aperture, the more severe the edge and bottom water invasion, and the more local residual gas remains; The optimal production-to-injection ratio in the eastern area of the reservoir is between 15 and 20 $m^3/10^4$ m^3. The conclusions suggest that the research results can provide certain reference value for field production.

Keywords: *fractured gas reservoir, high-conductivity fractures, embedded discrete fracture model, drainage indicators, numerical*

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Corrosion Behavior and Protection Technologies of Petrochemical Pipeline Materials in High-Pressure and High-Temperature Environments

This paper focuses on the corrosion behavior and protection technologies of petrochemical pipeline materials in high-pressure and high-temperature environments. The corrosion mechanisms, influencing factors, and common types of corrosion are systematically analyzed. Through in-depth research, the latest protection technologies are summarized and evaluated. Six tables are used to organize and present relevant data, providing a comprehensive understanding of the subject. This study aims to offer theoretical support and practical guidance for improving the service life and safety of petrochemical pipelines under harsh conditions, and to promote the development of the petrochemical industry.

Keywords: *petrochemical pipelines, high-pressure and high-temperature environments, corrosion behavior, electrochemical corrosion, chemical corrosion; corrosion fatigue, corrosion protection technologies, material selection; coating technology, cathodic protection, corrosion inhibitors, nanotechnology – based coatings, intelligent monitoring; green corrosion inhibitors, computational simulation.*

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On the issue of Reservoir densification and Hydrocarbon Accumulation in Oil and Gas Fields

The "sweet area" within the tight reservoir of the Shan-2 member of the Shanxi Formation in the Ordos Basin is identified in this study by exploring the relationship between reservoir densification and hydrocarbon accumulation. The diagenesis process of different sandstone facies are revealed by combining cast thin section, X-ray diffraction and scanning electron microscope. Based on fluid inclusion petrography, microthermometry and laser raman probe testing, combined with single well burial history and thermal history simulation, the hydrocarbon charging period were determined. The results show that there are mainly two periods of hydrocarbon charging in Shan-2 member of Shanxi Formation. The first period occurred in the late Triassic to early and middle Jurassic between 220-170 Ma, and the second period occurred in the late Jurassic and early Cretaceous between 160-100 Ma. The reservoir densification process and hydrocarbon charging sequence of different sandstone facies are obviously different. The pure quartz sandstone, quartz-rich and plastic-poor debris sandstone have good physical properties before hydrocarbon charging in the second period, the hydrocarbon is accumulation meanwhile the reservoir is dense in middle diagenetic stage B. The tuffaceous-rich quartz sandstone and plastic-rich debris sandstone have been basically compacted in early diagenetic stage, while carbonate cemented sandstone has been dense in middle diagenetic stage A, which are not conducive to the charging of hydrocarbon. Therefore pure quartz sandstone and quartz-rich and plastic-poor debris sandstone become the most favorable sandstone facies for natural gas exploration.

Keywords: *diagenetic process, hydrocarbon accumulation period, Shanxi Formation, Yan'an area.*

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Numerical Simulation of Gas Hydrate Decomposition for Single and Double Outlet Depressurization

Natural gas hydrate is a clathrate compound that remains stable under high pressure and low temperature conditions. As a clean and efficient alternative energy resource, the research on extraction technology is of great significance to the optimization of global energy structure. This paper focuses on the depressurization decomposition process of natural gas hydrate (methane hydrate $CH_4 \cdot nH_2O$), constructing mathematical models for the coupling

problems in the decomposition process, including multi-component, multiphase flow, seepage, heat and mass transfer, and phase change. The decomposition process of hydrate was numerically simulated by using finite difference method and calculated by MATLAB programming. This paper calculated the hydrate decomposition experiment of single and double outlets respectively, trying to analyze the single well and multi-well depressurization production process. The numerical results for double outlet reveal that this method can significantly enhanced decomposition efficiency, reducing the complete gas production time by approximately 28%. The numerical results were compared with the experimental data, showing good agreement in cumulative gas production for the single outlet case. The research provides reliable validation data and has significant engineering application value for optimizing hydrate development strategies.

Keywords: *methane hydrate, depressurization, multiphase flow, mass and heat transfer, finite difference method.*

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Physical Simulation Experiment on the Protection

of Primary Pores ɯn Reservoirs by Overpressure

Currently, reservoir evolution simulation experiments under normal pressure conditions are quite common, while reservoir evolution simulation experiments under abnormally high pressure conditions are relatively rare. In order to further clarify the quantitative impact of high temperature and overpressure on the evolution of reservoir pores, the reservoirs in the eastern area of Yinggehai Basin were taken as the research object. Physical simulation experiments were applied to explore the influence of overpressure on the evolution of reservoir pores under the background of sedimentation, diagenesis, and temperature and pressure, and to clarify the main controlling factors of high-quality reservoirs in the eastern area. The experimental results show that: Under normal pressure and overpressure conditions, there is a negative correlation between burial depth and porosity, that is, the porosity gradually decreases with increasing burial depth; Overpressure has a protective effect on porosity, and in this experiment, the maximum protection of porosity by overpressure can reach 12.54% The compaction effect causes microcracks in the sample particles, and as the temperature and pressure conditions increase, the number of microcracks gradually increases. The conclusion is that: Overpressure is conducive to the formation of microcracks and has a good protective effect on porosity. Compared with the normal pressure group, the overpressure group has more microcracks and higher porosity. The protection of primary pores by overpressure is the most constructive effect in reservoirs under high-temperature overpressure background, and the stronger the overpressure, the greater the protective effect on pores.

Keywords: *overpressure protection, pore evolution, eastern region, Yinggehai Basin.*

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Analysis of Vibration Drag Reduction in Horizontal Wells

During the process of coalbed methane extraction, the drill string is subjected to significant backing pressure, leading to a reduction in drilling efficiency. However, previous studies have demonstrated that the application of axial vibration excitation during drilling operations can mitigate friction and increase the elongation of the drill string. This paper establishes a mechanical model of the drill string with axial vibration tools during horizontal directional drilling in coal mines through discrete components. Considering the nonlinearity of friction and the boundary conditions and initial conditions of the system during actual drilling, the differential equations of motion of the system are obtained and numerically solved using the Runge-Kutta method. The behavior of the system with axial vibration tools during horizontal drilling is further analyzed. Finally, the effect of several factors on system behavior and axial vibration drag reduction effect is discussed. The research results indicate that the drilling process of a horizontal drilling system with axial vibration tools is mainly divided into four stages compared to traditional systems. The drag reduction effect of a single drag reducing vibrator gradually weakens with the drilling depth increases. Increasing the amplitude of the excitation force can reduce the axial friction force, thereby increasing the drag reduction effect. Although a small change in frequency has little effect on the drag reduction effect, there is still an optimal value within the range.

Keywords: *horizontal well, drill string, drag reduction, axial vibration.*

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Investigation of the Solubility of Thickening Additives
in the Base Oil of Compressor Lubricants

The use of thickening agents in the composition of industrial lubricants remains an important trend associated with the need to develop effective base formulations for rotating machinery lubricants. The use of both individual polymer compounds and block copolymers for thickening of petroleum and synthetic lubricants allows the desired viscosity of lubricating compositions to be promptly achieved. However, the solubility of such polymer structures in different types of oils remains a poorly investigated area. The lack of knowledge leads to an inefficient use of research resources. In this paper, we aim to empirically generalize information on the solubility of styrene-based block copolymers and lower olefin hydrocarbon-based polymers in the base oils of compressor lubricants.

Keywords: *compressor lubricants, screw compressor lubricants, thickening additives, styrene–butadiene–styrene block copolymer, styrene–ethylene–butylene–styrene block copolymer, block copolymers, solubility of thickening additives.*