

Chemistry and Technology of Fuels and Oils

4⁽⁶⁵⁰⁾ '2025

Head Editor

B. P. Tumanyan – Dr. Eng. Sci., prof.

Editorial Board

S. N. Volgin – Dr. Eng. Sci., prof.

I. B. Grudnikov – Dr. Eng. Sci., prof.

V. L. Lashkhi – Dr. Eng. Sci., prof.

A. Luksa – Dr. Eng. Sci., prof. (Poland)

A. M. Mazgarov – Dr. Eng. Sci., prof.

K. B. Rudyak – Dr. Eng. Sci., prof.

E. P. Seregin – Dr. Eng. Sci., prof.

Sun Tengfei – prof. (China)

Publisher— ICST «TUMA Group» LLC

Contents

TECHNOLOGIES

D. Stratiev. 3
Summary of 10 Years of Experience in Commercial Operation
of H-Oil Hydrocracker

Yu. K. Usmanova, S. M. Petrov, G. P. Kayukova. 10
The Relationship of Chemical Types of Heavy Oils and Natural Bitumen
with the Properties of Their Deasphaltation and Adsorption Purification Products

KINETICS AND CATALYSIS

*K. V. Shabalin, L. E. Foss, O. A. Nagornova,
Yu. Y. u. Borisova, D. N. Borisov.* 14
Sorption and Catalytic Activity of Ionites Based on Petroleum Asphaltenes,
Copper (II) and Manganese (II) Cations

CHEMMOTOLOGY

V. A. Mityagin, D. Yu. Glyadyaev. 21
Dispersion Medium Formation Features for Plastic Geases Purposed
for the Arctic and the Far North

RESEARCH

T. I. Stolonogova. 26
Changes in the Functional Characteristics of Gasoline in the Presence
of Mixtures of Ethanol and Glycerol Ether

M. Sh. Madygulov. 31
Formation of Freon-12 Gas Hydrate Based on Frozen Aqueous Solutions of Polyester

*D. A. Diakite, S. T. Shamsutdinova, F. S. Touzakov,
A. A. Kuchierskaya, D. S. Kopitsyn, A. A. Novikov.* 35
Icing of Hydrophobic Silica Coatings on Metal Substrates

S. R. Rasulov, M. B. Adygezalova, R. Ya. Ganiyeva. 38
Diagnostics of Structural Stability of Anomalous Flow Systems in Oil Collection Network

CHEMICAL ENGINEERING AND EQUIPMENT

I. R. Vezirov, U. R. Vezirov, E. G. Telyashev, R. R. Vezirov, R. N. Salahov. 42
Research into the Ultimate Vacuum Depth Achieved
by Single-Stage Hydraulic Ejector of Vacuum Generating Systems

I. R. Vezirov, U. R. Vezirov, E. G. Telyashev, R. R. Vezirov, R. N. Salahov. 50
Evaluation of Technical and Economic Efficiency
of Two-Stage Hydraulic Ejector of Vacuum Generating Systems

INNOVATIVE TECHNOLOGIES OF OIL AND GAS

*U. Zh. Mirzakimov, M. E. Semenov, M. A. Varfolomeev,
P. Yu. Kazakova, R. S. Pavelyev.* 57
The Effect of Sulfonated Nonylphenol Derivatives on Methane Hydrate Formation

*Sh. E. Gainullin, V. M. Tavochkin, R. S. Pavelyev, P. Yu. Kazakova,
M. M. Zagirov, M. E. Semenov, M. A. Varfolomeev.* 61
Amino Acids Modified with Nitrilotriacetic Acid
as Kinetic Promoters for CO₂ Hydrate Formation

*Fangping Chen, Dengfeng Wei, Bin Shi, Chao Gao,
Ying Liu, Baoting Li, Zhigang Wang.* 68
Fracture Initiation and Propagation in Hydraulic Fracturing of Tight Reservoirs

Chao Meng, Qing Chen, Yongfang Jiang, Longbo Lin, Xiaohua Yan. 76
Prediction of Oil Well Condition on the Splitting of Well Power Curve Characteristics

Xuefeng Bai, Haibin Zhao, Pengwan Wang, Ping Jiang, Famu Huang, Tao Yang. 82
Paleoenvironmental Changes in Organic Matter Deposition in Shales
and Their Significance for Shale Gas Exploration

Bing Wang, Baipeng Li, Jie Li, Teng Zhang, Gang Han, Xi Chen. 90
Study on Pressure Drop In Wellbore of Horizontal Wells
Considering Its Wellbore Trajectory Effects

*Chaoqun Xie, Zhifeng Luo, Haoran Fu, Li Shang,
Weihua Chen, Jie He, Chaozong Yan.* 97
Preparation and Performance Evaluation of the CQ-1
High-Temperature Acid Corrosion Inhibitor

Yitian Xie, Mingyi Hu. 105
Analysis of Oil Reservoir Distribution Patterns in Mid-Deep Lacustrine Fan

<i>Jingyuan Liu, Jiahao Wang, Xiaojing Wei, Lixia Kang, Chaoqi Zhang, Jianjun Gao, Yushuang Zhu.</i> Tight Oil Composite Accumulation Mechanism in Ordos Basin Oil Layers	110
<i>Linqi Zeng, Haotian Song, Xinxiu Jin, Lihui Cheng, Zhihong Wang, Shangfang Gao, Liangliang Li.</i> Factors Analysis of Affecting Reservoir Fracture Expansion in the Aspect of Revelation of Chemical Kinetics Mechanism Based on Artificial Intelligence	116
<i>Jian Sun, Long Ren, Yong Ai, Le Qu, Kang Tang, Zhe Zhang.</i> Machine Learning Based Fracturing Capacity Prediction Study for Horizontal Wells in Oilfields	124
<i>Xudong Zhang, Zhou Jun, Haoyu Sun, Jinfu Li, Zhili Chen, Xiangwei Kong.</i> Bedding Plane Effect and Pulsation Regulation Mechanism of Fracture Propagation in Shale Gas Reservoirs	131
<i>Hongqiao Yan, Wencai Li.</i> Research on Energy Consumption Optimization Model for Compressor Units in Oil and gas processing facility	135
<i>Fengxia Li, Zhengku Wang, Jianian Xu, Hongli Liu, Jiyin Zhang.</i> Research on Composition and Performance Evaluation of Environmentally Friendly Vegetable Gum Drilling Fluid system	142
<i>Zhanglong Tan, Junwen Lin, Zhaobing Hao, Fan Yang, Lei Feng, Peng Wang, Qi Yang, Wenjie Shen, Laiao Ren, Yuxin Chen.</i> Numerical Investigation of Cement Sheath Interface Integrity during Hydraulic Fracturing of Coalbed Methane Well	151
<i>Xuan Chen, Haiyue Yu, Xiongfei Xu, Jun Wei, Xuwei Zheng, Bo Su, Hao Qu, Chuang Li.</i> Analysis of Reservoir Physical Properties and Emulsification Law of Crude Oil	159
<i>Yan Yan, Shangyu Yang, Lihong Han, Caihong Lu.</i> The Impact of Carbon Dioxide Fluid Environments on the Integrity of Cement Sheath and Bonding Interfaces of a Wellbore	165
<i>Cankun Wang, Xuegang Wang, Yulong An, Jiwei Wu, Bo Zhang, Jun Zhao, Yilin Li, Wenzhe Li, Liang Zhao, Hualin Liao.</i> Explaining the Sustained Annular Pressure in High Pressure Ultra-Deep Gas Well with Tie-Back Casing through Numerical Simulation	172
<i>Cao Yi, Zhong Jinpan, Yan Ruifeng, Zhu Yangwen, Chen Junbin.</i> Numerical Simulation Study On CO ₂ Injection to Enhance Oil Recovery in Tight Reservoirs	178
<i>Xiang Dai, Long You, Xiaopeng Bai, Li Wang, Menglu Zhang, Junqiang Song, Ting Li, Hong Pan, Chuixian Kong, Dongsheng Yao, Shihong Li, Guanxing Luo, Wenying Wu.</i> Optimizing Development Strategies for Low-Porosity Fractured-Block Reservoirs	184
<i>Yantao Xu, Bumin Guo, Xuxing Wang, Wen Zhang, Bing Han, Xiuxing Zhu, Shiyong Shi.</i> A Perforation Density Optimization Method for Limited-Entry Fracturing Considering Injection-Production Fluid Balance	196
<i>Zhongfei Liu, Zhengqing Ai, Zhi Zhang, Ning Li, Xiuxing Zhu, Jie Liang, Zhongyuan Tang.</i> Pressure Surge Analysis During Tripping-in of Drill string Based on Fluid-Structure Interaction	204
<i>Tao Li, Xueru Hu, Wenjing Chu, Kerong Yang, Zhongjian Du, Hualian Zhang.</i> Analysis and Evaluation of the Benefit of Single-well Production Increase Measures in the Late Development	209
<i>Mingwei Ren, Rui Qiu, Yunbo Chen, Kewei Gao, Qinglin Cao.</i> Structure Design and Performance Analysis of Battery Pack Cover Composed of Fiber-Steel Laminates for new energy vehicles	216

Д. Стратиев^{1,2}

¹ ЛУКОЙЛ Нефтохим Бургас, Болгария,

² Институт биофизики и биомедицинской инженерии, Болгарская академия наук,

stratiev.dicho@neftochim.bg

Обобщение 10-летнего опыта промышленной эксплуатации установки гидрокрекинга H-Oil

В статье проанализированы среднегодовые показатели (свойства сырья, продуктов и уровень конверсии) установок гидрокрекинга гудрона H-Oil за период 2015–2025 гг. при переработке 35 сортов нефтей.

Установлено, что при повышении температуры в реакторах на 1°C и снижении нагрузки на 10 т/ч конверсия гудрона увеличивается на 1%. За 10 лет среднегодовой уровень конверсии увеличился с 43,4 в 2015 г. до 86,3% в 2020 г. Осадок при горячей фильтрации атмосферного остатка гидрокрекинга линейно уменьшается с 0,4 до 0,1% мас. при снижении объемной скорости с 0,22 до 0,12 ч⁻¹.

Ключевые слова: гидрокрекинг, вакуумный остаток, конверсия, асфальтены, интеркритериальный анализ, эмпирические корреляции.

DOI: 10.32935/0023-1169-2025-650-4-3-9

D. Stratiev^{1,2}

¹ LUKOIL Neftohim Burgas, Burgas, Bulgaria,

² Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences

Summary of 10 Years of Experience in Commercial Operation of H-Oil Hydrocracker

The article analyzes the average annual performance (properties of feedstock, products and conversion level) of commercial H-Oil vacuum residue hydrocracking unit for the period 2015-2025 at processing of 35 different crude oils. It was found that when the reactor temperature increases by 1°C and the throughput decreases by 10 t/h, the vacuum residue conversion increases by 1%. Over 10 years, the average annual conversion rate increased from 43.4 in 2015 to 86.3% in 2020. The sediment level in hydrocracked atmospheric residue decreases linearly from 0.4 to 0.1 wt% while the liquid hourly space velocity decreases from 0.22 to 0.12 h⁻¹.

Key words: hydrocracking, vacuum residue, conversion, asphaltenes, intercriteria analysis, empirical correlations.

Ю. Х. Усманова, С. М. Петров, Г. П. Каюкова

Казанский национальный исследовательский технологический университет

Lfm59@mail.ru

Взаимосвязь химических типов тяжелых нефтей и природных битумов со свойствами продуктов их деасфальтизации и адсорбционной очистки

В статье рассмотрены методологические подходы к прогнозной оценке влияния процессов деасфальтизации и адсорбционной очистки тяжелых нефтей и природных битумов, различающихся по химическому типу на выход и качество конечных продуктов, а также возможности их дальнейшего использования в нефтеперерабатывающей промышленности. Установлено, что более 20% массы соединений тяжелых нефтей и природных битумов, присутствующих во фракциях, выкипающих выше 350°C, являются ключевыми компонентами базовых минеральных масел. Эти компоненты характеризуются высокими индексами вязкости и низкими температурами застывания, что делает их ценными для производства смазочных

материалов. Также выявлены корреляционные зависимости, позволяющие прогнозировать основные физико-химические свойства минеральных масел, полученных из различных типов тяжелых нефтей, на основе показателя преломления, который отражает степень их адсорбционной очистки.

Ключевые слова: тяжелые нефти, природные битумы, деасфальтизация, адсорбционная очистка, базовые минеральные масла.

DOI: 10.32935/0023-1169-2025-650-4-10-13

Yu. K. Usmanova, S. M. Petrov, G. P. Kayukova.

Kazan National Research Technological University

The Relationship of Chemical Types of Heavy Oils and Natural Bitumen with the Properties of Their Deasphaltation and Adsorption Purification Products

The article discusses methodological approaches to predictive assessment of the impact of de-asphalting and adsorption purification processes of heavy oils and natural bitumen, differing in chemical type, on the yield and quality of final products, as well as the possibility of their further use in the oil refining industry. It has been established that more than 20% of the mass of heavy oils and natural bitumen compounds present in fractions boiling off above 350 °C are key components of base mineral oils. These components are characterized by high viscosity indices and low pour points, which makes them valuable for the production of lubricants. Correlations have also been identified that make it possible to predict the basic physico-chemical properties of mineral oils obtained from various types of petroleum products based on the refractive index, which reflects the degree of their adsorption purification.

Key words: heavy oils, natural bitumen, de-asphalting, adsorption purification, base mineral oils.

К. В. Шабалин, Л. Е. Фосс, О. А. Нагорнова, Ю. Ю. Борисова, Д. Н. Борисов

Институт органической и физической химии им. А. Е. Арбузова ФИЦ Казанский научный центр РАН
veritas777999@mail.ru

Сорбционная и каталитическая активность ионитов на основе нефтяных асфальтенов, катионов меди (II) и марганца(II)

Для сульфированных нефтяных асфальтенов, полученных в мягких (Sp-1) и жестких условиях (Sp-2), изучены особенности структурно-группового состава и сорбционная способность по отношению к двухзарядным катионам меди и марганца. Показано, что изотермы сорбции Ленгмюра, Фрейндлиха, Дубинина - Радуйкевича и Темкина с высокой степенью достоверности описывают сорбционный процесс. На основании расчета термодинамических параметров сорбции установлено, что процесс является самопроизвольным и носит физический характер. Выяснено, что наибольшим значением полной статической обменной емкости обладают асфальтены Sp-1, которые проявляют сорбционную способность по отношению к катионам меди выше, чем к катионам марганца. Иониты на основе сульфированных асфальтенов с сорбированными катионами меди показали высокую эффективность в качестве гетерогенных катализаторов окисления гидрохинона пероксидом водорода.

Ключевые слова: асфальтены, сульфирование, катионит, ионообменные материалы, изотермы сорбции.

DOI: 10.32935/0023-1169-2025-650-4-14-20

K. V. Shabalin, L. E. Foss, O. A. Nagornova, Yu.Y u. Borisova, D. N. Borisov.

Arbuzov Institute of Organic and Physical Chemistry, FRC Kazan Scientific Center, Russian Academy of Sciences

**Sorption and Catalytic Activity of Ionites Based on Petroleum Asphaltenes,
Copper (II) and Manganese (II) Cations**

For sulfonated petroleum asphaltenes obtained under mild (Sp-1) and harsh conditions (Sp-2), the features of the structural-group composition and sorption capacity with respect to divalent copper and manganese cations were studied. It was shown that the Langmuir, Freundlich, Dubinin-Radushkevich and Temkin sorption isotherms describe the sorption process with a high degree of reliability. Based on the calculation of the thermodynamic parameters of sorption, it was established that the process is spontaneous and has a physical nature. It was found that Sp-1 asphaltenes have the highest value of the total static exchange capacity, which exhibit a sorption capacity with respect to copper cations higher than to manganese cations. Ionites based on sulfonated asphaltenes with sorbed copper cations showed high efficiency as heterogeneous catalysts for the oxidation of hydroquinone with hydrogen peroxide.

Key words: asphaltenes, sulfonation, cationite, ion exchange materials, sorption isotherms.

В. А. Митягин, Д. Ю. Глядяев

ФАУ «25 ГосНИИ химмотологии Минобороны России»

25gosniihim@mil.ru

**Особенности формирования дисперсионной среды пластичных смазок для Арктики
и Крайнего Севера**

Рассмотрены вопросы особенностей применения пластичных смазок в узлах трения подвижных технических средств при их эксплуатации в природно-климатических условиях Арктической зоны. На основании анализа температурных, скоростных и нагрузочных режимов работы пластичных смазок в узлах и агрегатах техники в условиях низких температур и повышенной влажности обоснованы компоненты дисперсионной среды в наибольшей степени удовлетворяющие требования, предъявляемые к пластичным смазкам, обеспечивающим надежную эксплуатацию узлов трения различной техники.

Ключевые слова: узлы трения, пластичные смазки, дисперсионная среда, низкотемпературные свойства.

DOI: 10.32935/0023-1169-2025-650-4-21-25

V. A. Mityagin, D. Yu. Glyadyaev.

The 25-th State Research Institute of Chemmotology, Ministry of Defence of the Russian Federation

**Dispersion Medium Formation Features for Plastic Geases Purposed
for the Arctic and the Far North**

The issues regarding the dispersion medium composition impact on the low-temperature rheological properties of plastic greases to be applied in friction assembly units of mobile technical equipment, purposed for operation in the natural and climatic conditions of the Arctic zone, have been considered. Application of polysiloxane liquids in a mineral oil mixture in a ratio that meets the requirements for greases and that ensures reliable operation of friction assembly units in various equipment in the Arctic and the Far North, is justified.

Key words: plastic greases, dispersion medium, low-temperature properties.

Т. И. Столоногова

РГУ нефти и газа им. И. М. Губкина,

t.stolonogova@yandex.ru

Изменение функциональных характеристик бензинов в присутствии смесей этанола и эфира глицерина

В статье представлены результаты исследования влияния кислородсодержащего соединения — 1,3-ди-трет-бутилового эфира глицерина, синтезированного алкилированием эпихлоргидрина, на физико-химические и эксплуатационные характеристики автомобильных бензинов. В ходе работы были составлены модельная бензиновая смесь, бензиновые смеси с различным объемным содержанием добавки, а также топливные смеси с этанолом и добавкой, для которых определены основные нормируемые показатели качества автомобильного бензина и проведена оценка эффективности и применимости исследуемых соединений для использования в качестве октаноповышающей добавки. Выявлена наиболее эффективная концентрация 1,3-ди-трет-бутиловый эфир глицерина. Установлено, что исследуемое соединение ввиду своей гидротропности способно повышать фазовую стабильность бензино-этанольных смесей при низкой температуре.

Ключевые слова: бензин, бензиновые смеси, октаноповышающие добавки, 1,3-ди-трет-бутиловый эфир глицерина, этанол, октановые характеристики, гигроскопичность топлива, глицерин.

DOI: 10.32935/0023-1169-2025-650-4-26-30

T. I. Stolonogova.

Gubkin University

Changes in the Functional Characteristics of Gasoline in the Presence of Mixtures of Ethanol and Glycerol Ether

The article presents the results of a study of the effect of an oxygen-containing compound, 1,3-di-tert-butyl ether of glycerol (di-TBGE), synthesized by alkylation of epichlorohydrin, on the physico-chemical and operational characteristics of automobile gasoline. In the course of the work, a model gasoline mixture, gasoline mixtures with various volumetric additive contents, as well as fuel mixtures with ethanol and an additive were compiled, for which the main standardized quality indicators of automobile gasoline were determined and the effectiveness and applicability of the studied compounds for its use as an octane-enhancing additive were evaluated. The most effective concentration of 1,3-di-tert-butyl ether of glycerol was revealed. It has been revealed that the studied compound, due to its hydrotropicity, is capable of increasing the phase stability of gasoline-ethanol mixtures at low temperatures.

Key words: gasoline, gasoline mixtures, octane-enhancing additives, 1,3-di-tert-butyl ether of glycerol, ethanol, octane characteristics, hygrosopicity of fuel, glycerin.

М. Ш. Мадыгулов

Институт криосферы Земли Тюменского научного центра Сибирского отделения РАН, г. Тюмень

marat747@gmail.com

Образование газового гидрата фреона-12 на основе замороженных водных растворов полиэфира

Представлены экспериментальные данные по влиянию замороженных водных растворов полиэфира на скорость роста газового гидрата фреона-12, при циклическом изменении температуры образца от 263 до 276 К. По результатам р-V-T измерений выполнена оценка степени превращения образца в газовый гидрат. Установлено, что добавление полиэфира в небольших концентрациях активно влияет на скорость роста газового гидрата.

Ключевые слова: метод р-V-T, замороженные водные растворы, полиэфир, газовые гидраты, термоциклирование.

DOI: 10.32935/0023-1169-2025-650-4-31-34

M. Sh. Madygulov.

Institute of Earth Cryosphere, Tyumen Scientific Center, SB, RAS, Tyumen

Formation of Freon-12 Gas Hydrate Based on Frozen Aqueous Solutions of Polyester

Experimental data on the effect of frozen aqueous solutions of polyester on the growth rate of freon-12 gas hydrate are presented, with cyclic changes in sample temperature from 263 to 276 K. Based on the results of p-V-T measurements, an assessment of the degree of sample conversion into gas hydrate is made. It is established that the addition of polyester in small concentrations actively affects the growth rate of gas hydrate.

Key words: method p-V-T, frozen aqua solution, polyester, gas hydrate, thermocycling.

Д. А. Диаките, С. Т. Шамсутдинова, Ф. С. Тоузакوف, А. А. Кучиерская, Д. С. Копицын, А. А. Новиков

РГУ нефти и газа (НИУ) имени И. М. Губкина;

povikov.a@gubkin.ru

Обледенение гидрофобных кремнеземных покрытий на металлических подложках

Гидрофобные покрытия, получаемые самосборкой микрочастиц кремнезема с одновременной прививкой гидрофобных групп, существенно изменяют смачивание поверхности водой. Важной проблемой является стойкость таких покрытий к многократному обледенению. В данной работе проведено исследование стойкости покрытия к многоциклового замораживанию/размораживанию под слоем воды, а также оценена адгезионная прочность слоя льда, образовавшегося на покрытии.

Ключевые слова: краевой угол смачивания, адгезионная прочность, самосборка, наночастицы.

DOI: 10.32935/0023-1169-2025-650-4-35-37

D. A. Diakite, S. T. Shamsutdinova, F. S. Touzakov, A. A. Kuchierskaya, D. S. Kopitsyn, A. A. Novikov.

Gubkin University

Icing of Hydrophobic Silica Coatings on Metal Substrates

Hydrophobic coatings obtained by self-assembly of silica microparticles with simultaneous grafting of hydrophobic groups significantly change the wetting of the surface by water. An important problem is the resistance of such coatings to repeated icing. In this paper, a study was conducted on the resistance of the coating to multi-cycle

freezing/thawing under a layer of water, and the adhesive strength of the ice layer formed on the coating was assessed.

Key words: contact angle, adhesion strength, self-assembly, nanoparticles.

C. P. Расулов, М. Б. Адыгезалова, Р. Я. Ганиева

Азербайджанский государственный университет нефти и промышленности,
rasulovsakit@gmail.com

Диагностирование структурной устойчивости течения аномальных систем в нефтесборной сети

Реологические исследования различных сортов нефтей, нефтяных смесей и водонефтяных эмульсий показывают, что при определенных условиях может происходить потеря устойчивости их течения, которая, как правило, связана с внутренними структурными изменениями и упругостью системы. Такие системы относятся к реологически неравновесным жидкостям и кривые течения для них в большинстве случаев нелинейны. В работе показана возможность определения коэффициента структурной устойчивости при наличии сдвиговой деформации с учетом аналогии обобщенного реологического уравнения экспоненциального типа с уравнением линейной вязкоупругой жидкости максвелловского типа. Предложена зависимость, которая в случае структурообразующих нефтей позволяет оценить время структурной релаксации, которое соответствует началу потери структурной устойчивости потоков.

Ключевые слова: структурная устойчивость, время релаксации, реология, кривые течения, неравновесные системы, нефтесборная сеть.

DOI: 10.32935/0023-1169-2025-650-4-38-41

S. R. Rasulov, M. B. Adygezalova, R. Ya. Ganiyeva.

Azerbaijan State University of Oil and Industry, Azerbaijan, Baku

Diagnostics of Structural Stability of Anomalous Flow Systems in Oil Collection Network

Rheological studies of various grades of oil, oil mixtures and water-oil emulsions show that under certain conditions there may be a loss of stability of their flow, which is usually associated with internal structural changes and elasticity of the system. Such systems are related to rheologically nonequilibrium liquids and the flow curves for them are nonlinear in most cases. In the work, taking into account that in the presence of shear deformation, the generalized rheological equation of exponential type, taking into account the structural stability of the system, is an analogue of the equation of a linear viscoelastic fluid of Maxwell type and its extrapolation makes it possible to determine the coefficient of structural stability. A dependence is proposed that, in the case of structure-forming oils, allows estimating the time of structural relaxation, which corresponds to the onset of loss of structural stability of flows.

Key words: structural stability, relaxation time, rheology, flow curves, nonequilibrium systems, oil gathering network.

И. Р. Везилов, У. Р. Везилов, Э. Г. Теляшев, Р. Р. Везилов, Р. Н. Салахов

Уфимский государственный нефтяной технический университет,
ivezirov@yandex.ru

Исследование предельной глубины вакуума, достигаемого одноступенчатыми гидроэжекторными вакуумсоздающими системами

В статье приведено сравнение литературных и практических данных о работе одноступенчатых гидроэжекторных вакуумсоздающих систем (ВСС). Представлены данные о работе вакуумного блока, работающего в режиме «сухой» перегонки. Рассмотрены расчетные и практические данные о влиянии температуры рабочей жидкости на вакуум. Показаны результаты полупромышленных стендовых испытаний, где определена максимально возможная глубина создаваемого вакуума гидроэжекторной ВСС без подачи эжектируемой среды. Представлены и проанализированы существующие методы снижения давления насыщенных паров циркулирующей рабочей жидкости. Определен объем балластного газа, выделяющегося при различном содержании воды в циркулирующей рабочей жидкости. Полученные расчетные и экспериментальные данные сопоставлены с пусковыми и рабочими параметрами вакуумного блока, работающего в режиме «сухой» перегонки. Рассчитана предельная глубина вакуума, достигаемого обычными одноступенчатыми гидроэжекторными ВСС. Установлено, что главным ограничителем глубины вакуума является эмульгированная вода в рабочей жидкости.

Ключевые слова: «сухая» вакуумная перегонка, рабочая жидкость, предельный вакуум, давление насыщенных паров, балластный газ, эмульгированная вода.

DOI: 10.32935/0023-1169-2025-650-4-42-49

I. R. Vezirov, U. R. Vezirov, E. G. Telyashev, R. R. Vezirov, R. N. Salahov.

Ufa State Petroleum Technical University

**Research into the Ultimate Vacuum Depth Achieved
by Single-Stage Hydraulic Ejector of Vacuum Generating Systems**

The article presents a comparison of literature and practical data on the operation of single-stage hydraulic ejector vacuum generating systems. Data on the operation of a vacuum unit operating in the "dry" distillation mode is presented. The calculated and practical data on the effect of the temperature of the working fluid on the vacuum are considered. The results of semi-industrial bench tests are shown, where the maximum possible depth of the vacuum created by the hydraulic ejector vacuum generating systems is determined without supplying the ejected medium. The existing methods of reducing the saturated vapor pressure of the circulating working fluid are presented and analyzed. The volume of ballast gas released at different water contents in the circulating working fluid is determined. The calculated and experimental data obtained are compared with the starting and operating parameters of a vacuum unit operating in the "dry" distillation mode. The maximum vacuum depth achieved by conventional single-stage hydraulic ejector vacuum generating systems is calculated. It has been established that the main limiter of the vacuum depth is the emulsified water in the working fluid.

Key words: "dry" vacuum distillation, working fluid, maximum vacuum, saturated vapor pressure, ballast gas, emulsified water.

И. Р. Везилов, У. Р. Везилов, Э. Г. Теляшев, Р. Р. Везилов, Р. Н. Салахов

Уфимский государственный нефтяной технический университет,
ivezirov@yandex.ru

Оценка технико-экономической эффективности двухступенчатых гидроэжекторных вакуумсоздающих систем

В статье приведены основные недостатки современных одноступенчатых гидроэжекторных вакуумсоздающих систем (ГВСС). Рассчитаны и приведены сравнительные характеристики двухступенчатых ГВСС, определена наиболее эффективная из них. Показаны характеристики и вакуумного блока одного из российских НПЗ с двухступенчатой ГВСС. Рассчитаны сравнительные технико-экономические показатели одноступенчатых и новой двухступенчатой гидроэжекторных вакуумсоздающих систем. Представлена сравнительная разгонка вакуумного соляра существующих установок с одноступенчатыми ГВСС, работающих в режиме сухой перегонки, а также с подачей водяного пара и установки с двухступенчатой ГВСС. Приведены сравнительные технико-экономические характеристики вакуумных блоков с двухступенчатой и одноступенчатыми ГВСС.

Ключевые слова: гидроэжекторная вакуумсоздающая система, двухступенчатая гидроэжекторная вакуумсоздающая система, вакуумный блок, отбор дистиллятов, удельные затраты.

DOI: 10.32935/0023-1169-2025-650-4-50-56

I. R. Vezirov, U. R. Vezirov, E. G. Telyashev, R. R. Vezirov, R. N. Salahov.

Ufa State Petroleum Technical University

Evaluation of Technical and Economic Efficiency of Two-Stage Hydraulic Ejector of Vacuum Generating Systems

The article presents the main disadvantages of modern single-stage hydraulic ejector vacuum unit. The comparative characteristics of two-stage hot water pumps are calculated and presented, and the most effective of them is determined. The characteristics of the vacuum unit of one of the Russian refineries with two-stage hot water are shown. Comparative technical and economic indicators of single-stage and new two-stage hydraulic ejector vacuum unit are calculated. A comparative acceleration of the vacuum solar system of existing installations with single-stage hot water pumps operating in dry distillation mode, as well as with steam supply and installations with a two-stage hydraulic ejector vacuum unit is shown. Comparative technical and economic characteristics of vacuum units with two-stage and single-stage hot water pumps are given.

Key words: hydro-ejector vacuum unit, two-stage hydro-ejector vacuum unit, vacuum distillation unit, distillate selection, unit costs.

U. Zh. Mirzakimov, M. E. Semenov ✉, M. A. Varfolomeev, P. Yu. Kazakova, R. S. Pavelyev

Institute of Geology and Petroleum Technologies, Kazan Federal University.
xotoy_82@mail.ru

The Effect of Sulfonated Nonylphenol Derivatives on Methane Hydrate Formation

This study investigates promising reagents for gas hydrate formation as an alternative technology for storage and transportation of natural and associated gas. The use of sulfonated nonylphenol derivatives is proposed as hydrate formation promoters. Through chemical modification sulfonation it is possible to significantly enhance their ability to accelerate methane hydrate formation. Experimental studies conducted under laboratory conditions using autoclaves equipped with stirring systems confirmed the effectiveness of these compounds in methane hydrate formation.

Keywords: *nonylphenol, sulfonation, methane hydrate, conversion, promoter, stirring.*

**Sh. E. Gainullin^{1,2}, V. M. Tavochkin¹, R. S. Pavelyev^{1,2}, P. Yu. Kazakova¹,
M. M. Zagirov¹, M. E. Semenov^{1,3} ✉, M. A. Varfolomeev¹**

¹ Kazan Federal University, Kazan, Russia;

² Kazan National Research Technological University, Kazan, Russia;

³ Institute of Oil and Gas Problems, Siberian Branch of the Russian Academy of Sciences, Yakutsk, Russia;

xotoy_82@mail.ru

Amino Acids Modified with Nitrilotriacetic Acid as Kinetic Promoters for CO₂ Hydrate Formation

Hydrate-based CO₂ capture and storage (HCCS) is a promising approach for the safe and energy efficient handling of carbon dioxide. However, its practical implementation is hindered by the inherently slow kinetics of hydrate formation. To address this limitation, we investigated a new class of biocompatible, non-foaming kinetic promoters based on modified amino acids and nitrilotriacetic acid (NTA+AA), effective at low concentrations (0.05 wt%). The performance of these compounds was compared with that of the conventional surfactant sodium dodecyl sulfate (SDS) and with unmodified amino acids such as methionine, norleucine, glutamic acid and tryptophan. High-pressure autoclave experiments under dynamic stirring conditions demonstrated that most NTA+AA compounds exhibited significantly shorter induction times, higher water-to-hydrate conversion, and increased CO₂ uptake compared to both SDS and the parent amino acids. The most favorable results were observed for the NTA+Met system, which showed an induction time of 34 minutes, a time to reach 90% conversion of 95 minutes, a CO₂ uptake of 0.086 mol/mol, and a water-to-hydrate conversion of 56.2%. These values exceeded those obtained for SDS and unmodified methionine. Notably, all NTA+AA solutions remained foam-free under vigorous stirring and during hydrate dissociation, offering a considerable practical advantage over traditional surfactants. The NTA+Nva promoter also demonstrated high efficiency (57.4% conversion, 0.088 mol/mol CO₂ uptake), albeit with a slightly slower hydrate growth rate. Overall, NTA+Met can be considered one of the most effective and environmentally benign kinetic promoters for CO₂ hydrate formation among the compounds evaluated in this study.

Keywords: *gas hydrates, carbon dioxide hydrates, greenhouse gas storage, hydrate formation promotion, amino acids, kinetic hydrate promoters, carbon dioxide utilization, CO₂ capture and storage, greenhouse gas storage.*

Fangping Chen¹, Dengfeng Wei¹, Bin Shi¹, Chao Gao¹, Ying Liu¹, Baoting Li¹, Zhigang Wang^{2,3} ✉

¹ Research Institute of Shaanxi Yanchang Petroleum (Group) Co., Ltd, Xi'an, China;

² College of Petroleum Engineering, Xi'an Shiyou University, Xi'an, China;

³ Shaanxi Key Laboratory of Advanced Stimulation Technology for Oil & Gas Reservoirs, Xi'an, China.

Fracture Initiation and Propagation in Hydraulic Fracturing of Tight Reservoirs

Hydraulic fracturing represents a prevalently utilized and efficacious technique for augmenting the permeability of tight reservoirs, and it has been extensively employed in oil and gas field engineering scenarios to facilitate the efficient exploitation of tight oil and gas resources. The most critical issue in hydraulic fracturing is the initiation and propagation of fractures, which determine the effectiveness and extent of the fracturing process. There are abundant shale oil resources in the Chang 8 reservoir of the Ordos Basin; however, studies examining the influence of interlayer and multilayer system lithology on hydraulic fractures remain limited. In this paper, using the method of true triaxial fracturing physical test, the hydraulic fracture initiation and propagation of various tight reservoirs were conducted with the Ordos Basin Chang8 Reservoir, and the effects of injection rate, type of fracturing fluid, lithology, and interlayer thickness on the initiation and propagation of hydraulic fracturing fractures were investigated. Results show that increasing injection rate promotes faster and more complete initiation and propagation of fractures. CO₂ has a lower viscosity and stronger compressibility, which enables the fluid to enter the pore space and create a localized pressurisation effect, thereby assisting in the generation of more complex fracture patterns. The mudstone samples display uncertain fracture propagation directions owing to their plastic characteristics, while the fractures in sandstone samples exhibit more regular patterns due to their higher brittleness. The fractures in the sand-mud interbedded specimens tend to form in the more brittle sandstone, expanding in the direction of maximum stress and then turning as they encounter the more plastic mudstone, eventually forming an “I” shape. The thickness of the interlayer does not significantly impact fracture propagation, while the orientation of the interlayer significantly affects the fracture expansion path.

Keywords: tight reservoirs, hydraulic fracturing, initiation, expansion, Chang8.

Chao Meng¹, Qing Chen^{1,2}, Yongfang Jiang^{1,2}, Longbo Lin^{1,3}, Xiaohua Yan^{1,2}✉

¹ Hunan Geosun Hi-technology Co., Changsha, China;

² Hunan Provincial Engineering Technology Research Center for Electromagnetic Exploration of Deep Earth Resources, Changsha, China;

³ Chengdu University of Technology, Chendu, China.

goush2010@163.com

Prediction of Oil Well Condition on the Splitting of Well Power Curve Characteristics

In order to reasonably split power curve characteristic parameters and predict well conditions, this study first analyzes the method of splitting oil well power curve characteristic parameters. Based on this, the big data-based well condition prediction algorithm is explored. Finally, the prediction effect of well conditions is analyzed. The research lays the foundation for accurately determining the operating status of downhole equipment and optimizing the pump parameters. The study shows that the local characteristic parameters of the oil well power curve are interrelated yet have their own characteristics. By calculating their real-time values and comparing them with the historical normal range, it is possible to accurately predict various conditions, such as insufficient fluid supply and wax deposition. During the well condition comprehensive diagnosis and prediction process, when the results indicate insufficient fluid supply, gas interference, or wax deposition, the system will mark the well as pending

comprehensive diagnosis. If other issues are detected, an alarm will be triggered directly. For wells under comprehensive diagnosis, the system calculates the daily power curve characteristic parameters at 0:00 each day and compares them with the normal power curve parameters. If any parameter exceeds the normal range, a categorized alarm will be triggered. A large load difference indicates wax deposition; a reduction in effective stroke signals insufficient fluid supply; other parameter changes indicate corresponding real-time diagnosis results. The research concludes that accurately predicting the condition of the oil well can help optimize oil extraction strategies, improve liquid production capacity, extend equipment lifespan, and enhance the overall recovery rate of the oil field.

Keywords: oil well, power curve characteristic parameters, splitting method, well condition prediction, prediction effect.

Xuefeng Bai¹, Haibin Zhao¹, Pengwan Wang²✉, Ping Jiang¹, Famu Huang¹, Tao Yang³

¹ PipeChina Energy Storage Technology Co., Ltd, Shanghai, China;

² PetroChina Hangzhou Institute of Petroleum Geology, Hangzhou, China;

³ Liaohe Oilfield of CNPC, Panjin, China.

wangpw_hz@petrochina.com.cn

Paleoenvironmental Changes in Organic Matter Deposition in Shales and Their Significance for Shale Gas Exploration

The Lower Silurian Longmaxi Formation is a key stratigraphic layer for shale gas exploration and development in the Middle Yangtze Block. The organic matter content of this formation is a crucial indicator of the shale gas enrichment. However, no systematic comparative research has been conducted on the factors controlling the organic matter enrichment of the shale in the western Middle Yangtze Block. In this paper, we compare the sedimentological and geochemical characteristics of the Longmaxi Formation shales in the passive continental margin and cratonic depression in the western Middle Yangtze Block in order to explore the main controlling factors and formation patterns of the differential organic matter enrichment. The results show that the section of the shale with a total high organic carbon (TOC) content is located at the bottom of the Longmaxi Formation, and it formed in a foreland flexural subsidence setting characterized by low terrestrial input, high paleoproductivity, and good preservation conditions. Subsequently, as the flexural migration gradually strengthened and the sea level continued to decline, the shale experienced increased terrestrial input and deteriorating preservation conditions. However, the paleoproductivity level was weakly affected by the sea level decline, exhibiting a gradual increase; this was mainly due to the fact that the flexural migration caused the gradual opening of the barrier in the northern Yangtze Basin and the gradual increase in the influx of ocean currents. Therefore, vertically, the decrease in the TOC content in the Longmaxi Formation was mainly controlled by the deterioration of the preservation conditions and the increase in the terrestrial input. Laterally, the shale transitioned from the passive continental margin to the cratonic depression, with decreasing sea level and ocean current activity, along with deteriorating preservation conditions and paleoproductivity levels, leading to a decrease in the TOC content. As a result, the focus of shale gas exploration and development in the Longmaxi Formation should be focused the northwest region. The results of this study have significant implications for gaining a deeper understanding of the evolution of the paleoenvironment of the Longmaxi Formation shales and the mechanisms of organic matter enrichment and thus provide guidance for shale gas exploration practices.

Keywords: western Middle Yangtze Block, black shale, organic matter, upwelling ocean currents, main factors controlling enrichment, formation pattern.

Bing Wang¹, Baipeng Li¹, Jie Li¹, Teng Zhang¹, Gang Han¹, Xi Chen²✉

¹ Petrochina Changqing Oilfield Company First Gas Production Plant, Yulin, Shaanxi, China; ² College of Petroleum Engineering, Xi'an Shiyou University, Xi'an, China. Corresponding author: Xi Chen✉. E-mail: c13992324214@163.com

Study on Pressure Drop in Wellbore of Horizontal Wells

Considering Its Wellbore Trajectory Effects

Liquid accumulation in wellbores severely impacts pressure distribution in low-permeability gas fields, leading to increased pressure drop, impeded drainage, and reduced gas production and recovery. The complexity of liquid-loading mechanisms and pressure drop patterns in horizontal wells arises from variations in the curvature radius of deviated sections and undulating trajectories within reservoirs. This necessitates urgent investigation into the effects of wellbore trajectory on pressure distribution. An experimental platform was designed based on the Froude similarity criterion to simulate gas-liquid two-phase flow. Key parameters investigated include the number of undulations, wellbore inclination angle, build-up rate of deviated sections, and liquid-gas ratio. Increased undulation frequency leads to a significant rise in pressure drop within subsequent uphill pipeline segments. The mean pressure drop in uphill section a (3.351 kPa) is approximately 37.4% lower than that in section c (5.353 kPa), demonstrating a cumulative pressure loss effect with repeated elevation changes. Reduced undulation gradient decreases overall pressure drop. When inclination decreases from 9° to 3°, pressure drops in sections a and c decline from 3.787 kPa to 3.073 kPa and 5.700 kPa to 5.11 kPa, respectively. Higher build-up rate intensifies pressure drop. Increasing build-up rate from 3°/30m to 5°/30m raises the average pressure drop in deviated sections from 9.653 kPa to 11.477 kPa. Lower liquid-gas ratio reduces pressure drop. Decreasing the ratio from 1.6 m³/10⁴ m³ to 0.6 m³/10⁴ m³ reduces average pressure drops: Sections a and c: 3.787 kPa □ 2.62 kPa; 5.7 kPa □ 5.553 kPa; Section b (downhill): 2.22 kPa □ 1.850 kPa; Section d (deviated): 10.04 kPa □ 9.73 kPa. These findings elucidate the impact of wellbore trajectory on pressure loss, providing critical insights for optimizing drainage strategies in field operations.

Keywords: wellbore pressure drop, gas-liquid two-phase flow, wellbore liquid loading, wellbore undulation gradient, build-up rate.

Chaoqun Xie¹, Zhifeng Luo¹✉, Haoran Fu¹, Li Shang², Weihua Chen³, Jie He¹, Chaozong Yan¹

¹ State Key Laboratory of Oil and Gas Reservoir Geology and Exploitation, Southwest Petroleum University, Chengdu, Sichuan, China;

² Petrochina Chuanqing Drilling Engineering Co., LTD. Geological Exploration and Development Research Institute, Chengdu, Sichuan, China;

³ PetroChina Southwest Oil and Gas Field Company No. 3, Section 1, Fuqing Road, Chenghua District, Chengdu, Sichuan, China.

lzf103429@163.com

Preparation and Performance Evaluation of the CQ-1 High-Temperature Acid Corrosion Inhibitor

The Mannich base corrosion inhibitor CQ-1 was synthesized using cinnamaldehyde, piperazine, and aniline as the primary reagents. The successful synthesis of the product was confirmed by infrared spectroscopy. The corrosion inhibition performance in hydrochloric acid solution was evaluated through weight loss measurements, scanning electron microscopy (SEM), electrochemical polarization, and electrochemical impedance spectroscopy (EIS). The corrosion inhibition mechanism was further validated through molecular simulations and thermodynamic calculations. The results indicated a positive correlation between corrosion rate and inhibitor concentration. At 200°C, with a 6% mass fraction of the inhibitor, the corrosion rate was 61.9961. The polarization curve revealed that the inhibitor behaves as a mixed-type corrosion inhibitor. Thermodynamic calculations were consistent with the Langmuir adsorption model. Molecular dynamics simulations indicated that the CQ-1 inhibitor has a molecular energy gap of 1.815 eV and an adsorption energy of -3436.69 kcal/mol, demonstrating a strong tendency for adsorption on the metal surface and structural stability. Experimental results showed a strong correlation with theoretical findings, providing valuable insights for the development of high-temperature corrosion inhibitors.

Keywords: acidizing corrosion inhibitor, Mannich base, polarization curve, molecular dynamics simulation, microscopic morphology.

Yitian Xie, Mingyi Hu✉

Yangtze University School of Geosciences, Wuhan, China.

xbdx_xbdx@163.com

Analysis of Oil Reservoir Distribution Patterns in Mid-Deep Lacustrine Fan

With the strengthening of exploration efforts in Bohai, lithologic traps have gradually become new exploration targets. The Luda 10-56 well area is a newly evaluated gas field dominated by lacustrine fan deposits in Bohai. Well exploration has confirmed that the lacustrine fan has complex rock physical properties and indistinct reflection characteristics. The lithologic sand body reservoir changes rapidly laterally. The distribution range of sand bodies and their internal connectivity relationships are very complex. With limited oil field data, seismic and geological approaches were combined to form a new workflow for detailed characterization of lacustrine fan reservoirs. First, sedimentary microfacies research was conducted based on seismic geomorphological feature analysis in paleoenvironmental settings, which provided favorable facies belts and qualitative predictions for reservoir prediction. Meanwhile, morphology inversion technology based on facies-controlled modeling was used for quantitative reservoir prediction. The purpose of facies-controlled reservoir prediction is to combine microfacies analysis (a genetic method) with inversion-rock physics (a numerical analysis method) to improve the accuracy of reservoir prediction. The above detailed characterization techniques laid a reliable foundation for early development plan research and also have guiding significance for the study of other similar lacustrine fans in the area.

Keywords: Lacustrine fan, seismic facies, seismic sedimentology, seismic attributes.

Jingyuan Liu^{1,2}, Jiahao Wang^{1,2}, Xiaojing Wei³, Lixia Kang⁴, Chaoqi Zhang⁵, Jianjun Gao⁶, Yushuang Zhu² ✉

¹ School of Earth Sciences and Engineering, Xi'an Shiyou University, Xi'an, Shaanxi, China;

² Shaanxi Key Laboratory of Petroleum Accumulation Geology, Xi'an, Shaanxi, China;

³ Zhongyuan Measurement and Control Company, Sinopec Jingwei Company, Puyang, Henan, China;

⁴ Fourth Oil Production Plant, Changqing Oilfield Branch, Yulin, China;

⁵ Sinopec Zhongyuan Oilfield Exploration and Development Research Institute, Puyang, China;

⁶ Geological Research Institute of XDEC (Logging Engineering Branch), Karamay, Xinjiang, China.

ospy2019@163.com

Tight Oil Composite Accumulation Mechanism in Ordos Basin Oil Layers

With the continuous decrease of conventional oil and gas resources in the Ordos Basin, oilfield development has gradually shifted towards unconventional resources such as tight oil. To address this, research was conducted on the accumulation mechanism and geological “sweet spot” distribution patterns of tight oil in Yanchang Oilfield. Three types of advantageous tight oil zones were classified, their geological parameter indicators were explored, and the influencing factors of tight oil distribution in Chang 7 and Chang 8 layers were determined from two aspects: geological “sweet spot” influencing factors and engineering “sweet spot” influencing factors. Research shows that the sandstones of Chang 7 and Chang 8 oil layers in the study area are generally low-permeability tight lithologic reservoirs with no obvious oil-water differentiation. The oil layers are controlled by reservoir physical properties and sedimentary facies zones. The oil reservoir interface generally presents a gentle west-dipping monocline structure. Locally developed low-amplitude nose uplift structures have no obvious relationship with the range of oil reservoir traps and the distribution of main oil layers. The Chang 7 and Chang 8 oil layers in the Ordos Basin mainly have two types of source-reservoir configurations: “source-reservoir” integrated type and “source-reservoir” adjacent type. Among them, Chang 8₂² belongs to Class I sweet spot area, Chang 8₂¹ belongs to Class III sweet spot area, Chang 8₁² belongs to Class I sweet spot area, Chang 8₁¹ belongs to Class III sweet spot area, and the northern Yuchahua 18 area of Chang 7₂ is a Class I sweet spot area, while the Yuchahua 50 well area is a Class III sweet spot area.

Keywords: Chang 7 and Chang 8 tight oil, accumulation mechanism, Ordos Basin.

Linqi Zeng¹ ✉, Haotian Song², Xinxiu Jin³, Lihui Cheng⁴, Zhihong Wang⁵, Shangfang Gao⁵, Liangliang Li⁶

¹ The University of Sydney, Business School, Darlington, Australia;

² School of Automation, Xi'an Jiaotong University, Xi'an, China;

³ No.2 Oil Production Plant of PetroChina Changqing Oil Field Company Ltd., Qingyang, China;

⁴ No.4 Oil Production Plant of PetroChina Changqing Oil Field Company Ltd., Jingbian, China;

⁵ Beijing Zhonghai Wobang Energy Investment Co. Ltd., Beijing, China;

⁶ No.3 Gas Production Plant of PetroChina Changqing Oil Field Company Ltd., Wushenqi, China.

laizhongqcylf8@126.com

Factors Analysis of Affecting Reservoir Fracture Expansion in the Aspect of Revelation of Chemical Kinetics Mechanism Based on Artificial Intelligence

The present study aims to explore the influence of rheological parameters of fracturing fluid and reservoir material parameters on the law of fracture expansion in unconventional reservoirs. A fluid-solid coupling model has been constructed, utilising artificial intelligence technology, with the aim of analysing the coupling behaviour between water-based fracturing fluid and reservoir rock in low-permeability reservoirs. Concurrently, the cracking criterion and rock damage criterion of brittle materials such as low-permeability rocks are established to analyse the influence of different factors on the law of reservoir fracture expansion. Finally, molecular dynamics and microscopic analysis of chemical fluids reveal the expansion mechanism of water-based fracturing fluid on reservoir fractures. The outcomes demonstrate that the rheological parameters of water-based fracturing fluid exhibit remarkable enhancement of reservoir fractures, predominantly attributable to the markedly minimal fracturing fluid filtration under elevated viscosity. While the effect of reservoir temperature on fracturing fluid viscosity is negligible, the formation of a 65m fracture at 180°C does suggest a positive correlation between reservoir temperature and fracture expansion. Furthermore, it is evident that reservoir pressure and elastic modulus also exert an influence on the crack expansion law of water-based fracturing fluid, a phenomenon that can be elucidated by molecular dynamics and rock mechanics. This study provides a foundation for the application of artificial intelligence in the transformation of water-based fracturing fluids within reservoirs.

Keywords: *enhanced oil recovery, reservoir transformation, artificial intelligence, water-based fracturing, low permeability reservoir.*

Jian Sun^{1,2}✉, Long Ren^{1,2}, Yong Ai³, Le Qu¹, Kang Tang⁴, Zhe Zhang¹

¹ College of Petroleum Engineering, Xi'an Shiyou University, Xi'an, Shanxi, China;

² Engineering Research Center of Development and Management for Low to Ultra-Low Permeability Oil & Gas Reservoirs in West China, Ministry of Education, China;

³ Research Institute of Exploration and Development, Tarim Oilfield Company, Petro China, Korla, China;

⁴ Changqing Oilfield Company of PetroChina, Xi'an, China.

dizhan17726@163.com

Machine Learning Based Fracturing Capacity Prediction Study for Horizontal Wells in Oilfields

Tight oil and gas resources occupy a considerable proportion in China's petroleum resource reserves, and the dense lithology and poor physical properties of tight reservoir reservoirs determine that the exploitation of tight reservoirs becomes very difficult. Large volume fracturing technology is the core technology for the successful development of tight reservoirs, which aims to improve the inflow capacity of the reservoir and expand the drainage area, and has been widely used in the field. There are many factors affecting the production capacity of wells after fracturing, which makes it difficult to predict the production capacity of volumetric fracturing wells. Therefore In this paper, based on the horizontal well capacity prediction model of machine learning, BP neural network and support vector machine are used to predict the capacity of three decreasing stages, and by comparing with the data generated by the seepage mathematical model of volumetrically fractured horizontal wells, the root-mean-square error (RMSE) and the coefficient of determination (R²) are computed, and the improved method combining the two algorithmic models, i.e., the combined prediction model, is proposed. The results show that it is better than the single prediction model of BP neural network and support vector machine in terms of prediction accuracy and stability.

Using the established combined prediction model method to give two examples of the application of volume fracturing horizontal well production prediction in tight oil reservoirs. The method of optimal design of fracturing parameters for volumetric fracturing horizontal wells is established, and combined with the actual data of a horizontal well in a tight oil reservoir, the optimal design of fracturing parameters is carried out for the completed well to be fractured M well.

Keywords: *tight reservoirs, horizontal well fracturing, machine learning, production capacity prediction.*

Xudong Zhang^{1,2}, Zhou Jun^{1,2}, Haoyu Sun³, Jinfu Li⁴, Zhili Chen⁴, Xiangwei Kong⁵ ✉

¹ State Key Laboratory of Shale Oil and Gas Enrichment Mechanisms and Effective Development, Sinopec, China;

² Sinopec Research Institute of Petroleum Engineering Co., Ltd, China;

³ SINOPEC CORP.Co.Ltd.North China Branch, China;

⁴ Drilling Technology Research Institute of Shengli Petroleum Engineering Co., LTD, China;

⁵ School of petroleum engineering, Yangtze University, China.

76922591@qq.co

Bedding Plane Effect and Pulsation Regulation Mechanism of Fracture Propagation in Shale Gas Reservoirs

Faced with the complex problem of fracture initiation and propagation in shale gas reservoirs caused by developed bedding planes, geomechanically parameter heterogeneity, and natural fracture anisotropy, existing commercial software and models fail to accurately describe fracture propagation laws due to insufficient consideration of bedding planes and reservoir anisotropy. Based on the lithological characteristics of shale, a mathematical model integrating wellbore pressure wave amplitude, reservoir perforation flow distribution friction, and pressure wave time-lag response constraints was established. By introducing a dynamic correction formula for perforation friction coefficients, the influence of proppant erosion on perforation flow coefficients was quantified. Taking a shale gas well (total depth 6530 m, horizontal section length 2130 m) as a case study, the evolution characteristics of fracture propagation volume under different pulse frequencies were simulated by integrating field fracturing parameters (displacement 11–18 m³/min, pulse frequency 0.001–0.7 Hz). The results show that there is a nonlinear correlation between pulse frequency and fracture propagation efficiency: the growth rate of fracture propagation volume is the highest at medium frequencies (0.3–0.5 Hz); excessively high frequencies (0.7 Hz) slow down the efficiency due to stress interference effects; and low frequencies (≤ 0.02 Hz) limit fracture extension due to insufficient stress disturbance.

Keywords: *shale gas reservoirs, pulse frequency, fracture propagation, fracturing monitoring*1 introduction.

Hongqiao Yan ✉, Wencai Liu

CNPC Research Institute of Safety & Environment Technology, Beijing, China.

yanhongqiao@cnpc.com.cn

Research on Energy Consumption Optimization Model for Compressor Units in Oil and gas processing facility

With the increasing global focus on energy efficiency and environmental protection, the energy consumption of compressor units has gradually become a research hotspot. This study integrates process simulation with machine learning optimization to establish a simulation model of the Fan 6 station compressor unit utilizing Aspen software. The model's reliability is rigorously validated through comparative analysis with field-collected operational data. Based on 1000 sets of simulation data, machine learning methods are employed to optimize and analyze the energy consumption of the compressor unit, establishing an energy consumption optimization model for the compressor unit. This achieves a global optimal energy consumption analysis under different operating conditions, establishing both theoretical foundations and actionable operational guidelines for energy consumption optimization of compressor units at various stations.

Keywords: compressor unit, simulation; energy consumption optimization, machine learning.

Fengxia Li¹, Zhengku Wang¹ ✉, Jianian Xu¹, Hongli Liu¹, Jiyin Zhang²

¹ School of Petroleum Engineering, Chongqing University of Science and Technology, Chong Qing, China;

² PetroChina Southwest Oil and Gas Field Branch Engineering Technology Research Institute, Deyang, China.

453192322@qq.com

Research on Composition and Performance Evaluation

of Environmentally Friendly Vegetable Gum Drilling Fluid system

The main treating agent of the vegetable gum drilling fluid system is preferred and evaluated on account of its good performance. Based on the laboratory orthogonal experimental research, it is confirmed that the composition of vegetable gum drilling fluid include: water + 3% bentonite + 0.6% soda ash + 0.4% ZWJ-B (vegetable gum, natural polymer coating agent) + 1-1.5% ZWJ-J (vegetable gum, natural polymer filtrate reducer) + 2-3% HX-KYG (high temperature stabilizer, filtrate reducer) + 0.2% XC-T (high temperature protective agent, viscosifier) + 2% SWH-F (inhibitor, formation sealing and anti-caving agent) + 2% SWH-R + 3-4% polyethylene glycol + barite + 15% weigh3 (deoxidant, water soluble weighting agent). It is indicated from laboratory performance evaluation that: the shale recovery rate of the vegetable gum drilling fluid system is up to 96.76% with low core expansion rate, good inhibition performance, 9mL high temperature and pressure water loss, 1mm mud cake, 0.05 mud cake friction coefficient, and lowest friction coefficient of different fluids and friction surfaces, at the same time the oil layer protection effect is better than other water-based drilling fluids and the temperature resistance up to 180°C. The evaluation results show that the vegetable gum drilling fluid system EC50 is greater than 30000 mg/L, which meets the national marine I level emission standards. And it is non-stimulating to the eyes and skin, non-toxic, and easily biodegradable.

Keywords: vegetable gum, treating agent, drilling fluid, performance evaluation.

**Zhanglong Tan^{1,2}, Junwen Lin^{1,2}, Zhaobing Hao³, Fan Yang^{1,2}, Lei Feng^{1,2}, Peng Wang^{1,2},
Qi Yang^{1,2}, Wenjie Shen^{1,2}, Laiao Ren⁴ ✉, Yuxin Chen⁴**

¹ China United Coalbed Methane Co. Ltd., Beijing, China;

² Technology Innovation Center of Coal Measure Gas Co-production, Taiyuan, China;

³ Engineering & Technology Company, China National Offshore Oil Corporation, Tianjin, China;

⁴ College of Safety and Ocean Engineering, China University of Petroleum, Beijing, China.

2023211015@student.cup.edu.cn

Numerical Investigation of Cement Sheath Interface Integrity during Hydraulic Fracturing of Coalbed Methane Well

The issue of cement sheath sealing failure hinders the development of coalbed methane (CBM). The direct cause of cement sheath sealing failure is damage at the cement sheath interface, but the specific failure modes remain unclear and require targeted research. This study establishes a casing-cement sheath-formation assembly model for CBM wells and uses numerical simulation methods to investigate the effects of wellbore pressure changes during actual fracturing operations on the assembly. The stress-strain distribution on the wellbore wall and cement sheath bonding interface, as well as the displacement distribution of the casing-cement sheath-formation assembly during fracturing, are analyzed. Combined with the simulation results of interface integrity, the failure characteristics of the cement sheath bonding interface in CBM wells are identified. The redistribution of stress states in the casing-cement sheath-formation assembly caused by wellbore pressure changes, along with the combined effects of operational pressure and in-situ stress, leads to elliptical deformation of the casing. During fracturing, the strain in the assembly is minimal, and the bonding interface is damaged due to internal stress changes in the assembly. After the pressure testing phase, large-scale failure occurs in the casing-cement sheath interface outside the maximum principal stress direction and in the cement sheath-formation interface outside the minimum principal stress direction. The failure mode of the bonding interface is shear failure. The research results contribute to understanding the failure modes of the cement sheath bonding interface in CBM wells and provide guidance for optimizing cement sheath parameters.

Keywords: coalbed methane well, hydraulic fracturing, cement sheath interface, integrity, numerical simulation.

Xuan Chen¹✉, Haiyue Yu¹, Xiongfei Xu¹, Jun Wei², Xuwei Zheng³, Bo Su⁴, Hao Qu⁵, Chuang Li⁶

¹ Exploration and Development Research Institute of China Petroleum Tuha Oilfield Company, Hami City, Xinjiang Uygur Autonomous Region, China;

² No. 7 Oil Production Plant of PetroChina Changqing Oilfield Branch, Qingyang, Gansu, China;

³ Gas Field Development Division of PetroChina Qinghai Oilfield Company, Gansu, China;

⁴ Downhole Operation Company of PetroChina Qinghai Oilfield Company, Qinghai China;

⁵ Liaohe Engineering Technology Branch of Liaohe Petroleum Exploration Co., Ltd, Liaoning, China;

⁶ Yumen Petroleum Chad Co. Ltd Succursale of Yumen Oilfield of China National Petroleum Corporation, Gansu Province, China.

prxi0@163.com

Analysis of Reservoir Physical Properties and Emulsification Law of Crude Oil

China is rich in unconventional oil and gas resources, and the Jimushar Depression in the eastern uplift of Junggar Basin has a large longitudinal span and a wide planar distribution, with abundant shale oil resources, and the large-scale development has been carried out in a comprehensive manner. The shale oil in the Jimushar Depression has the characteristics of overall consistency and poor fluidity, etc. At present, the reasons for the emulsification of crude oil and the influencing factors have not been clarified, which greatly affects the extraction of crude oil. In this paper, the interaction between crude oil and formation water is simulated by different conditions such as water content, mineralisation, water quality, guanidine gel concentration, alkali concentration, etc. The causes of crude oil

emulsification and the influencing factors of emulsion stability in M horizontal wells are investigated, so as to provide a basis for the smooth extraction of shale oil. The results show that the lower the water content of crude oil is, the stronger the stability of emulsion is, and the mineralisation degree plays a key role in the emulsification of crude oil. Under the condition of the same guanidinium gel concentration, the higher the guanidinium gel concentration, the more unfavourable to the crude oil emulsification; when the guanidinium gel concentration is 0.2% or less, the crude oil has good emulsification and stability; when the guanidinium gel concentration is 0.3%, the crude oil breaks the emulsion quickly; the concentration of 0.2% sodium hydroxide solution has strong emulsion breakage for the emulsion, and the strong alkali is unsuitable for the on-site application.

Keywords: *reservoir physical properties, crude oil emulsification, mineralisation, guanidine gum concentration, alkali concentration.*

Yan Yan✉, **Shangyu Yang**, **Lihong Han**, **Caihong Lu**

State Key Laboratory of Oil and Gas Equipment, CNPC Tubular Goods Research Institute, Xi'an, China.

yansanbao302@163.com

The Impact of Carbon Dioxide Fluid Environments on the Integrity of Cement Sheath and Bonding Interfaces of a Wellbore

With the growing adoption of CCUS-EOR (Carbon Capture, Utilization, and Storage-Enhanced Oil Recovery) projects, wellbore integrity under CO₂ exposure has become a critical concern. High-temperature, high-pressure (HTHP) conditions exacerbate CO₂-induced corrosion, threatening cement sheath and casing integrity, potentially leading to leakage and environmental hazards. This study investigates CO₂ corrosion effects on two cement systems (conventional and hollow-particle-modified) and three casing materials (Q125, 3Cr, 13Cr). Static corrosion experiments were conducted at 80-120°C and CO₂ partial pressures of 15-30 MPa (50-100% concentration) for 28 days. Phase composition and microstructure were analyzed via XRD and SEM, while interface integrity was evaluated pre- and post-corrosion. Cement Systems: Both systems formed similar hydration products (e.g., calcium silicate hydrates), but System #2 (with hollow particles) exhibited additional SiO₂ and C₅S₂CO₃ phases, enhancing high-temperature stability. Post-corrosion, SiO₂ dominated as the primary product, with CaCO₃ transitioning from calcite (≤90°C) to aragonite (>110°C). System #2 showed denser microstructures and reduced porosity, indicating superior corrosion resistance. After corrosion, Q125 and 3Cr interfaces exhibited cement loosening and micro-pores, while 13Cr interfaces remained intact. System #2 paired with 13Cr casing demonstrated minimal degradation, highlighting optimal sealing integrity. The hollow-particle-modified cement (System #2) improves corrosion resistance, particularly when combined with 13Cr casing. These findings provide critical insights for designing durable wellbore systems in CCUS-EOR applications, mitigating leakage risks under HTHP CO₂ environments.

Keywords: *CO₂ corrosion, cement sheath integrity, casing-cement interface, microstructure, cement slurry system.*

Cankun Wang¹, **Xuegang Wang**², **Yulong An**³, **Jiwei Wu**², **Bo Zhang**⁴✉, **Jun Zhao**⁴,

Yilin Li², **Wenzhe Li**⁴, **Liang Zhao**², **Hualin Liao**⁵✉

¹ Engineering Technology Department of Xinjiang Oilfield Company PetroChina, Karamay, Xinjiang, China;

² Production Technology Research Institute, PetroChina Xinjiang Oilfield Company, Karamay, Xinjiang, China;

³ Exploration Utility Department, PetroChina Xinjiang Oil field Company PetroChina, Karamay, Xinjiang, China;

⁴ School of Mechanical and Electrical Engineering, Beijing University of Chemical Technology, Beijing, China;

⁵ School of Petroleum Engineering, China University of Petroleum (East China), Qingdao, Shandong, China.

zhangboup@126.com, liaohualin2003@upc.edu.cn

Explaining the Sustained Annular Pressure in High Pressure Ultra-Deep Gas Well with Tie-Back Casing through Numerical Simulation

Sustained annular pressure in the tieback casing annulus of ultra-deep gas wells significantly affects the long-term safe and stable production of the well. Based on the actual case of sustained annular pressure in the tieback casing annulus, this study analyzes the pressure variations in the wellbore caused by changes in the wellbore fluid density. A finite element numerical model was established to examine the distribution patterns of micro-annuli, and a mathematical quantitative relationship between micro-annuli and the combined permeability of the cement sheath was developed. The study also investigates the variation in gas leakage rate with changes in cement sheath permeability. The results show that wellbore pressure variations and the effective stress within the micro-annuli are the primary causes of cement sheath seal integrity failure. The micro-annuli leads to a significant increase in the permeability of the cement sheath, which in turn allows high-pressure gas to leak to the wellhead, resulting in sustained annular pressure. This study provides a theoretical basis for the control of seal integrity in the tieback casing of ultra-deep gas wells.

Keywords: ultra-deep gas well, tie-back casing, cement integrity, micro annulus distribution, gas leakage rate.

Cao Yi^{1,2,3}, Zhong Jinpan^{1,2}✉, Yan Ruifeng⁴, Zhu Yangwen^{1,2}, Chen Junbin³

¹ State Key Laboratory of Shale Oil and Gas Enrichment Mechanisms and Effective Development, Beijing, China;

² Research and Development Center for the Sustainable Development of Continental Sandstone Mature Oilfield by National Energy Administration, Beijing, China;

³ Key Laboratory of Shaanxi Province for Well Stability and Fluid and Rock Mechanics in Oil and Gas Reservoirs, Xi'an Shiyou University, Xi'an, Shaanxi, China;

⁴ PetroChina Changqing Oilfield Company New Energy Business Division, Xi'an, Shaanxi, China.

cao_yi_666@163.com

Numerical Simulation Study on CO₂ Injection to Enhance Oil Recovery in Tight Reservoirs

The oil recovery of Lianchi tight oil reservoir Da'an Zhai section was lowly and development was difficult, then carried out the numerical simulation study of CO₂ injection in Lianchi tight oil reservoir. Established the CO₂ development numerical model of Lianchi oilfield (double pore model and compositional model) through combined the reservoir characteristics of Lianchi oilfield and fluid properties. Respectively predicted the increasing oil effect of three injection-production methods with displacement mode, CO₂ huff and puff, cyclic huff and puff mode. Evaluated the development effect on the basis of CO₂ oil draining rate and the increment of oil recovery. The results showed that, the development effect of cyclic huff and puff mode was best in three kinds of gas injection modes, the best time of well shut in was 3 months, the injection-production cycle of CO₂ cyclic huff and puff was 4 years. At the same time, the optimal scheme of the gas injection was determined through comparative research, which provided the technical reference for the development of Lianchi oilfield for injection CO₂.

Keywords: tight oil reservoir, injection CO₂, experimental fitting, numerical simulation, oil draining rate, scheme optimization.

Xiang Dai¹, Long You², Xiaopeng Bai³✉, Li Wang¹, Menglu Zhang², Junqiang Song², Ting Li², Hong Pan², Chuixian Kong², Dongsheng Yao², Shihong Li², Guanxing Luo², Wenying Wu²

¹ Research Institute of Exploration and Development, Xinjiang Oilfield Company, PetroChina, Karamay, China;

² Development Department, Xinjiang Oilfield Company, PetroChina, Karamay, China;

³ State Key Laboratory for Geomechanics and Deep Underground Engineering, China University of Mining and Technology (Beijing), Beijing, China.

xiaohengchinapetro@163.com

Optimizing Development Strategies for Low-Porosity Fractured-Block Reservoirs

This study comprehensively analyzes and evaluates the development scheme of Bai 802 well fractured-block Carboniferous reservoir in Nine Area of Karamay Oilfield. The reservoir is located in the northwestern edge of Junggar Basin, and is a fractured-block reservoir with dual fracture-porosity media under tectonic control. The study begins with a detailed description of the geological characteristics of the reservoir, including stratigraphy, tectonics, reservoir properties, and fluid properties. Based on the special situation of the reservoir, the development program adopted horizontal well volume fracturing technology to increase the recoverable reserves and oil recovery efficiency of the reservoir. The longitudinal span of the reservoir and the type of reservoir space were considered in the program design, and reasonable well spacing and horizontal section length were determined. Through comprehensive well test method, analogy method and economic limit production capacity method, single well production capacity was predicted, and 20 horizontal wells were deployed as a whole to achieve a new production capacity of $10.8 \cdot 10^4$ tons. The review stated that the scheme design is reasonable and aligns with the actual reservoir, and also offered suggestions to further optimize the well spacing and improve the degree of well control. This study offers important references and lessons for effectively developing similar low porosity and extra low permeability reservoirs.

Keywords: reservoir development, horizontal wells, volumetric fracturing, Karamay oil.

Yantao Xu^{1,2}, Bumin Guo^{1,2}, Xuxing Wang^{1,2}, Wen Zhang^{1,2}, Bing Han³, Xiuxing Zhu³, Shiyong Shi⁴✉

¹ China Oilfield Services Limited, Tianjin, China;

² Tianjin Key Enterprises Laboratory of Offshore Oil Reserves Exploitation, Tianjin, China;

³ College of Pipeline and Civil Engineering, China University of Petroleum (East China), Qingdao, China;

⁴ Key Laboratory of Mechanics in Fluid Solid Coupling Systems, Institute of Mechanics, Chinese Academy of Sciences, Beijing, China.

shishiyong@imech.ac.cn

A Perforation Density Optimization Method for Limited-Entry Fracturing

Considering Injection-Production Fluid Balance

Fracturing stimulation serves as a vital technique for enhancing unconventional reservoir development, where limited-entry fracturing (LEF) plays a critical role in achieving uniform cluster activation. However, uneven fluid

distribution among clusters often leads to limited effective fractures and imbalanced production profiles, severely compromising reservoir productivity. To address these challenges, this study proposes an optimization method for perforation density in LEF, aiming to improve injection-production balance along horizontal wellbores. A coupled flow model integrating fracturing fluid injection and production phases is established, incorporating reservoir heterogeneity and perforation erosion effects. Field case analysis reveals that conventional uniform perforation schemes preferentially allocate fracturing fluid to heel-end clusters, causing localized over-fracturing while leaving toe-end clusters under-stimulated. Perforation erosion significantly enlarges hole diameter and discharge coefficients, reduces perforation friction, and exacerbates uneven fluid distribution and fracture propagation. To achieve injection-production balance, the equivalent perforation diameter should progressively increase from heel to toe. Under fixed hole diameters, this necessitates variable perforation density. After optimization using the proposed method, the coefficient of variation (CV) of fracturing fluid injection rates along horizontal wellbores decreases from 19.45% to 4.27%, while the CV of production fluid rates across stages reduces from 22.6% to 7.53%, demonstrating method effectiveness. This study provides theoretical guidance for designing perforation schemes in limited-entry fracturing operations.

Keywords: perforation density, wellbore flow model, limited flow fracturing, injection production balance, unconventional well.

Zhongfei Liu^{1,2,3,4}, Zhengqing Ai^{1,2,3,4}, Zhi Zhang^{1,2,3,4}, Ning Li^{1,2,3,4},

Xiuxing Zhu⁵✉, Jie Liang^{1,2,3,4}, Zhongyuan Tang^{1,2,3,4}

¹ Petrochina Tarim Oilfield Company, Korla, China;

² R&D Center for Ultra Deep Complex Reservoir Exploration and Development, CNPC, Korla, China;

³ Engineering Research Center for Ultra-Deep Complex Reservoir Exploration and Development, Xinjiang Uygur Autonomous Region, Korla, China;

⁴ Xinjiang Key Laboratory of Ultra-Deep Oil and Gas, Korla, China;

⁵ College of Pipeline and Civil Engineering, China University of Petroleum (East China), Qingdao, China.

zhuxx99@upc.edu.cn

Pressure Surge Analysis During Tripping-in of Drill string

Based on Fluid-Structure Interaction

During drilling operations, the tripping-in process of the drill string can easily induce pressure surges, leading to transient pressure fluctuations in the wellbore. These fluctuations may exceed the formation fracture pressure, potentially causing mud loss or wellbore instability. To investigate the characteristics of pressure surges during tripping-in, this study establishes a fluid-structure interaction (FSI) coupling model that integrates drill string vibration with pressure wave propagation in the wellbore. First, considering the initial stress of the drill string, a finite element model for drill string dynamics is developed and solved numerically using the central difference method. Second, transient water hammer pressure models are established for the drill pipe interior, annulus, and open-hole section (without drill pipe), which are solved using the method of characteristics (MOC). The dynamic interaction between drill string vibration and wellbore fluid pressure is realized through the FSI interface at the bottom of the drill string, thereby simulating pressure surge effects during tripping-in. Numerical results indicate that: The pressure surge amplitude increases significantly with well depth, primarily due to the increased

compliance of the drill string and compressibility of drilling fluid at greater depths. In deviated wells, drill string vibration is suppressed by friction between the drill string and wellbore wall, leading to reduced pressure surges with higher inclination angles. Pressure surges intensify with higher tripping speeds due to stronger fluid disturbances. The findings provide a theoretical basis for optimizing tripping speeds and assessing pressure surge impacts, offering crucial engineering significance for preventing downhole pressure control failures.

Keywords: fluid-structure interaction, tripping-in, pressure surge, finite element method.

Tao Li, Xueru Hu, Wenjing Chu, Kerong Yang, Zhongjian Du, Hualian Zhang ✉

Exploration Division of Yumen Oilfield Branch of China National Petroleum Corporation, Jiuquan City, Gansu, China.

kxhualian@163.com

Analysis and Evaluation of the Benefit of Single-well Production

Increase Measures in the Late Development

Yinger Depression Block A is rich in reserves, due to this type of reservoir is dense, low permeability, belongs to low permeability tight oil reservoir type, and the original formation energy in the study area is insufficient, the production decay is fast in the actual development process, and the degree of recovery is low, the development effect of the field is significantly improved by using water injection and throughput, but the mechanism of water injection and throughput to increase the production is still not clear, so the study of the mechanism of the role of the various factors in increasing production capacity is important for the guidance of the development of the oil field. Therefore, it is of great significance to study the mechanism of various factors to increase production capacity to guide oilfield development. In this paper, we take the long 2 reservoir in Yinger Depression Area A as the research object, and through indoor water injection and throughput experiments in the tight reservoir, we reveal the influence of the main controlling factors on the effect of water injection and throughput and the effect of production increase. The results show that the study area has low natural energy, strong non-homogeneity and weak hydrophilicity, and the adoption of water injection and throughput technology to drive oil can effectively achieve a higher recovery rate. The basic physical properties and wettability of the reservoir in the study area are the key factors affecting the production effect of water injection and throughput. The injection volume and the injection rate mainly affect the degree of formation energy recovery and thus the reach of the injected water; the time of well curing and the recovery rate mainly affect the degree of seepage and absorption of the injected water. The cycle injection volume has the greatest influence on the throughput effect, followed by the injection rate and well curing time, and the recovery rate has the least influence on the throughput effect.

Keywords: Yinger Depression, tight oil reservoir, water injection and throughput, production increase measures, effect evaluation.

Mingwei Ren^{1,2} ✉, **Rui Qiu³**, **Yunbo Chen¹**, **Kewei Gao²**, **Qinglin Cao³**

¹ Beijing National Innovation Institute of Lightweight Ltd., Beijing, China;

² School of Materials Science and Engineering, University of Science and Technology Beijing, Beijing, China;

³ School of Mechanical Engineering Jiangsu University of Technology, Changzhou, China.

Structure Design and Performance Analysis of Battery Pack Cover

Composed of Fiber-Steel Laminates for new energy vehicles

Alternative energy sources are becoming increasingly important and in some cases are replacing traditional types of fuel. Therefore, any questions regarding the creation and operation of vehicles using alternative energy sources are of significant interest. The battery pack is the most important element for the efficient operation of modern electric vehicles. The improvement of the battery pack top cover for new energy vehicles provided a cost-effective way to produce lightweight vehicle components with high performance. To produce a lightweight, high-performance battery pack top cover for new energy vehicles, glass fiber-steel plate laminated composite was selected, and the structures of composites and battery pack top cover were designed. Further, static strength and modal characteristics of the top cover were analyzed using a HyperWorks software. On the basis of structural design and numerical simulation, a top cover was trial-produced by a PCM molding process, and its performances were tested. Results indicated that using a structural composite composed of a layer of DP590 high-strength steel plate and 3 layers of glass fiber prepreg, the top cover presented a maximum deformation of 0.001-3.58 mm, and a maximum stress of 0.44-96.66 MPa, less than the required values (5 mm, 480 MPa) under extreme working conditions. The first six orders of intrinsic frequencies were in the range of 35.25-67.94 Hz, greater than the required frequency of 30 Hz. Even with a weight reduction of 39.7%, the produced top cover showed a tensile strength and bending strength of 566, 901 MPa, respectively, much greater than the required values. The results verified the feasibility of producing battery pack top cover efficiently through materials selection, structural design and simulation on the basis of targeting performances.

Keywords: structural design, simulation, performance analysis, glass fiber-steel laminate, battery pack cover.