

Chemistry and Technology of Fuels and Oils

1 (641) '2024

Head Editor

B. P. Tumanyan – Dr. Eng. Sci., prof.

Editorial Board

I. A. Arutyunov – Dr. Eng. Sci., prof.

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.

Publisher— ICST «TUMA Group» LLC

Редактор

В. С. Дмитриева

Ответственный секретарь

О. В. Любименко

Графика и верстка

В. В. Земсков

Подготовка материалов

С. О. Бороздин,

А. Д. Остудин,

В. Ю. Попова

Адрес редакции:

105318, г. Москва,

Измайловское шоссе, д. 20-1Н

e-mail: httm@list.ru

Материалы авторов не возвращаются.

Редакция не несет ответственности

за достоверность информации

в материалах, в том числе

рекламных, предоставленных

авторами для публикации.

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

Contents

CHEMICAL ENGINEERING AND EQUIPMENT

- I. R. Vezirov, U. R. Vezirov, E. G. Telyashev, R. R. Vezirov, R. N. Salakhov.* Analysis of the Operation of a Two-Stage Hydro-Ejector Vacuum-Generating System, Determination of its Optimal Technological Parameters 3

CHEMOTOTOLOGY

- Yu. M. Pimenov, A. V. Ulit'ko.* Problems and Methods of Decision Making Forfuels and Lubricants Use in Equipment 7

RESEARCH

- A. F. Sattarova, D. N. Gordeev, S. N. Ubaizoda, I. M. Sahautdinov, M. Yu. Ovchinnikov, Yu. N. Biglova, I. A. Mustafin, A. F. Akhmetov.* Kinetic Parameters of Synthesis of a Fullerene Derivative Containing Diterpene Fragment 14

- I. N. Kulyashova, A. D. Badikova, A. R. Muzafarova, S.R. Sahibgareev.* Investigation of the Possibility of Obtaining a Lignosulfonate Reagent Based on Complex Compounds to Regulate the Parameters of the Drilling Mud 20

- I. N. Kulyashova, A. D. Badikova, A.I. Voloshin, S.R. Sahibgareev.* Studies of Surface and Adsorption Activity of Modified Lignosulfonate Reagent for Regulation of Drilling Mud Parameters 26

- Ph. M. Kalmykov, A. F. Shakirov, K. G. Kichatov, T. R. Prosochkina.* The Analysis of the Effect Of Structural Characteristics of Polyethylene Terephthalate and Its Recycled Products on the Technological Parameters of Filament Production 31

- I. I. Gumerov, A. K. Ivlev, K. G. Kichatov, T. R. Prosochkina.* The Development of a Digital Twin of the Extruder f or Low-Density Polyethylene Filament Production 38

- A. K. Gabitov, T. R. Prosochkina, K. G. Kichatov.* Forecasting Properties of Polyethylene Terephthalate and Its Carbon Nanotube Composites 43

REVIEWS

- V. V. Ignatev, R. Muller, S. G. Pasyukov, A. M. Petunin, K. A. Bardina.* Classification of Methods for the Synthesis of Polyhydroxylated Fullerenes. Part I 50

INNOVATIVE TECHNOLOGIES OF OIL AND GAS

- Lin Zhang, Changqing Zhang, Zhigang Yao, Jie Shen, Changwu Han, Xiaoliang Zhao, Yi Pan.* Copolymer Grafted Nano Silica Particles for Enhanced Oil Recovery from Low-Permeability Reservoirs 57

- Yuan Bai, Yunjie Shu, Hailong Dang, Yanshu Yun, Xingping Tu, Liang Zhang, Tao Gao, Ming Zhang, Xiaoliang Zhao, Shuangchun Yang,* A Review on the Application of Numerical Simulation of Oil Shale Electrical Heating Technology 63

- Zhaozhou Wang, Zhe Zhang, Yujian Liu, Bing Wei, Xiaohai Lin.* Experimental Study on Porosity & Permeability Characteristics of Typical Tight Oil Reservoirs 71

- Maoxian Pu.* Experimental Study on Logging Evaluation of Matrix Mineral Modulus of Tight Sandstone Reservoir 76

- Lihua Shi, Tuo Chen, Yunjie Shu, Hailong Dang, Changbing Tong, Pengxing Cui, Diaodiao Shi, Min Wang, Xiaoliang Zhao, Shuangchun Yang.* Simulation Study of the Effect of Fractures on Convective Heating Efficiency in Oil Shale 80

- Zhongbin Ye, Tianyu Liu, Bao Xiao, Xiaokang Xian, Nanjun Lai.* Preparation of Polyacrylamide Konjac Gum Double Network Gel Liquid Bridge Plug 89

<i>Jie Bai, Qi Feng, Gang Yang, Xiaoxi Ai, Siyuan Cheng, Yi Pan, Yuxin Lu, Zhengwang Zhao, Min Jia, Ziyuan Li.</i> Research Progress of Friendly Carbon Dioxide Expansion Flooding: a Review	93
<i>Weiwei Jiao, Yang Huang, Haijie Zhang, Ye Zhang, Difei Zhao, Lei Wen, Ping Guo, Jiaming Zhang.</i> Characteristics of Typical Shale Reservoir Development and Its Gas-Bearing Influencing Factors	100
<i>Yingwei Di, HuanWang, Yunfei Feng.</i> Sedimentary Components Responsibilities on the Holocene	109
<i>Jin Chai, Ruifei Wang, Sen Zheng.</i> Effect of Primary Production, Dilution and Preservation on Organic Matter Accumulation for the Lower Cambrian Shale	116
<i>Yanchao Li, Jianguo Shen, Junxiang Li, Zhe Zhang.</i> Experimental Study on Temporary Plugging and Unblocking Performance of Water-Soluble Preformed Gel for Specific Shale Reservoirs	120
<i>Wei Huang, Kaituo Zhang, Rui Liu, Shengli Wang, Shenshen Deng, Hewen Zhu, Yutong Pang.</i> Microgravity Anomaly Extraction Technique Based on the MSSF and Its Application to the Identification of Reservoir Fluid Dynamic Changess	127
<i>Li Yuan, Song Jiaxuan, Diao Yuwei, Li Jinyuan, Zhang Yaqin, Zhengwang Zhao, Min Jia, Ziyuan Li.</i> Characterization of the Coarse-Crystalline Dolomite	135
<i>Zhang Lei, Li Chenguang, Yang Hongping, Yu Haipeng, Zhu Hongtao, Bai Yang.</i> Relationship between Electricity and Renewable Energy Sources in an Aspect at "Carbon Neutrality"	142
<i>Manfei Chen, Wenhao Tang, Li Wang, Xianda Sun, Nong Li, Jie Tan, Wenjin Zhang.</i> Tracer Research Methods for Hydrocarbon Substances in Shale Oil Reservoirs	146
<i>Chao Fu, Jin Yang, Shujie Liu, Mengjie Lu, Ming Luo, Chuanhua Ma, Yanhui Wu, Jiwen Liang, Xiao Li.</i> Analysis of the Application of Horizontal Well Technology in the Development of Offshore Natural Gas Hydrate	152
<i>Shenghong Chen, Yanxin Lv, Xiaoyu Fang, Jinsong Zuo, Haibo Li, Chao Yuan, Weiji Liu.</i> Thermal-Induced Fault Weakening and Fluid Pressurization during Fluid Injection	158
<i>Sun Whenzhen, Liu Xuwei, Xiong Shengchun, Dong Qinghao, Liu Guozhong, Su Heying.</i> Study on the Plugging Mechanism of Carbon Dioxide Oil Drive in Shale	167

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

Уфимский государственный нефтяной технический университет

ivezirov@yandex.ru

Анализ работы двухступенчатой гидроэжекторной вакуумсоздающей системы, определение ее оптимальных технологических параметров

В статье рассмотрены особенности работы гидроэжекторных вакуумсоздающих систем. Описана схема двухступенчатой гидроэжекторной вакуумсоздающей системы, приведён алгоритм расчета.

Проведен анализ зависимости выхода компонентов парогазовой смеси от температуры рабочей жидкости, определена необходимая температура нагрева рабочей жидкости. Произведен расчет двухступенчатой гидроэжекторной вакуумсоздающей системы, определена зависимость расхода рабочей жидкости от давления и потребляемой мощности насосов.

Ключевые слова: парогазовая смесь, гидроэжекторная вакуумсоздающая система, остаточное давление, подпитка, рабочая жидкость.

DOI: 10.32935/0023-1169-2024-641-1-3-6

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

Ufa State Petroleum Technological University

Analysis of the Operation of a Two-Stage Hydro-Ejector Vacuum-Generating System, Determination of its Optimal Technological Parameters

The article considers the features of the operation of hydro-ejector vacuum-generating systems. The diagram of a two-stage hydro-ejector vacuum-generating system is described, and a calculation algorithm is given. The dependence of the yield of the components of the vapour-gas mixture on the temperature of the working fluid was analyzed, and the required heating temperature of the working fluid was determined. A calculation of a two-stage hydraulic ejector vacuum-creating system was made, and the dependence of the flow rate of the working fluid on the pressure and power consumption of the pumps was determined.

Key words: vapour-gas mixture, two-stage hydro-ejector vacuum-generating system, residual pressure, recharge, working fluid.

Ю. М. Пименов, А. В. Улитко

ФАУ «25 ГосНИИ химмотологии Минобороны России»

25gosniihim@mil.ru

Проблемы и методы принятия решений на применение горюче-смазочных материалов в технике

Дана краткая характеристика проблем, связанных с повышением объективности принятия технических решений на применение горюче-смазочных материалов (ГСМ) в технике. Проанализированы возможности теории принятия решений в аспекте применения ГСМ. Предложены и апробированы два метода принятия решений на базе интегральных критериев и оценки склонности ГСМ к превращениям в технике и на количественных оценках показателей эксплуатационных свойств. На примере моторных топлив

и гидравлических жидкостей рассмотрены результаты апробации методов и моделей принятия решений на применение ГСМ.

Ключевые слова: принятие решений, горюче-смазочные материалы, эксплуатационные свойства техники, интегральные критерии.

DOI: 10.32935/0023-1169-2024-641-1-7-13

Yu. M. Pimenov, A. V. Ulit'ko.

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

Problems and Methods of Decision Making Forfuels

and Lubricants Use in Equipment

Applied problems that restrain the enhancing of decision making objectiveness of fuels and lubricants use in equipment are shortly characterized. Several possibilities as to the theory of decision making application for the decision making of fuels and lubricants use in equipment are analyzed. Two methods are introduced and explained to make rational decisions based on integral evaluation criterions as well as on quantitative estimates of properties indicators of fuels and lubricants propensity for transformations in equipment. In addition some simple illustrations of implementation of new methods with regards to diesel fuels and hydraulic fluids are provided.

Key words: *decision making, fuels and lubricants, equipment, performance property, integral evaluation.*

*A. Ф. Саттарова^{1,2}, Д. Н. Гордеев¹, С. Н. Убайзода¹, И. М. Сахаутдинов², М. Ю. Овчинников²,
Ю. Н. Биглова¹, И. А. Мустафин³, А. Ф. Ахметов³*

¹Уфимский университет науки и технологий,

²Институт органической химии, Уфимский научный центр РАН,

³Уфимский государственный нефтяной технический университет

brux1995@mail.ru

Кинетические параметры синтеза производного фуллерена, содержащего дитерпеновый фрагмент

В статье представлены результаты кинетического исследования синтеза нового производного фуллерена, содержащего дитерпеновый фрагмент, полученные с помощью метода высокоэффективной жидкостной хроматографии и последующего математического моделирования. Определены кинетические и активационные параметры циклопропанирования фуллерена по методике Бингеля, предложен механизм реакции. Выявлены оптимальные условия синтеза: предпочтительно использование небольшого избытка хлорсодержащего агента циклопропанирования и проведение реакции при комнатной температуре.

Ключевые слова: фуллерен C₆₀, производные фуллерена, реакция Бингеля,

дитерпеноиды, метиловый эфир малеопимаровой кислоты

DOI: 10.32935/0023-1169-2024-641-1-14-19

*A. F. Sattarova^{1,2}, D. N. Gordeev¹, S. N. Ubaizoda¹, I. M. Sahautdinov², M. Yu. Ovchinnikov²,
Yu. N. Biglova¹, I. A. Mustafin³, A. F. Akhmetov³.*

¹Ufa University of Science and Technology,

²Institute of Organic Chemistry, Ufa Scientific Center RAS,

³Ufa State Petroleum Technological University

Kinetic Parameters of Synthesis of a Fullerene Derivative Containing Diterpene Fragment

The article presents the results of a kinetic study of the synthesis of a new fullerene derivative containing a diterpene fragment, obtained using the HPLC method and subsequent mathematical modeling. The kinetic and activation parameters of fullerene cyclopropanation by the Bingel method were determined, and the reaction mechanism was proposed. Optimal synthesis conditions were found: it is preferable to use a small excess of a chlorine-containing cyclopropanation agent and carry out the reaction at room temperature.

Key words: *bfullerene C₆₀, fullerene derivatives, Bingel phenomena, diterpenoids, maleopimaric acid methyl ester.*

I. N. Куляшова¹, А. Д. Бадикова¹, А. И. Волошин^{2,3}, С. Р. Сахибгареев¹

¹Уфимский государственный нефтяной технический университет,

²ООО «РН-БашНИПИнефть», г. Уфа,

³Уфимский институт химии, Уфимский научный центр РАН,

irina-0472@yandex.ru

Исследование возможности получения лигносульфонатного реагента на основе комплексных соединений для регулирования параметров бурового раствора

Исследована возможность получения реагента для регулирования параметров бурового раствора на основе комплексных соединений путем введения комплексообразующих катионов Fe (II) в состав лигносульфоната натрия с последующим дополнительным модифицированием фосфоновыми соединениями и получение полиэлектролитного комплекса на основе анионного полиэлектролита-лигносульфоната натрия и модифицированного катионного крахмала. Методом ИК-спектроскопии установлено наличие функциональных групп исследуемого лигносульфоната натрия способных к комплексообразованию. Определены оптимальные соотношения исходных компонентов для получения комплексных соединений на основе лигносульфоната, сульфата железа и фосфоновых соединений. С целью изучения структуры макромолекулы лигносульфоната натрия и полиэлектролитного комплекса на основе лигносульфоната натрия и катионного крахмала исследовано распределением частиц по размерам. Путем подбора мольных соотношений анионных и катионных составляющих получен полиэлектролитный комплекс с применением метода импедансной спектрометрии. Исследована возможность применения полученного лигносульфонатного реагента на основе комплексных соединений в качестве реагента для регулирования параметров буровой промывочной жидкости в диапазоне температур от 20 до 180°C.

Ключевые слова: лигносульфонат натрия, модифицированный лигносульфонатный реагент, полиэлектролит, метод импедансометрии, полиэлектролитный комплекс, понизитель фильтрации, буровой раствор.

DOI: 10.32935/0023-1169-2024-641-1-20-25

I. N. Kulyashova¹, A. D. Badikova¹, A. R. Muzafarova², S.R. Sahibgariev¹.

¹Ufa State Petroleum Technical University

²LLC "RN-BashNIPIneft", Ufa

³Institute of Chemistry, Ufa Scientific Center RAS

Investigation of the Possibility of Obtaining a Lignosulfonate Reagent Based on Complex Compounds to Regulate the Parameters of the Drilling Mud

Investigation of the possibility of obtaining a reagent for regulating the parameters of drilling mud based on complex compounds by introducing complex-forming Fe (II) cations into the composition of sodium lignosulfonate, followed by additional modification with phosphonic compounds and obtaining a polyelectrolyte complex based on anionic polyelectrolyte-sodium lignosulfonate and modified cationic starch. The presence of functional groups of the studied sodium lignosulfonate capable of complexation was established by IR spectrometry. The determination of the optimal ratios of the initial components for the production of complex compounds based on lignosulfonate, iron sulfate and phosphonic compounds was carried out. Studies of the surface activity of experimental samples were carried out by the stalagmometric method (the method of counting drops). In order to study changes in the structure of a macromolecule of sodium lignosulfonate and a polyelectrolyte complex based on sodium lignosulfonate and cationic starch, the particle size distribution method was investigated. Obtaining a stable polyelectrolyte complex, by selecting the molar ratios of anionic and cationic components, consisted in measuring the dependence of the impedance of an electrochemical cell on the frequency of alternating current. The possibility of using the obtained lignosulfonate reagent based on complex compounds as a reagent for regulating the parameters of the drilling fluid at temperatures from 20 to 160–180°C.

Key words: *sodium lignosulfonate, modified lignosulfonate reagent, polyelectrolyte, impedance measurement method, polyelectrolyte complex, filtration reducing agent, drilling mud.*

И. Н. Куляшова, А. Д. Бадикова, А. Р. Музафарова, С. Р. Сахибгареев

Уфимский государственный нефтяной технический университет

irina-0472@yandex.ru

Исследования поверхностной и адсорбционной активности модифицированного лигносульфонатного реагента для регулирования параметров бурового раствора

Рассмотрена возможность получения модифицированного лигносульфонатного реагента на основе акриловой и лигносульфонатной составляющих. Для изучения действия электролитов на поверхностную активность комплексного реагента на основе акриловой и лигносульфонатной составляющих определяли значения поверхностного натяжения водных растворов неорганических солей NaCl и CaCl₂ различной концентрации при введении от 0,1 до 2% реагента. Оценка адсорбционной активности проведена на основе построения изотермы поверхностного натяжения на границе жидкость/жидкость в статических условиях во времени при постоянной концентрации реагента. Установлена способность модифицированного лигносульфонатного реагента эффективно снижать показатель условной вязкости глинистого бурового раствора при температуре от 20 до 180°C.

Ключевые слова: акриламид, лимонная кислота, синтезированный модификатор, лигносульфонат натрия, модифицированный лигносульфонатный реагент, буровой раствор.

DOI: 10.32935/0023-1169-2024-641-1-26-30

I. N. Kulyashova, A. D. Badikova, A. R. Muzafarova, S.R. Sahibgarееv.

Ufa State Petroleum Technological University

Studies of Surface and Adsorption Activity of Modified Lignosulfonate Reagent for Regulation of Drilling Mud Parameters

The possibility of obtaining a modified lignosulfonate reagent based on acrylic and lignosulfonate components is considered. To study the effect of electrolytes on the surface activity of a complex reagent based on acrylic and lignosulfonate components, the surface tension of aqueous solutions of inorganic salts of NaCl and CaCl₂ of different concentrations was determined with the introduction of 0.1 to 2% of the reagent. The assessment of adsorption activity was carried out on the basis of constructing an isotherm of surface tension at the liquid-liquid interface under static conditions in time at a constant concentration of the reagent. The possibility of a modified lignosulfonate reagent to effectively reduce the conditional viscosity of clay drilling mud in the temperature range from 20 to 180°C has been established.

Key words: *scitric acid, synthesized modifier, sodium lignosulfonate, modified lignosulfonate reagent, drilling mud.*

Ф. М. Калмыков, А. Ф. Шакиров, К. Г. Кичатов, Т. Р. Просочкина

Уфимский государственный нефтяной технический университет

Kichatov_k@mail.ru

Влияние структурных характеристик полиэтилентерефталата и вторичных продуктов его производства на технологические параметры получения филамента

Для образцов полиэтилентерефталата с вовлечением вторичного полиэтилентерефталата (продукт Vivilen) и отходов его производства методами дифференциальной сканирующей калориметрии и рентгено-структурного анализа проанализированы температуры фазовых переходов и определено соотношение кристаллической и аморфной фаз. Исследованные образцы полиэтилентерефталата ранжированы по значениям температуры стеклования и плавления, что позволило соотнести образцы по степени кристалличности. Для получения филамента на основе пылевидных отходов процесса твердофазной поликонденсации обоснован температурный режим экструзии и получены образцы филаментов для 3D печати.

Ключевые слова: полиэтилентерефталат, филамент, 3D-печать, дифференциально сканирующая калориметрия, экструзия, рентгено-структурный анализ.

DOI: 10.32935/0023-1169-2024-641-1-31-37

Ph. M. Kalmykov, A. F. Shakirov, K. G. Kichatov, T. R. Prosochkina.

Ufa State Petroleum Technological University

The Analysis of the Effect Of Structural Characteristics of Polyethylene Terephthalate and Its Recycled Products on the Technological Parameters of Filament Production

The temperatures of phase transitions were analyzed and the ratio of crystalline and amorphous phases was determined for polyethylene terephthalate samples involving secondary PET (Vivilen product) and its wastes by methods of differential scanning calorimetry and X-ray structural analysis. The studied polyethylene terephthalate samples were ranked according to their glass transition and melting temperatures, which made it possible to correlate the samples according to the degree of crystallinity. To obtain filament on the basis of dust-like wastes of the solid-phase polycondensation process, the extrusion temperature conditions were justified and filament samples for 3D printing were obtained.

Key words: *polyethylene terephthalate, filament, 3D printing, differential scanning calorimetry, extrusion, X-ray structural analysis.*

И. И. Гумеров, А. К. Ивлев, К. Г. Кичатов, Т. Р. Просочкина

Уфимский государственный нефтяной технический университет

Kichatov_k@mail.ru

Разработка цифрового двойника экструдера для получения филамента из полиэтилена низкой плотности

На основании экспериментально определенных характеристик полиэтилена низкой плотности с применением геометрических размеров деталей экструдера и использовании программного обеспечения COMSOL MULTIPHYSICS создана цифровая модель аппарата и выполнен гидродинамический расчет скорости истечения расплава полимера из сопла экструдера. Совпадение экспериментально измеренной скорости истечения полимера с вычисленной с применением модели находится в пределах допустимой погрешности, что свидетельствует об адекватности модели цифрового двойника, которая будет использоваться для прогнозирования вязкостных свойств композиционных материалов на основе полиэтилена низкой плотности и технологических режимов их получения blendingом в экструдере.

Ключевые слова: *экструдер, цифровая модель, COMSOL Multiphysics, филамент, показатель текучести расплава, метод конечных элементов, вычислительная гидродинамика, цифровой двойник.*

DOI: 10.32935/0023-1169-2024-641-1-38-42

I. I. Gumerov, A. K. Ivlev, K. G. Kichatov, T. R. Prosochkina.

Ufa State Petroleum Technological University

The Development of a Digital Twin of the Extruder for Low-Density Polyethylene Filament Production

On the basis of experimentally determined characteristics of low-density polyethylene, geometric dimensions of extruder parts and using COMSOL MULTIPHYSICS software, a digital model of the apparatus was created and hydrodynamic calculation of the polymer melt flow velocity from the extruder nozzle was performed. The agreement of the experimentally measured polymer melt flow velocity with the one calculated using the model is within the acceptable tolerance. This indicates the adequacy of the digital twin model, which can be used to predict the viscosity properties of composite materials based on low-density polyethylene and process conditions of their production by extruder blending.

Key words: *extruder, digital model, COMSOL Multiphysics, filament, melting flow rate, finite element method, computational fluid dynamics, digital twin.*

А. К. Габитов, Т. Р. Просочкина, К. Г. Кичатов

Уфимский государственный нефтяной технический университет,

kichatov_k@mail.ru

Прогнозирование свойств полиэтилентерефталата и композитов

с углеродными нанотрубками на его основе

Выполнено молекулярно-динамическое моделирование полимера – полиэтилентерефталата – и композиционных материалов на его основе с различными одностенными углеродными нанотрубками в качестве наполнителя. Исследовано влияние надмолекулярной структуры на некоторые физико-химические и механические свойства полимерного композиционного материала. Выявлено, что величина межфазного межмолекулярного взаимодействия системы полимерная матрица – наполнитель является основным определяющим фактором, оказывающим влияние на физико-химические и механические свойства, следовательно, именно ее необходимо учитывать в первую очередь при прогнозировании свойств подобных материалов.

Ключевые слова: полиэтилентерефталат, углеродная нанотрубка, молекулярная динамика, межмолекулярные взаимодействия, модуль Юнга.

DOI: 10.32935/0023-1169-2024-641-1-43-49

A. K. Gabitov, T. R. Prosochkina, K. G. Kichatov.

Ufa State Petroleum Technological University

Forecasting Properties of Polyethylene Terephthalate and Its Carbon Nanotube Composites

Molecular dynamic modeling of polymer – polyethylene terephthalate and composite materials based on it with different single-walled carbon nanotubes as filler has been performed. The influence of supramolecular structure on some physicochemical and mechanical properties of polymer composite material has been investigated. It was found that the value of interphase intermolecular interaction of the system "polymer matrix – filler" is the main determining factor influencing the physicochemical and mechanical properties, therefore, it is necessary to consider it mainly when predicting the properties of such materials.

Key words: polyethylene terephthalate, carbon nanotube, molecular dynamics, intermolecular interactions, Young's modulus.

B. B. Игнатьев¹, P. Мюллер¹, С. Г. Пасынков¹, А. М. Петунин¹, К. А. Бардина²

¹ООО «Научно-технологический центр «ЭПИКТЕХ», г. Москва,

²РГУ нефти и газа (НИУ) имени И. М. Губкина»

info@epictechnology.ru

Классификация методов синтеза полигидроксилированных фуллеренов.

Часть 1 — Одностадийные процессы

Выполнен анализ существующих методов синтеза полигидроксилированных фуллеренов с применением прямого химического взаимодействия, а также альтернативных способов создания, с целью выявления оптимальных методик получения, для их реализации в различных технологических и биомедицинских областях. Обобщена и классифицирована научная литература данной сферы исследований с предоставлением сравнительной оценки эффективности и возможности практической реализации

разработанных методов синтеза на основании всестороннего рассмотрения литературной и патентной информации.

Ключевые слова: фуллерен, полигидроксилированный фуллерен, фуллеренол, методы синтеза.

DOI: 10.32935/0023-1169-2024-641-1-50-56

V. V. Ignatev¹, R. Muller¹, S. G. Pasyukov¹, A. M. Petunin¹, K. A. Bardina².

¹ "EPICTECH" LLC

² Gubkin University

Classification of Methods for the Synthesis of Polyhydroxylated Fullerenes.

Part I

A complete analysis of the existing methods of synthesis of polyhydroxylated fullerenes using direct chemical interaction, as well as alternative methods of creation, in order to identify the optimal methods of production, for their implementation in various technological and biomedical fields is performed. The scientific literature of this field of research is summarized and classified, providing a comparative assessment of the efficiency and feasibility of practical implementation of the developed synthesis methods based on a comprehensive review of the data presented in the chemical literature.

Key words: fullerene, polyhydroxylated fullerene, fullereneol, synthesis methods.

Lin Zhang¹, Changqing Zhang^{2,3}, Zhigang Yao⁴, Jie Shen¹, Changwu Han¹, Xiaoliang Zhao⁵*, Yi Pan²

¹ Sulige Gas Field Branch of China Petroleum Corporation West Drilling Engineering Company, Ordos, China; ² Department of Petroleum and Natural Gas Engineering College, Liaoning Petrochemical University, Fushun, China; ³ Inner Mongolia West Natural Gas Pipeline Operation Co. Ltd, Ordos, China; ⁴ West Drilling Geological Research Institute, Karamay, China; ⁵ China University of Petroleum (Beijing), State Key Laboratory of Petroleum Resources and Prospecting, Beijing, China.

sdzhaoxl@163.com

Copolymer Grafted Nano Silica Particles for Enhanced Oil Recovery from Low-Permeability Reservoirs

Because of their small particle size, excellent stability, high temperature tolerance, and salt tolerance, polymer nanoparticles are attracting a lot of attention in low-permeability reservoirs. In this study, SiO₂, acrylamide (AM), and 2-acrylamido-2-methylpropanesulfonic acid (AMPS) were used to synthesize novel copolymer-grafted nano-silica particles (HPGN). HPGN's overall performance in low-permeability reservoirs was evaluated. The results demonstrate that the viscosity of a 2000 mg/L HPGN solution at 50 °C is 75.8 mPa·s, with high stability under high temperature, high salt, and shear conditions. More notably, the displacement experiment proved that under the condition of 18450 mg/L, a 2000 mg/L HPGN solution enhanced the recovery rate by 21.89%. This research indicates that HPGN has great applicability potential in low-permeability reservoirs with high temperatures and salinities.

Keywords: enhanced oil recovery; copolymer grafted nano silica particles; nano-silica; low-permeability reservoirs; polymer flooding.

*Yuan Bai*¹, *Yunjie Shu*², *Hailong Dang*¹, *Yanshu Yun*³, *Xingping Tu*¹, *Liang Zhang*¹, *Tao Gao*¹,
*Ming Zhang*¹, *Xiaoliang Zhao*⁴*, *Shuangchun Yang*²

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

² College of Oil and Gas Engineering, Liaoning Petrochemical University, Fushun, Liaoning, China;

³ Yan'an vocational & technical college, Yan'an, Shaanxi, China;

⁴ China University of Petroleum, State Key Laboratory of Petroleum Resources and Prospecting, Beijing, China.

shiyou_nengyuan@163.com

A Review on the Application of Numerical Simulation of Oil Shale Electrical Heating Technology

Oil shale is an unconventional energy source with abundant reserves. However, the global oil shale resources have not been fully exploited. In-situ oil shale extraction technology based on electric heating has gradually become a research focus in this field. In this study, the construction of a numerical simulation model for the in-situ extraction of oil shale by electric heating and the results of the numerical simulation study are summarized. By summarizing the research progress and current status of numerical simulation of electrically heated in-situ oil shale extraction, the core issues, main challenges, progress made, and bottlenecks to be solved in the current numerical simulation research are analyzed.

Keywords: *oil shale, electric heating, shale oil upgrading, pyrolysis, numerical simulation.*

Zhaozhou Wang^{1,2}, *Zhe Zhang*¹*, *Yujian Liu*^{1,2}, *Bing Wei*², *Xiaohai Lin*²

¹ School of Electrical Engineering and Information, Southwest Petroleum University, Chengdu, China;

² Anton Petroleum Technology (Group) Co., Ltd., Beijing, China.

zhangbao5121@126.com

Experimental Study on Porosity & Permeability Characteristics of Typical Tight Oil Reservoirs

Tight oil has become one of the important energy sources for increasing reserves and production in China's oil and gas field. Chang 8 Member of Ordos Basin shows great exploration potential, and the classification and evaluation of tight reservoirs are critical to reservoir optimization and reserve evaluation. However, the classification and evaluation of tight reservoirs in Chang 8 Member of Ordos Basin have not been unified. Therefore, on the basis of previous research results, this paper systematically studied the petrological characteristics, physical properties and microscopic pore throat structure characteristics of tight sandstone reservoirs by means of rock slice observation, overburden porosity and permeability test and high-pressure mercury injection test. On this basis, the weight coefficient of the correlation between the key parameters and the oil-bearing property of the reservoir is determined by screening the key parameters, and the mathematical model of reservoir classification evaluation is established by using the analytic hierarchy process. The research results show that the reservoir composition maturity of Chang 8 Member in Ordos basin is medium, and the lithology is mainly lithic arkose and feldspathic lithic sandstone. The physical property of Chang 8 reservoir is poor, and it belongs to low porosity, low permeability - ultra-low permeability reservoir as a whole. The reservoir space is dominated by intergranular pores and dissolution pores, and micro fractures are developed locally. The pore throat structure of the reservoir is fine, and the pore type is smaller than 10 μm , and the throat and micro throat are dominant with 0.2 μm . Considering porosity, permeability,

displacement pressure, average pore throat radius and other parameters comprehensively, normalize each parameter, and determine the weight of each parameter according to its correlation with oil saturation. The reservoir classification and evaluation model were established by using the analytic hierarchy process (AHP), and the reservoir quality index (RMI) is used to classify the reservoirs of Chang 8 Member in Ordos Basin into 4 types. This study can provide a basis for efficient exploration and development of tight oil.

Keywords: *tight oil reservoir, reservoir evaluation, analytic hierarchy process.*

Maoxian Pu

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

pangde11125@163.com

Experimental Study on Logging Evaluation of Matrix Mineral Modulus of Tight Sandstone Reservoir

Porosity has an important influence on the elastic properties of tight sandstone. Using acoustic models to study the matrix mineral modulus of tight sandstone reservoirs can provide an important reference for tight sandstone reservoir evaluation. In this paper, taking tight sandstone as an example, starting from the microscopic pore scale and considering the heterogeneity of the rock skeleton, the effect of the effective stress coefficient of porosity (n) on the elastic properties of tight sandstone was discussed. In addition, the acoustic model was used to construct the calculation method of the matrix mineral shear modulus. The research results showed that the porosity disturbance model can better describe the change law of the elastic properties of the tight sandstone. As the value of n decreases from 1 to 0, the bulk modulus (K_j) of the unencapsulated rock gradually decreases. In the process of increasing from $n=0$ to $n=4$, the rock K_{ud} has a slight increase trend. The fluid pressure does not produce a reverse stress effect on the movement of the rock pore boundary, that is, the fluid pressure does not have any effect on the change of the rock porosity. When $n>0$, the pore fluid pressure will affect the movement of the rock pore boundary to a certain extent. When the porosity disturbance is not considered, the K_j value of the formation rock will be overestimated. The K_o of tight sandstone can be obtained using Gassmann fluid substitution equation. The calculation results of modulus parameters accord with the internal mineral composition and structural characteristics of tight sandstone, which shows the effectiveness of the method.

Keywords: *porosity, bulk modulus, shear modulus, tight sandstone, well logging evaluation.*

Lihua Shi¹, Tuo Chen², Yunjie Shu³, Hailong Dang¹, Changbing Tong⁴, Pengxing Cui¹,

Diaodiao Shi¹, Min Wang¹, Xiaoliang Zhao^{5,6}*, Shuangchun Yang³

¹ Research Institution of Shanxi Yanchang Petroleum (Group) Company Ltd., Xi'an, Shanxi, China;

² Hilong Petroleum Industries Group Ltd., No. 1825 Luodong Road, Baoshan District, Shanghai, China;

³ College of Oil and Gas Engineering, Liaoning Petrochemical University, Fushun, Liaoning, China;

⁴ Baota Oil Production of Yanchang Oil Field Company Ltd., Yan'an, Shanxi, China;

⁵ China University of Petroleum (Beijing), State Key Laboratory of Petroleum Resources and Prospecting, Beijing, China;

⁶ School of Petroleum and Natural Gas Engineering, Liaoning Petrochemical University, Fushun, Liaoning, China.

hiyou_nengyuan@163.com

Simulation Study of the Effect of Fractures on Convective Heating Efficiency in Oil Shale

Oil shale, as an unconventional energy source, has attracted much attention in countries worldwide. The traditional way of extracting oil shale from the open pit is not only costly but also polluting to the environment. Sufficient understanding of the relationship between subsurface fractures and temperature fields is important for the extraction of oil shale and is of great significance for the actual in-situ extraction of oil shale. The study of fracture initiation and expansion in oil shale formations is based on the effect of fractures on convective heating efficiency in oil shale in situ conversion technology. In view of the objective situation that hydraulic fracturing can enhance the rate of the permeability and heating efficiency of oil shale formations, and hence the oil yield, the effect of single fractures with different fracture heights (2 mm, 4 mm, 8 mm) on the temperature field of oil shale; and the effect of multiple fractures (two, three and four fractures) on the temperature field of oil shale are investigated under convective heating methods.

Keywords: *oil shale, convective heating, fracturing, numerical simulation.*

Zhongbin Ye*, Tianyu Liu, Bao Xiao, Xiaokang Xian, Nanjun Lai

School of Chemistry and Chemical Engineering, Southwest Petroleum University, Chengdu, China.

729783570@qq.com

Preparation of Polyacrylamide Konjac Gum Double Network Gel Liquid Bridge Plug

Synthesized a kind of polyacrylamide konjac gum double network gel system, and studied the possibility of replacing mechanical bridge plug with this system. Studied the effects of covalent bond cross-linking, ionic bond cross-linking and monomer ratio on the mechanical properties of gel, including the stress-strain curve, elastic modulus, critical stretch and fracture energy. And conducted indoor simulation wellbore sealing experiments. The results show that the double network gel has higher strength than the single network gel, and the plugging ability of the well bore is greatly improved, which is expected to replace the mechanical bridge plug in construction.

Keywords: *polyacrylamide, konjac gum, double network gel, bridge plug.*

Jie Bai¹, Qi Feng^{1*}, Gang Yang², Xiaoxi Ai¹, Siyuan Cheng¹, Yi Pan¹, Yuxin Lu³

¹ Liaoning Petrochemical University, Liaoning Fushun, China;

² Greatwall Well Drilling Company, Sludge Department of China National Petroleum Corporation, Liaoning Panjin, China;

³ Yuxi Minyou Environmental Technology Co.,Ltd, Yunnan Yuxi, China.

fengqi086@126.com

Research Progress of Friendly Carbon Dioxide Expansion Flooding: a Review

CO₂ expansion flooding technology has the potential to significantly enhance oil recovery in low permeability and ultra-low permeability reservoirs, while also facilitating carbon capture, utilization, and storage (CCUS) to a certain extent. This paper provides a comprehensive review of the mechanism of CO₂ expansion flooding, the current

research status of two main methods - self-generated expansion with viscosity reduction and gas injection expansion with viscosity reduction - as well as advancements in simulation studies on expansion flooding. Currently, achieving optimal CO₂ flooding conditions remains challenging due to limited availability of large-scale gas sources and concerns regarding equipment pipeline corrosion during transportation. Finally, this environmentally friendly CO₂ flooding technology is summarized and its future prospects are discussed.

Keywords: CO₂, expansion flooding, environmentally friendly, viscosity reduction, summarize.

**Weiwei Jiao^{1*}, Yang Huang¹, Haijie Zhang², Ye Zhang³,
Difei Zhao⁴, Lei Wen¹, Ping Guo¹, Jiaming Zhang⁵**

¹ School of Architecture and Engineering, Chongqing Industry Polytechnic College, Chongqing China;

² Chongqing Shale Gas Exploration and Development Co., Ltd, Chongqing, China;

³ Chongqing Institute of Geology and Mineral Resources, Chongqing, China;

⁴ Artificial Intelligence Research Institute, China University of Mining and Technology, Xuzhou, China;

⁵ School of Resources and Geosciences, China University of Mining and Technology, Xuzhou, China.

jiaoweiw-210@163.com

Characteristics of Typical Shale Reservoir Development and Its Gas-Bearing Influencing Factors

The Longmaxi Formation in the Sichuan Basin is a hotspot formation for shale gas exploration. In this paper, taking the Longmaxi Formation shale in Yuxi area as an example, a large number of TOC tests, X-diffraction whole-rock mineral fraction tests, electron microscope observations, physical properties, gas content, and CT scanning experiments were carried out, which in turn analyzed the characteristics of the shale gas reservoir and the factors influencing the gas content. The results of the study show that there are seven types of shale facies developed in Yuxi area, which are organic-rich siliceous shale facies (I), organic-rich carbonate-siliceous shale facies (II), organic-rich clayey shale facies (III), organic-poor clayey shale facies (IV), organic-poor carbonate-siliceous shale facies (V), organic-poor siliceous shale facies (VI), and organic-poor siliceous-carbonate shale facies (VII). The microstructural characteristics of the shale reflect that it was disturbed by multiple environmental factors at the time of deposition, and the sources of brittle minerals include both terrestrial clasts and biogenic siliciclastics. The bottom 30 m shale of Longmaxi Formation has good physical properties and gas content, which is a high-quality target section for shale gas exploration and development. TOC, R_o, permeability, quartz content and clay mineral content all have a significant effect on shale gas content and are important control factors for shale gas content.

Keywords: Longmaxi Formation, shale gas, physical properties, gas content, influencing factors.

Yingwei Di, HuanWang, Yunfei Feng*

Department of Resource Management, Tangshan Normal University, Tangshan, China.

lifenghgqbc1@126.com

Sedimentary Components Responsibilities on the Holocene

Heihai Lake, a freshwater lake in the area of the East Kunlun Mountains is an accurate monitor of climate-driven hydrological and environmental changes during the past 2000 yr BP. In order to reconstruct the environment in the

north Tibetan Plateau, we studied the multi-proxy records from Heihai lake sediments. Major analyses comprise mineral composition (XRD), morphology of minerals (ATEM), geochemical data (XRF), Ostracoda analysis and chronological framework based on AMS¹⁴C data. Climate was cold and dry since 1972 yr.BP of the Holocene, which was mainly physical weathering and with a weak chemical weathering. The sedimentary discontinuity happened during 1352 yr.BP and 352 yr.BP, is seen as the size of the lake shrink, which is in consistent with the extremely low temperature and dry climate conditions during the global Glacier Time. From the study, we can conclude that the climate of Tibetan plateau was unstable during the last 2000 years, and extremely cold and dry event happened on Tibetan plateau during the warmer Holocene in China.

Keywords: Holocene sedimentary profile, Heihai Lake, environmental information, Tibetan plateau.

Jin Chai, Ruifei Wang*, Sen Zheng

Xi'an Shiyou University, China.

wruifei@163.com

Effect of Primary Production, Dilution and Preservation on Organic Matter Accumulation for the Lower Cambrian Shale

In order to investigate the influence of primary production, dilution and preservation on organic matter accumulation, geochemical data and geochemical proxies of primary production, clastic influx and redox conditions were presented from the Cambrian Niutitang Formation organic-rich shales. The primary production proxies (TOC, Mo, P, Ba and Bario) and redox proxies (Ni/Co, V/Cr, U/Al and Th/U) suggest that the black organic-rich shales of the Niutitang Formation are deposited in anoxic/euxinic condition with high primary production. The pyrite of the Niutitang Formation is composed of spherical framboids, indicating that the anoxic bottom water could not prevail before organic matter degradation during the Niutitang Formation deposition. High primary production enhances organic carbon flux into chemocline layer and bottom water, leading to the anoxic bottom water from oxygen consumption by microorganisms and organic matter degradation. The anoxic bottom water in turn is beneficial to preservation of organic matter. In addition, Ti/Al ratios correlate well with TOC contents through the Niutitang Formation, indicating that clastic inputs enhance the burial rate for preventing organic matter from degradation during Niutitang Formation deposition. Therefore, the accumulation of organic matter in the Niutitang Formation is mainly influenced by primary production rather than the redox conditions in bottom water.

Keywords: primary production, dilution, preservation, organic matter accumulation.

Yanchao Li¹, Jianguo Shen¹, Junxiang Li¹, Zhe Zhang^{2*}

¹ Chuanqing Drilling Engineering Company Limited, Chengdu, China;

² School of Electrical Engineering and Information, Southwest Petroleum University, Chengdu, China.

zhangyiqcwan881@163.com

Experimental Study on Temporary Plugging and Unblocking Performance of Water-Soluble Preformed Gel for Specific Shale Reservoirs

Shale gas reservoirs usually have well-developed fractures and joints, and the fracturing development process is prone to forming complex fracture networks near the wellbore, which is not conducive to the effective migration and

efficient development of shale gas. The development of temporary plugging agents related to shale fracturing reservoir transformation is a key technology to solve this problem in the shale gas development process. Therefore, a water-soluble preformed gel temporary plugging agent was developed, and its expansion/swelling characteristics and temporary plugging performance were analyzed through experiments. At the same time, experimental evaluation was conducted on its unblocking performance. Research has found that although there are differences in the swelling rate of temporary plugging agents at different stages, they gradually increase during plugging operations. The volume of the temporary plugging agent expanded nearly 8.24 times throughout the entire experimental process. In addition, temporary plugging agents can temporarily seal micro fractures and rapidly expand hydraulic fractures, thereby significantly improving shale gas recovery rate. The shale gas recovery rate when temporary plugging agents are used in fracturing operations is about 12.3% higher than when temporary plugging agents are not used. In addition, the increase in working fluid temperature and the concentration of surfactants will mostly stimulate the activity of water molecules, thereby stimulating the hydrolysis of temporary blocking agents in microcracks. Taking into account the development cost and efficiency, it is reasonable to control the temperature of the working fluid and the concentration of surfactant during the unblocking process after the fracturing operation between 110-140°C and 0.75 g/m³, respectively. In order to provide technical support and design basis for the efficient development of shale gas through this study.

Keywords: *Weiyuan block, shale gas, temporary plugging agent, unblocking performance, gel.*

Wei Huang¹, Kaituo Zhang¹, Rui Liu¹, Shengli Wang¹, Shenshen Deng^{2*}, Hewen Zhu², Yutong Pang²

¹ Northwest Oilfield Branch of SINOPEC, Urumqi, Xinjiang, China;

² Beijing CSGG Energy Technology Co. Ltd, Beijing, China.

2358432202@qq.com

Microgravity Anomaly Extraction Technique Based on the MSSF and Its Application to the Identification of Reservoir Fluid Dynamic Changess

In order to improve the accuracy of gravity anomaly data processing, this study utilizes multi-scale surface fitting techniques (MSSF) to separate the Bouguer gravity field into residual gravity fields and regional gravity fields at different depths. By sequentially stripping away layers, the residual gravity anomalies of the target layer are obtained as the data basis for subsequent gravity interpretation. This study selects appropriate parameters and establishes different lithology forward modeling templates based on actual geological data in the study area. The method is verified to accurately separate gravity anomalies generated by different density bodies, with accurate anomaly locations, complete shapes, and clear boundaries. It can also serve as a quantitative template for rock properties and provide theoretical references for practical cases. Additionally, the method exhibits high noise resistance, resolution, and accuracy. The practical application of the method is validated through microgravity monitoring data in carbonate reservoirs in western China and time-shifted microgravity monitoring data in tight sandstone reservoirs. The results demonstrate that the obtained residual gravity anomaly data of the target layer can effectively reflect the distribution of reservoir fluids.

Keywords: *microgravity, residual gravity anomaly, abnormal separation, time-lapse microgravity, fluid monitoring.*

Li Yuan^{1*}, Song Jiakuan², Diao Yuwei³, Li Jinyuan⁴, Zhang Yaqin⁵

¹ Yanchang Gas Field Gas Production Plant No. 3, Shaanxi Yanchang Petroleum (Group) Co., Ltd., Yan'an, Shaanxi, China;

² Natural Gas Research Institute Branch, Shaanxi Yanchang Petroleum Company Limited, Xi'an, Shaanxi, China;

³ Zhongsheng Environmental Science and Technology Development Co., Ltd., Xi'an, Shaanxi, China;

⁴ Second Gas Production Plant, Changqing Oilfield Branch, Yulin, Shaanxi China;

⁵ Xi'an Alberta Analytical and Testing Technology Co., Ltd., Xi'an, Shaanxi, China.

15882022316@163.com

Characterization of the Coarse-Crystalline Dolomite

Medium-coarse-crystalline dolomite is a major variant of dolomite, and its structural heterogeneity inside and outside the crystals makes it an ideal vehicle for studies of dolomite genesis, fluid evolution and elemental migration. In this paper, the medium-coarse crystalline dolomite from the fifth section of the Majiagou Formation of the Lower Ordos Basin was systematically studied by petrographic, cathodoluminescence and related geochemical methods. The rock is developed in the context of mud powder crystal dolomite and granular dolomite, possessing significant ring band structure, fluorite and quartz intergrowth. Compared with other dolomites, it is characterized by Fe and Mn enrichment and low Na and Sr contents, as well as a negative \square Eu anomaly and a strong negative \square^{18} O offset. Combined with the evolutionary history of diagenesis, it is believed that the medium-coarse-crystal dolomite is the end product of a series of diagenetic effects such as early dolomitization-atmospheric freshwater leaching-secondary burial recrystallization-deep burial dissolution. Electron microprobe analysis reveals the structural and compositional heterogeneity inside and outside the crystals. The formation of medium-coarse-crystalline dolomite is associated with an increase in Fe-Mn content, a rise in the Mn/Sr ratio, a decrease in Sr, and a first rise and then a fall in Na concentration. This study provides a valuable reference for further research on the genesis of the medium-coarse crystalline dolomite.

Keywords: Ordos Basin, medium-coarse crystalline dolomite, recrystallization, diagenetic evolution, elemental migration.

Zhang Lei¹, Li Chenguang², Yang Hongping², Yu Haipeng³, Zhu Hongtao^{2*}, Bai Yang²

¹ State Grid Tibet Electric Power Company Limited, Lhasa, China;

² State Grid East Inner Mongolia Electric Power Supply Co., LTD, Hohhot, China;

³ Inner Mongolia Hengrui New Energy Co., LTD, Hohhot, China.

lwfbzyzht@163.com

Relationship between Electricity and Renewable Energy Sources in an Aspect at “Carbon Neutrality”

East Inner Mongolia region is rich in renewable energy and is an important power station. The aim of this study was to further enhance the development and utilization of wind power and photovoltaic in the East Inner Mongolia region, and help build a new type of power system in the region. Based on the research targets in Chifeng, Tongliao, Xing'an and Hulunbuir in the East Inner Mongolia region, Study of load characteristics, wind power and photovoltaic output characteristics and optimal ratios throughout the year, and study the scale and mode of operation of energy storage in the banner county seats. Research shows that wind power, photovoltaic monthly output during the year as a whole

shows the law of “winter big summer small, spring big winter small”, applies. Taking into account the operating costs and the average standard deviation of slow regions, the optimal ratio of wind and photovoltaic power in Chifeng should be 4.7:1, in Tongliao 4.8:1 and in Hulunbuir and Xing’an 4.4:1; Compared with the adjustment of the before energy storage method, the combined power formed by the power storage of grid is relatively gentle, with a low peak valley difference, and the overall performance of the grid side storage is better than that of the supply side storage. Therefore, research on the ratio of wind and photovoltaic power and the energy storage analysis of these regions can effectively promote the development of power and accelerate the realization of strategic goals such as “dual carbon”, as well as providing a reference for the future planning of the East Inner Mongolia region power network.

Keywords: *East Inner Mongolia Power network, wind-photovoltaic output characteristics, wind-photovoltaic ration, energy storage.*

Manfei Chen^{1,2}, Wenhao Tang^{2,3*}, Li Wang¹, Xianda Sun³, Nong Li^{1,2,4}, Jie Tan¹, Wenjin Zhang¹

¹ PetroChina Southwest Oil & Gas Field Company, Chengdu, China;

² Shale Gas Evaluation and Exploitation Key Laboratory of Sichuan Province, Chengdu, China;

³ School of Earth Science; Northeast Petroleum University, Daqing, China;

⁴ Sichuan Kelit Oil and Gas Technology Service Limited Company, Chengdu, China.

Wenhao.tang@qq.com

Tracer Research Methods for Hydrocarbon Substances in Shale Oil Reservoirs

Shale oil is currently a key area for unconventional oil and gas exploration and represents a new field to ensure national energy security. As a major contributor to unconventional oil and gas in China, Sichuan Basin has enormous potential as an oil and gas resource. The exploration of Jurassic shale oil reservoirs is in its infancy, with diverse reservoir lithology and the ability to store oil and gas. Therefore, whether the generated hydrocarbon substances in shale are still gathering in situ or have undergone short distance migration plays a guiding role in the formulation of the next oil and gas exploration and development plan. In this study, we focused on the shale oil reservoirs of Lianggaoshan Formation in northeastern Sichuan Basin. Firstly, the lithological characteristics of shale oil reservoirs, as well as the physical and geochemical characteristics of different lithological reservoirs were determined via core observations and conventional reservoir geological characteristic experiments. Secondly, Laser confocal scanning microscopy (LCSM) was used to conduct three-dimensional modeling and quantitative testing of the shale oil occurrence characteristics of different lithological reservoirs. Finally, based on the differences in the occurrence of hydrocarbons in different lithological reservoirs and the physical characteristics of rocks, hydrocarbon migration is traced. The following three insights were obtained based on the experimental results: The crude oil produced was primarily composed of light hydrocarbons. The physical properties of sandstone profiles are superior, with a higher proportion of light hydrocarbons compared to shale reservoirs. The above experimental results indicate that hydrocarbons generated in shale migrated over short distances and were enriched in adjacent sandstone and siltstone bands with relatively desirable physical properties. This study provides experimental means and data support for subsequent flowability evaluations and development plan preparation for Jurassic shale oil extraction in northeastern Sichuan.

Keywords: *Sichuan Basin, Jurassic Lianggaoshan Formation, shale oil, laser confocal scanning microscope, shale oil occurrence characteristics, shale oil migration.*

Chao Fu¹, Jin Yang¹, Shujie Liu², Mengjie Lu^{1*}, Ming Luo², Chuanhua Ma², Yanhui Wu², Jiwen Liang², Xiao Li²

¹ CNOOC China Limited, Hainan Branch, Haikou, China;

² China University of Petroleum-Beijing, Beijing, China.

943110224@qq.com

Analysis of the Application of Horizontal Well Technology in the Development of Offshore Natural Gas Hydrate

Horizontal well development of natural gas hydrate (NGH) can greatly improve gas production and make it cost-effective, which is one of the key technologies for the efficient development of NGH in the future. World widely, there is only limited experience in drilling horizontal wells into gas hydrate sediments, which lacks certain reference. In this paper, the practice of drilling horizontal wells into gas hydrate sediments, were analyzed the challenges. The challenges encountered when drilling horizontal wells into hydrate sediments were also analyzed. At least, the application of horizontal wells and complex well structure, which based on horizontal wells are analyzed. The advantages and disadvantages of several novel well structure are compared. This paper will contribute to the development of natural gas hydrate of our country.

Keywords: natural gas hydrate, horizontal well, complex structural well, application.

Shenghong Chen^{1,2*}, Yanxin Lv^{3*}, Xiaoyu Fang³, Jinsong Zuo³, Haibo Li⁴, Chao Yuan⁵, Weiji Liu⁶

¹ Sanya Institute of South China Sea Geology, Guangzhou Marine Geological Survey, Sanya, China;

² Department of Natural Resources and Planning of Hainan Province, Haikou, China;

³ Southern Marine Science and Engineering Guangdong Laboratory (Zhanjiang), Zhanjiang, China;

⁴ State Key Laboratory of Geomechanics and Geotechnical Engineering, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan, China;

⁵ Shenzhen Key Laboratory of Deep Engineering Sciences and Green Energy, College of Civil and Transportation Engineering, Shenzhen University, Shenzhen, China;

⁶ School of Mechatronic Engineering, Southwest Petroleum University, Chengdu, China.

chen123789yang@163.com

lv.yanxin@hotmail.com

Thermal-Induced Fault Weakening and Fluid Pressurization during Fluid Injection

Thermal pressurization of the trapped pore fluid is considered to be a widespread fault weakening during fluid injection in confined geological formations. Tremendous amounts of heats will be generated within the narrow shear zone during fault slip. Considering the melting of the fault gouge, the fault seal zone is adopted to construct the fluid pressurization model, thermal pressurization implemented in Comsol Multiphysics is established to illustrate the fault weaken coefficient and effective normal stress during fluid injection. The friction weakening coefficients m_T and m_F are proposed to research the performance of fault weakening during fluid injection. The results indicate that, the friction coefficients m_T and m_F both exhibit the initially decreasing and then increasing tendency, and thermal-induced fault weakening of CO₂ injection occurs earlier than that of water injection. It was found that initial pore pressure and fault sealing porosity have a negligible influence on the evolutions of friction weakening and

effective normal stress. Initial normal stress and fault sealing permeability have certain obvious influences on fault weakening during CO₂ injection. Fault thickness is the primary factor influencing the friction weakening coefficient. When the fault thickness is over 1 mm, the variation of fault weakening is totally different from that when the thickness is less than 1 mm. This investigation of friction weakening during fault slip provides an effective reference for fluid injection.

Keywords: *fault weakening, thermal pressurization, fluid injection, fault slip, CO₂ injection.*

Sun Whenzhen^{1,2,3}, **Liu Xuwei**^{2,3} *, **Xiong Shengchun**^{1,2,3}, **Dong Qinghao**^{1,2,3}, **Liu Guozhong**^{2,3}, **Su Heying**^{2,3}

¹ University of Chinese Academy of Sciences, Beijing, China;

² Institute of Porous Flow & Fluid Mechanics, Chinese Academy of Sciences, Langfang, China;

³ Research Institute of Petroleum Exploration & Development, PetroChina, Beijing, China.

15753903797@qq.com

Study on the Plugging Mechanism of Carbon Dioxide Oil Drive in Shale

The CO₂ enhanced oil recovery (EOR) technology is widely utilized in the development of shale oil reservoirs. However, reservoir plugging issues often occur during the CO₂ injection process, leading to reduced onsite development efficiency. Currently, the mechanism behind reservoir plugging is still unclear. Therefore, this research selects Jimsar crude oil from Xinjiang to conduct CO₂ displacement experiments on shale cores and analysis of crude oil components. A comparative analysis is conducted with previous studies to explore the plugging mechanism. The research results demonstrate that core plugging occurs when the displacement pressure exceeds 25 MPa, resulting in a significant decrease in core permeability. Under a displacement pressure of 40 MPa, the additional resistance accounts for as much as 72% of the total resistance, with high asphalt content and the extractive effect of CO₂ on crude oil components being important factors leading to core plugging. Therefore, in the field development process, the CO₂ enhanced oil recovery technology should be applied in a rational and tailored manner according to the properties of the field's crude oil.

Keywords: *shale reservoir, carbon dioxide flooding, reservoir blockage mechanism, carbon dioxide extraction, asphaltene deposition.*