Laboratory Technology for Oil and Gas Reservoir Development

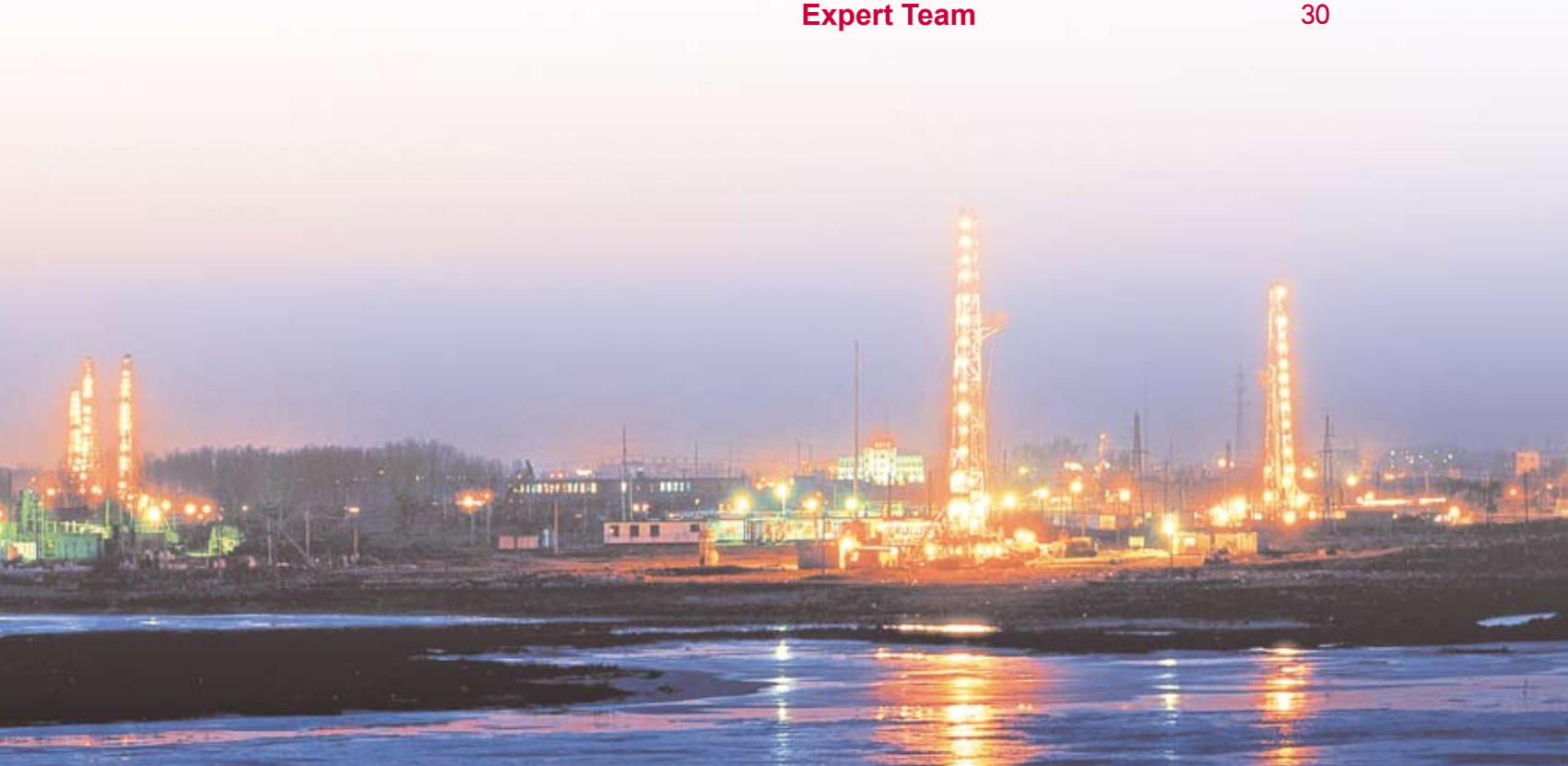
Science & Technology Management Department

2011

CHINA NATIONAL PETROLEUM CORPORATION

We wish to share the advanced experimental technologies and successful experience for the oil and gas reservoir development with the whole world!

Contents



China National Petroleum Corporation (CNPC) is a state-authorized investment agency and a state holding company. As an integrated oil company of cross-regions, cross-industries and cross-countries, it adopts modern enterprise system to realize the integration of upstream and downstream operations, internal and external trade and production and marketing. CNPC has 17 upstream companies, 33 downstream companies and 36 large-scale marketing companies. It is China's largest producer and supplier of oil and gas, and also one of the largest refined oil products and petrochemicals. In 2010 CNPC produced 105 million tons of crude oil and 72.5 billion cubic meters of natural gas, while crude processing volume reached 135 million tons. The total revenue of RMB1,720 billion with a profit of RMB172.7 billion had been achieved the same year. Its profit is among the highest of the domestic enterprises in China.

CNPC was ranked 10th in Fortune Global 500 in 2010 and 5th among global top 50 oil companies.

CNPC strictly follows by the combined strategies of increasing resource capacity, expanding market shares and consolidating the international role, and persists in regarding technical innovation as a key framework to advance technological progress. To develop its core businesses, focuses will be placed on the solutions of key bottleneck technologies and key proprietary technologies. Thanks to continuously improving of the technical innovation system, optimizing the configuration of technological resources and strengthening the construction of strong talent teams, CNPC's technological creativity has been considerably upgraded. Consequently, a large number of technologies have been developed independently, with its own intellectual property.

The Laboratory Technology for Oil and Gas Reservoir Development is one of representatives for major innovations of CNPC.

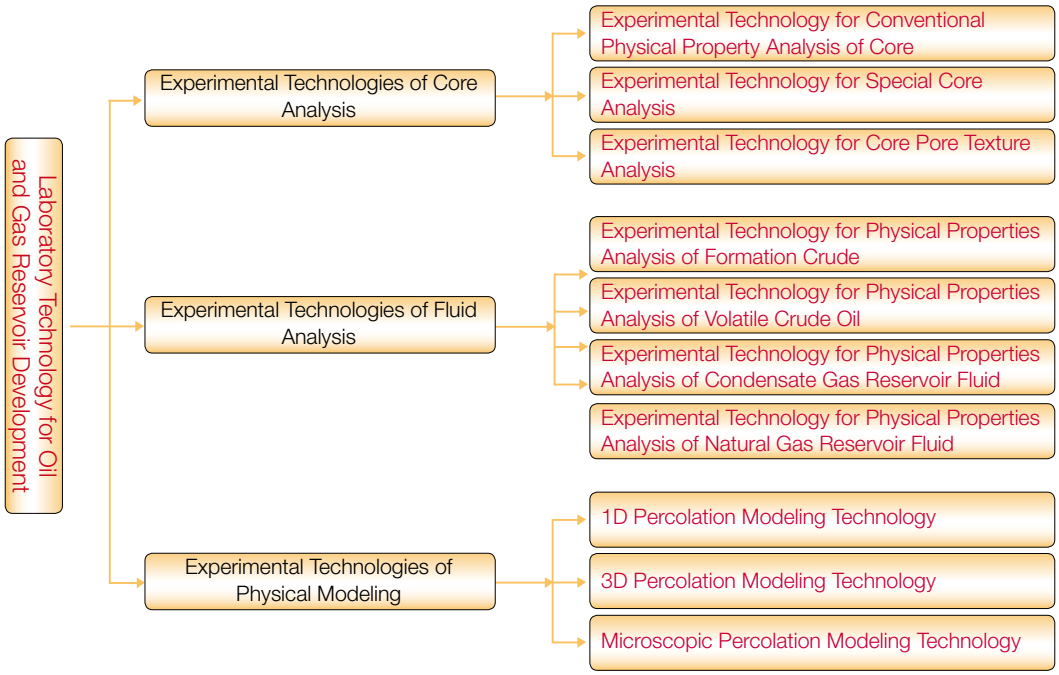
CLEAN ENERGY SUPPLY FOR BETTER ENVIRONMENT

1 Introduction

Equipped with a large number of technical experts and top laboratories, CNPC devotes itself to developing Laboratory Technology for Oil and Gas Reservoir Development and can provide various technical services.

CNPC's Laboratory Technology for Oil and Gas Reservoir Development has been widely applied both domestically and abroad. CNPC has served ten oil fields and units as well as foreign petroleum companies and research organizations, such as British Cluff Oil Corporation, Laizhou Bay Oil Corporation of Japan, Venezuela Maraven Oil Corporation, Ukraine Natural Gas Research Institute, Petroperu, and relevant organizations in Sudan, Azerbaijan, Pakistan, Niger, etc.

The experiment for development oil and gas reservoir, as the basis for the development of oil and gas fields, is composed of reservoir physical researches including core analysis, fluid analysis and reservoir physical simulation, etc. The reliable data, required whether at the initial development stage of oil reservoirs or at late high water-cut stage (development stage), or even by the wide application of methods for improving recovery ratio, indeed rely on experiments for development. Laboratory Technology for Oil and Gas Reservoir Development plays an important role at each historic stage of oil and gas field development in China and has laid a solid foundation for the steady and sound development of China petroleum industry.



1. British Cluff Oil Corporation
2. SOCAR
3. Ukraine Natural Gas Research Institute
4. Niger Oil Corporation
5. Sudan Oil Corporation
6. Saudi Aramco
7. NIOC
8. Indonesia Medco Oil Corporation
9. Laizhou Bay Oil Corporation of Japan
10. Petroperu
11. Venezuela Maraven Oil Corporation

2 Unique Technologies

1. Experimental Technologies of Core Analysis

In oil and gas field exploration, it is important to determine the physical property parameters of oil and gas reservoir rocks. The experimental data of core analysis is the important basic data for the calculation of reserves, development plan, reservoir engineering and oil production technology research, so the detailed and accurate experimental data of core analysis are needed in designing the development plan of oil and gas field and enhancing recovery ratio.

The experiment of core analysis is a basic approach to obtain the data of reservoir rock.

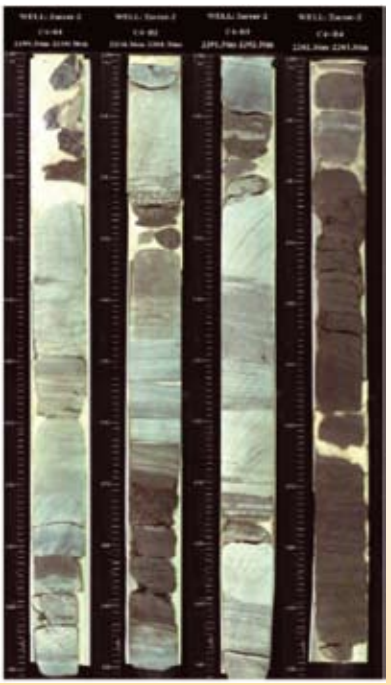
Experimental Technologies of Core Analysis include Experimental Technology for Conventional Physical Property Analysis of Core, Experimental Technology for Special Core Analysis and Experimental Technology for Core Pore texture Analysis.

With the advanced Experimental Technologies of Core Analysis, excellent core laboratories and splendid scientific research teams, CNPC can provide comprehensive services on core analysis and tests to petroleum companies both at home and abroad.

(1) Experimental Technology for Conventional Physical Property Analysis of Core

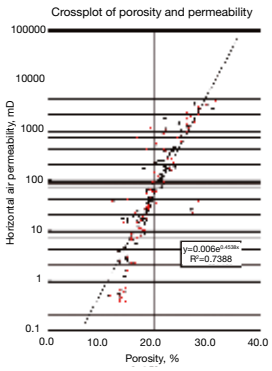
• Core pretreatment

In order to get high-quality samples for core analysis experiment, the core shall be preserved and protected, shaved, drilled, stoved and saturated. And particularly, the samples with high clay content shall be stoved and the unconsolidated core shall be treated. The core shall be photographed and undergone γ test.



- Core porosity, permeability and saturation tests

Different methods can be employed to conduct the porosity, permeability and saturation tests (gas, liquid and Klinkenberg permeability) on the core under conventional conditions and confining stress (incl. full-diameter core). Particularly, the accurate determination shall be done for samples with low permeability and ultra-low permeability. CNPC is the manufacture and calibration unit of standard test block for porosity and permeability authorized by State Bureau of Quality and Technical Supervision. For different rock types, fluid saturation can be tested with different testing methods.



- Pore volume compressibility

Pore volume compressibility of rock, which reflects the relation between deformation of reservoir rock pores and pressure, can be tested and the determination result in triaxial direction may be corrected in uniaxial direction.

- Standardization and serialization of domestic outcrop core

There are 5 series of domestic outcrop cores that are applied in oil reservoir physical modeling experiments, especially as the standard core samples used for the evaluation of tertiary oil recovery displacement experiment, thus improving the standardization and normalization of reservoir petrophysical research.

(2) Experimental Technology for Special Core Analysis

- Wettability

Wettability of reservoir rock controls the distribution of oil and water in oil reservoir, and the determination of wettability helps to strengthen the oil recovery projection. The wettability of reservoir rocks can be evaluated with the contact angle determination or Amott wettability index.

- Relative permeability

Relative permeability is the ratio of effective permeability to basic permeability for each phase when multiphase flow coexists. Oil-water relative permeability can be tested with steady-state and unsteady-state methods. Gas-oil relative permeability can be tested with the unsteady-state gas drive method, and particularly, the relative permeability can be tested for CO2 displacing oil. Gas-water relative permeability can be tested with steady-state intake method and displacement method, and the three-phase (oil-gas-water) relative permeability can be tested.

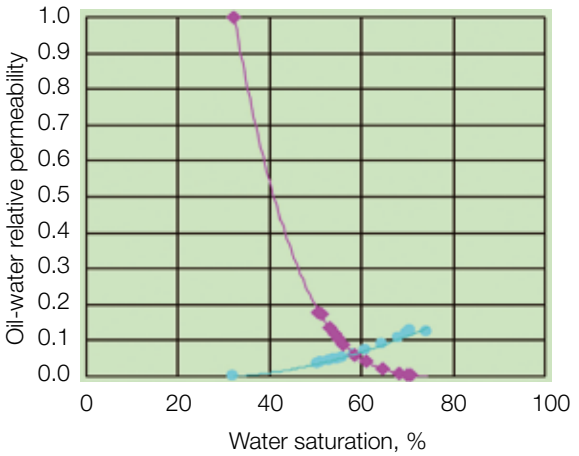
- Sensibility

Damage mechanism of reservoir in waterflooding or chemical flooding processes can be realized with the research of sensibility. The following can be evaluated: rock sensibility (acid sensitive, alkali sensitive, velocity sensitive, water sensitive and pressure sensitive) and damage from inflow fluid. Cation exchange capacity can be tested.

- Electric property and acoustic property

For simulating the conditions of formation, the electric property and acoustic property of rock are tested, with the testing parameters covering resistivity, cementation index, saturation exponent, formation factor, acoustic velocity (or acoustic travel time), Young's modulus, shear modulus, Poisson's ratio, elastic modulus and attenuation coefficient, etc.

Oil-water Relative Permeability Curve



- Grading evaluation of low permeable oil and gas reservoir

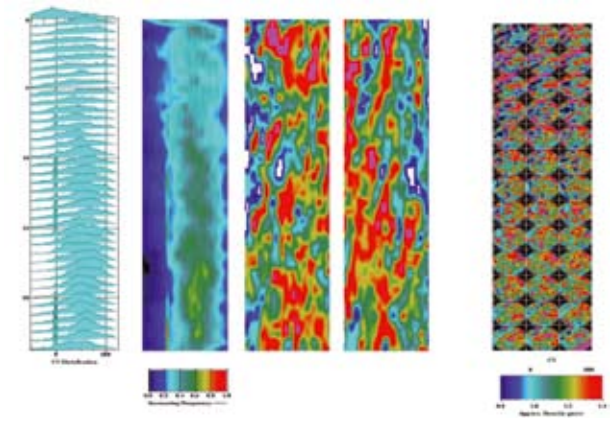
The evaluation method for low-permeability reservoir consists of three unique technologies involving reservoir pore texture (constant velocity mercury injection apparatus), movable fluid saturation (nuclear magnetic resonance apparatus) and non-linear percolation. The evaluation method for the ultra-low-permeability reservoir (oil reservoir) is established. The nonlinear simulation technology is developed with the non-linear percolation model of ultra-low-permeability oil reservoir, which describes the percolation rules of ultra-low-permeability reservoirs. And the evaluation parameters for ultra-low-permeability reservoirs (gas reservoir) are proposed.

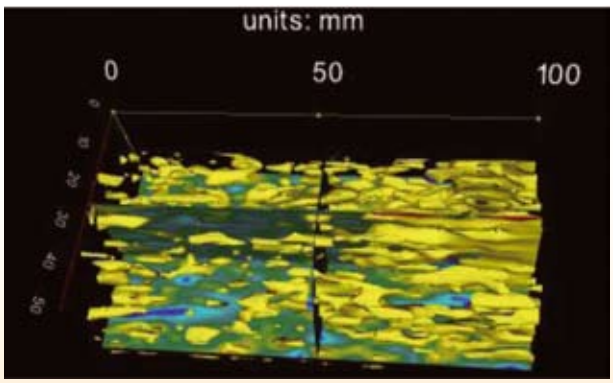
- Permeability
- Throat radius of main flow
- Movable fluid saturation
- Starting pressure gradient
- Crude oil viscosity
- Clay type and content

(3) Experimental Technology for Pore Texture Analysis of Core

- CT scanning imagery

Scanning imagery of core is obtained with CT to finely describe rock pore features and visually recover rock's internal texture.





- Capillary pressure curve

Rock's capillary pressure curve, which is determined with mercury intrusion method, septa method or centrifugal method, shows the rock texture parameters including pore type, sorting coefficient, skewness, peak position and peak value of pore distribution, uniformity coefficient, maximum pore radius, average pore radius, median and average value of pore radius, relative sorting coefficient and characteristic texture, etc.

2 Experimental Technologies of Fluid Analysis

Determining the physical properties of fluid in reservoirs is extremely significant for designing the general scheme of reservoir exploitation technology. The experiment of reservoir fluid analysis is a kind of basic means to obtain physical property data of reservoir fluid.

The physical properties of reservoir fluid is mainly related to formation pressure, temperature, oil and gas composition and amount of dissolved gas in oil. The basic physical property parameters including saturation pressure, volume factor, viscosity and solution gas-oil ratio of oil and gas reservoir, etc. are indispensable for the determination of reservoir type, development plan and different kinds of reservoir engineering calculation.

Experimental Technologies of Reservoir Fluid Analysis include Experimental Technology for Physical Properties Analysis of Formation Crude, Experimental Technology for Physical Properties Analysis of Volatile Crude Oil, Experimental Technology for Physical Properties Analysis of Condensate Gas Reservoir Fluid and Experimental Technology for Physical Properties Analysis of Natural Gas Reservoir Fluid.

CNPC, possessing the advanced Experimental Technologies for Physical Property Analysis of Reservoir Fluids, excellent laboratories for physical property analysis of fluids and splendid scientific research teams, is able to provide comprehensive services on physical properties analysis and tests of reservoir fluids to petroleum companies both at home and abroad.

(1) Experimental Technology for Physical Properties Analysis of Formation Crude

- Single degassing experiment

Parameters, such as formation crude components, gas/oil ratio (GOR), volume factor, formation crude density, are determined.

Analysis of formation crude components: H_2, He, O_2, N_2, CO, CO_2, H_2S, C1– C36+.

- Constant mass expansion test

It is also called the P-V relation; parameters (e.g. saturation pressure, compressibility factor, relative volume, Y function of formation fluid) are tested at the formation temperature.

- Variant degassing experiment

At the formation temperature, parameters, such as solution gas-oil ratio, volume factor and density of saturated oil, deviation factor, relative density and volume factor of extracted gas, and volume factors of oil and gas two-phase, are determined for each grade of pressure.

- Viscosity test of formation crude oil

At the formation temperature, formation crude viscosity is tested for each grade of pressure.

- Separation test of formation crude

Parameters, such as gas/oil ratio, density of tank oil and formation volume factor, are tested under different separation conditions, and the effects of different separation conditions upon crude oil recovery, are determined for selecting the best separation condition.

(2) Experimental Technology for Physical Properties analysis of Volatile Crude Oil

- Physical compound sample of formation fluids

As per the gas/oil ratio, the oil and gas samples obtained in separator are compounded into samples of volatile formation crude with acceptable formation conditions.

- Composition analysis of well effluent

Components of volatile formation crude are analyzed and tested.

- Constant mass expansion test

Parameters of formation fluids, e.g. saturation pressure, compressibility, relative volume and Y function, are tested at the formation temperature.

- Isometric depletion test

Under the formation temperature and different depletion pressures, such parameters are tested, i.e. deviation factor of volatile crude oil fluids, cumulative recovery rate, cumulative yield of tank oil and flash gas yield, cumulative yield of heavy components.

- Viscosity test of formation crude

At the formation temperature, viscosities of

volatile crude oil at all pressure levels are tested.

(3) Experimental Technology for Physical Properties Analysis of Condensate Gas Reservoir Fluid

- **Preparation of fluids for condensate gas formation**

As per the gas/oil ratio, the oil and gas samples obtained in separator are compounded into samples of fluids of condensate gas reservoir with acceptable formation conditions.

- **Composition analysis of well effluent**

Components of fluids of condensate gas reservoir are analyzed and tested.

- **Constant mass expansion test**

At the formation temperature, parameters for condensate gas reservoir fluids are tested, e.g. dew point pressure, gas deviation factor and relative volume of fluids under different pressures.

- **Isometric depletion test**

To provide the theoretical evidence and basic data for the preparation of the development scheme, modeling should be done for the depletion type of recovery process, and studies shall be carried out for the composition and properties of well effluent, the retrograde condensation amount of hydrocarbons in condensate gas reservoir and the recovery under different depletion pressures during the depletion development.

(4) Experimental Technology for Physical Properties Analysis of Natural Gas Reservoir Fluid

- **Composition analysis of well effluent**

Components of natural gas reservoir fluid are analyzed and tested.

- **Constant mass expansion test**

Under the formation temperature and different pressures, P-V relation curve of gas reservoir fluid is tested; parameters for gas reservoir fluid, e.g. volume factor, density, deviation factor, compressibility of gas, are tested.

3. Experimental Technologies of Physical Modeling

Determining the percolation parameters of hydrocarbon reservoir fluid is significant in the development of oil and gas fields. Physical modeling experiment is an important way to obtain the data of fluid flow through porous medium.

The data and recognition of percolation rules are obtained with the physical modeling experiment. They are the important data for the development plan of oil and gas reservoir, reservoir engineering and research of oil production technologies, and provide the reference and direction for designing the development plan of oil and gas field and bettering recovery techniques.

CNPC, bearing the advanced physical modeling laboratories and excellent scientific research teams, is able to provide services on physical modeling experiments to petroleum companies both at home and abroad. Experimental Technologies of Physical Modeling include 1D Percolation Modeling Technology, 3D Percolation Modeling Technology and Microscopic Percolation Modeling Technology.

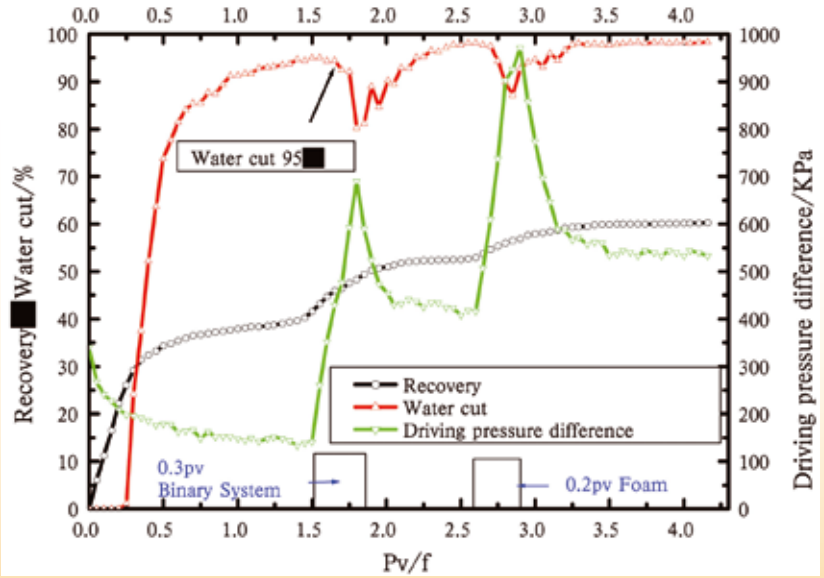
(1) 1D Percolation Modeling Technology

- Conventional 1D model

Conventional 1D model refers to that core is processed to the short core (with length less than 100mm) of 25.4mm or 38.0mm diameter. This kind of model can truly reflect the natural pore features of oil and gas reservoir, with wider research area.

- 1D model for long core

1D model for long core is the core model whose



Variation curve of recovery, water cut and deriving pressure difference

length is more than 800mm after the joint of natural cores. 1D model for long core has the advantages of small measuring error and true reflection of fluid metasomatism.

- Large-diameter sand pack model

Large-diameter sand pack model is the core model that is made by the compaction of loose sand or clean quartz sand, with the diameter less than 100mm and length more than 800mm.

With the consideration of formation permeability parameter, the model for simulating the pore features of oil and gas reservoir is established via proper compaction procedures. This kind of model effectively solves the problems in the modeling for loose oil and gas reservoirs.

- Other model types

For different research purposes, 1D percolation model is developed into various forms of models, e.g. synthetic anisotropic cementation model, 1D core model with quadrate section, sand pack model with its external part made from organic materials, etc.

These models do enrich the categories of 1D percolation model and expand the research area.

(2) 3D Percolation Modeling Technology

- Model preparation

① Select from the natural outcropping rocks;
② Cut and process the outcropping rock;
③ Test the basic parameters of physical properties, e.g. rock permeability;

④ Design the well pattern and monitoring points for saturation and pressure, and install the monitoring devices;

⑤ Package the models, etc.

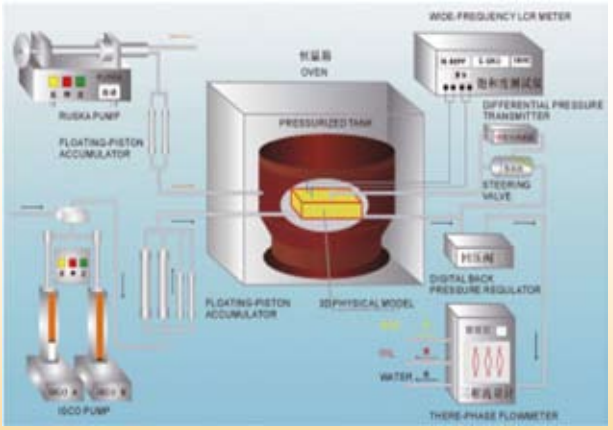
- Fluid percolation test

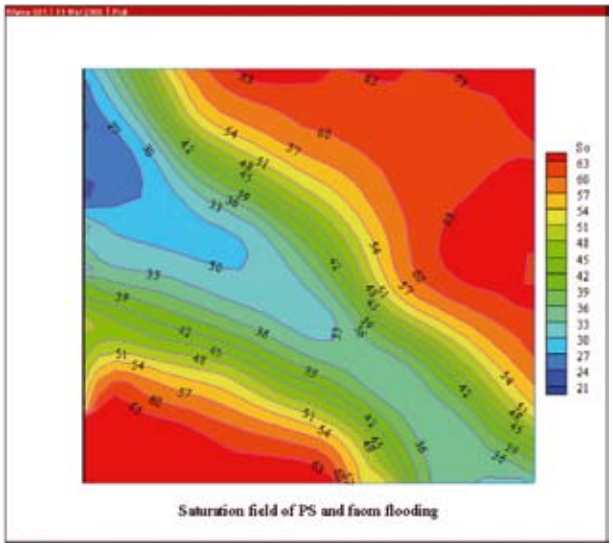
After the model preparation, installations are done step by step, involving pressure difference pipeline, saturation probe pipeline, temperature controlling pipeline and safety protection system.

The percolation test is controlled with the special software program. The return pressure and oil, gas & water are automatically controlled and measured, and the data for saturation, pressure and temperature, etc. are collected automatically by computers. Meanwhile, the observation methods (e.g. real-time curve) are used.

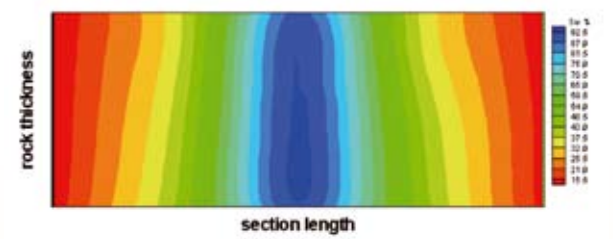
- Monitoring of percolation domain

The distribution and difference of the spread effects of different fluids on plane can be identified by the percolation within the model. As rock thickness increases, gravity differentiation phenomenon in vertical direction can be displayed in the model.

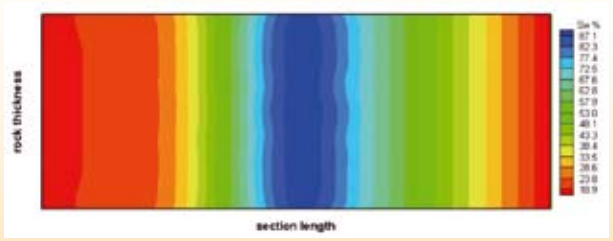




Saturation field map in the water-oil displacement process



Saturation longitudinal section when with larger rock thickness

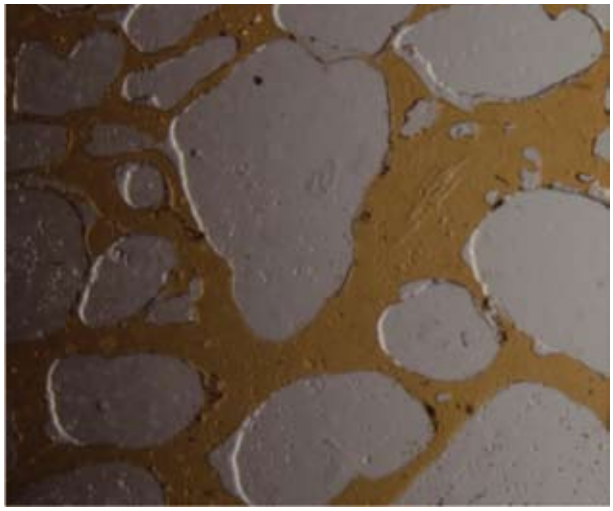


Saturation longitudinal section when with lower rock thickness

(3) Microscopic Percolation Modeling Technology

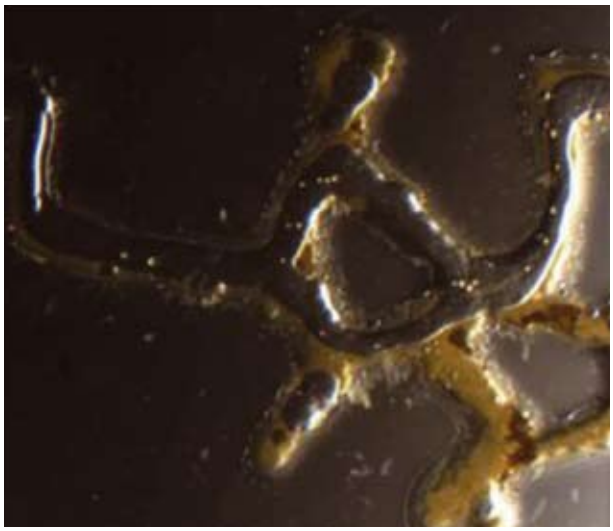
Microscopic Percolation Modeling Technology refers to the visualized analysis technology that uses glass etched porosity model to study the fluid percolation features.

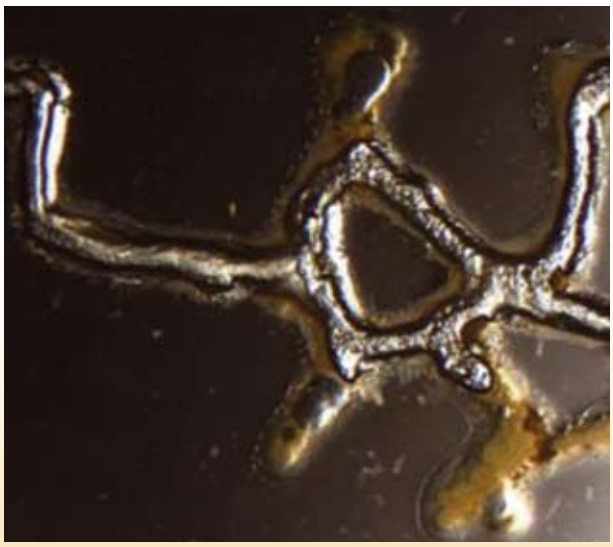
There are many kinds of glass models, mainly including pore channel model, regular (e.g. square) graphical models , plane image model for true core porosity, etc.



Microscopic model after saturated oil

The major advantage of Microscopic Percolation Modeling Technology is that it can clearly display the fluid flow mechanism, thereby theoretically supporting the development of oil and gas fields.





Residual oil distribution after water–oil displacement/CO_2 flooding

3 Typical Cases

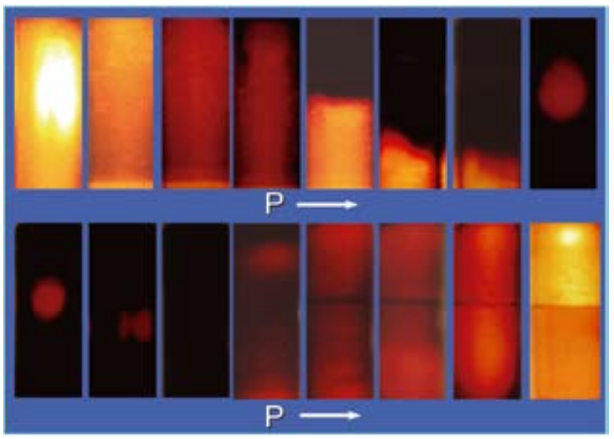
1. Application of Experimental Technologies of Core Analysis

CNPC provides core analysis services for Petrodar Company of Sudan. Conventional physical properties analysis, special analysis and pore texture analysis of core were conducted for the 21 perpendicular core columns (total length 21.74m) in Yabus horizon of Well Zarzor-2 in Gumry Oilfield. It has provided full and accurate experimental data of core analysis for calculating reserves and designing development plan of this oilfield.

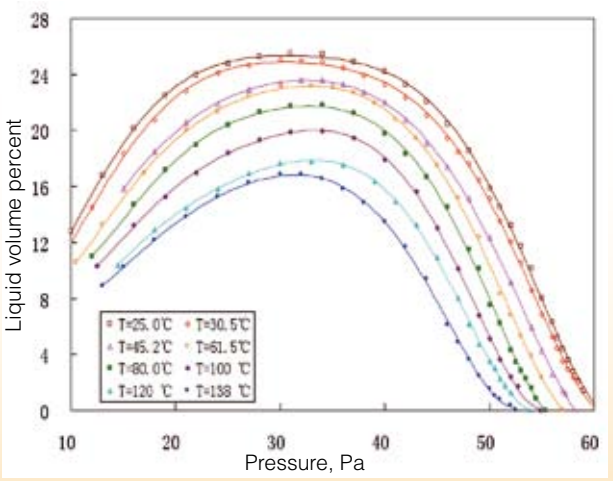
2. Application of Experimental Technologies of Fluid Analysis

The analysis and test of physical property parameters of fluid was conducted for Yaha Condensate Gas Reservoir with Experimental Technology for Physical Properties Analysis of Condensate Gas Reservoir Fluid, providing physical property parameters and variation rules of phase characteristics which directly guided the formulation of development plan for this condensate gas reservoir.

For Yaha condensate gas reservoir, its formation pressure is 56MPa, formation temperature 138° C, condensate oil content 600g/m3 and paraffin content of condensate oil 12%, so it is a typical condensate gas reservoir with high paraffin content and rich condensate oil. The dew point pressure of Yaha condensate gas is 52.5MPa. In view of the



Optical phenomena of near—critical fluid phase state variation in Yaha Condensate Gas Reservoir



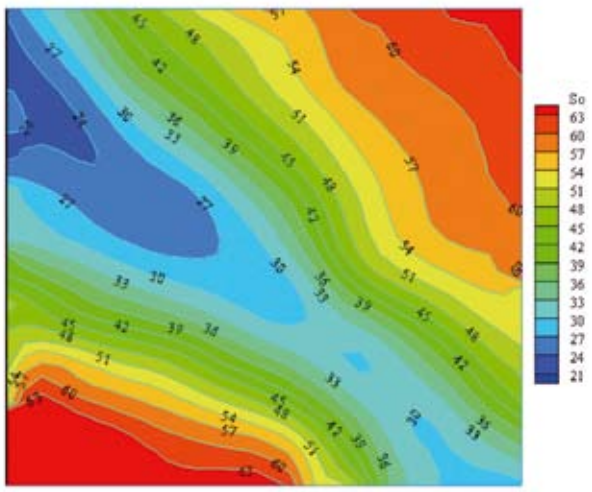
Variation curve of fluid volume of retrograde condensed liquid

small differential pressure between the formation pressure and dew point pressure as well as the serious retrograde condensate phenomenon (i.e. the maximum amount of retrograde condensed liquid is 20%), the cyclic gas injection & pressure-maintaining production method should be applied because the application of conventional depletion type of production here will only bring about a very low recovery rate.

3. Application of Experimental Technologies of Physical Modeling

In Kaji-Semoga Oilfield of Indonesia, reservoirs present the biolithite feature, with the average content of calcite 96%. The outcropping sample analysis demonstrates strong anisotropy. The analysis of weakly water-wet samples through the scanning electron microscope indicates that the rocks contain less macropores (i.e. mainly dissolved pores) and more micropores (i.e. mainly intercrystalline pores and filling pores).

The 2D physical modeling technology is used to conduct the laboratory study of enhanced oil recovery. After waterflooding, foam flooding is attempted. The resistance of water communication is increased, the swept extent is improved and the displacement efficiency is increased greatly through Jamin effect after the foam injection. The experiment proves that the foam system can control the mobility and enhance the oil recovery with some mechanisms—one is to increase the swept volume.



Map showing water saturation field of foam flooding

4 R&D Equipment

CNPC has established the State Key Laboratory for Enhanced Oil Recovery with excellent instruments and advanced technologies. The domestically leading and internationally top level has been attained in the analysis means and methods for conventional analysis, special analysis and pore texture analysis of core. And the level of means and methods in the field of fluid analysis (incl. analysis of fluid phase state of oil and gas reservoirs and study of gas injection mechanism, etc.) is in line with that of the international peers. In aspect of the physical modeling experiment and via the upgrading and reformation, the microscopic, middle and macroscopic physical modeling methods of fluid percolation are in consistent with those of the international peers.

CT扫描系统

恒速压汞仪

油藏条件下岩心分析系统

地层伤害评价系统

1. Core Analysis Laboratory

It owns the advanced instruments including PHI220 porometer, Ka-210 permeameter, AP-60 confining-stress permeameter and permeability determinator, VpVs-200 sound wave measurement system, PorMaster-33 high pressure mercury injection apparatus, RCS760 resistivity-capillary pressure joint measurement system, QUIZIX SP-5000 high pressure metering pump, etc.

超高压PVT装置

固溶物检测装置

长岩心驱替系统

高温高压界面张力装置

2. Fluid Analysis Laboratory

The laboratory owns the advanced superpressure PVT device, superpressure analytic device for fluid physical properties, detection device for dissolved solid matter, displacement system for long core, HTHP interfacial tensiometer, 6890N gas chromatograph, etc.

一维渗流模型实验装置

三维渗流模型实验装置

微观渗流模型实验装置

3. Physical Modeling Laboratory

The laboratory is armed with a lot of advanced instruments, such as HTHP 3D physical modeling device, HTHP 3D physical cementation model, medium-pressure device, microscopic/high-speed camera device.

5 Qualification and Standard

1. Qualification

In 1989, CNPC, which developed the pore-type standard substance for permeability which was identified by the State Bureau of Quality and Technical Supervision in 1990, becomes the first unit manufacturing this kind of standard substance in China.

On Oct. 19th, 1993, after having been evaluated by the Petroleum Assessment Group of State Bureau of Quality and Technical Supervision, CNPC became one of the first batch of units that passed the metrological certification for experiment of oil development, and hereafter passed the certification checks and reviews of extending scope organized by the State Bureau of Quality and Technical Supervision.

2. Standard

CNPC's experiments for oil and gas reservoir development are strictly in accordance with the national or industry standards. Its laboratories have sponsored or partaken in the formulation of many national and industry standards.

SY/T 5336-2006 Practices for core analysis

SY/T 5346-2005 Determination of rock capillary pressure curve

SY/T 5345-2007 Test method for relative permeability of two-phase fluid in rock

SY/T 5358-2002 Evaluation method for reservoir sensitivity—flow rate test

SY/T 6154-1995 Determination of rock specific surface and pore size distribution by static nitrogen adsorption

SY/T 5815-2008 Test method for rock pore volume compressibility

SY/T 6385-1999 The porosity and permeability measurement of core in net confining stress

SY/T 5385-2007 Measurement and calculation methods of rock resistivity parameters in laboratory

SY/T 6351-1998 Laboratory measurement of acoustic properties on rock

SY/T 6107-2002 Test method for rock thermal petrophysical parameters

GB/T265-1998 Test and calculation methods of dynamic viscosity for oil product

GB/T1884-2000 Petroleum products—Determination of kinematic viscosity and calculation of dynamic viscosity

SY/T 5543-2002 Analysis method for condensate gas properties

SY/T6434 Analysis method for natural gas reservoir fluids' physical properties

SY/T6435 The method for measuring volatile oil properties

SY/T5542 Analysis method for reservoir crude oil physical properties

GB/T 13610-2003 Analysis of natural gas composition by gas chromatography

SY/T 5779-2008 Analytical method of hydrocarbons in petroleum and sediment by gas chromatography

6 Expert Team

Guo Shangping

(Academician of China Academy of Science, expert in Hydromechanics, biomechanics and oil field development)

He principally involves himself in scientific researches related to oil field development, reservoir engineering, biomechanics etc., and has made many important achievements. He is the main designer of Karamay Oilfield that was developed with the standard design earliest in China as well as the leader of the fluid flow computation team of Development Workgroup in Daqing Oilfield. He has made significant contributions to China's oil field development. He was awarded the third prize of "National Natural Science Prize".

E-Mail: guosp@petrochina.com.cn

Shen Pingping

(Engineering expert in oil and gas field development)

He has been dedicated to the theoretical, method and technical innovation for higher oil recovery in all kinds of oilfields. He has presided over and participated in a series of momentous projects, with his research findings successfully applied in many oilfields both home and abroad and winning notable effects. He was awarded 1 prize of "National Science Conference Award", 3 second-prizes of "National Science and Technology Progress Award" and 2 patents, and has published 7 monographs and more than 40 research papers.

E-Mail: spp@petrochina.com.cn

Wang Jialu

(Engineering expert in oil and gas field development, Member of SPE, Chinese Petroleum Society and Chinese Society of Theoretical and Applied Mechanics)

He has devoted himself to the fundamental research of oil and gas field development. He has made remarkable achievements in horizontal well technology, 3D physical modeling of oil reservoir, tertiary recovery new technology and other fields. He has published more than 40 research papers, 3 monographs and 1 translated work, and has been granted with 6 patents.

E-Mail: wjl@petrochina.com.cn

Qin Jishun

(Engineering expert in oil and gas field development, Member of SPE, SCA and Chinese Petroleum Society)

He has gone into teaching and research on petrophysics, fluid mechanics in porous media and enhanced oil recovery for a long time. He has published more than 30 research papers and 1 monograph and has been granted with 1 patent.

E-Mail: qinjs@petrochina.com.cn

Zheng Xitan

(Expert in experimental technology of oil and gas field development)

He has more than 30 years' work experience in fluid analysis. He has participated in the formulation of many standards for fluid analysis experiments and published over 20 research papers in relevant domains.

E-Mail: zhengxt@petrochina.com.cn

Liu Qingjie

(Expert in experimental technology of oil and gas field development)

He has more than 10 years' work experience in core analysis, filtration theory, besides being familiar with testing methods and standards related to core analysis, fluid flow experiment, etc. He has published over 20 papers in relevant domains.

E-Mail: lqj@petrochina.com.cn

Li Shi

(Expert in experimental technology of oil and gas field development)

He has more than 20 years of work experience in fluid analysis. He has participated in the formulation of many standards for fluid analysis experiments, and published more than 10 research papers in relevant domains.

E-Mail: PVT@petrochina.com.cn

Zhang Zubo

(Expert in experimental technology of oil and gas field development)

He has more than 20 years' work experience in fluid analysis. He has participated in the formulation of many standards for fluid analysis experiments and published more than 10 research papers in relevant domains.

E-Mail: zzbo@petrochina.com.cn

Chen Xinglong

(Expert in experimental technology of oil and gas field development)

He has years' work experience and has published more than 10 research papers in relevant domains.

E-Mail: chxlhdpu@petrochina.com.cn

CNPC
中国石油

联系人：刁顺 先生
电　话：59986059
Email: sdiao@cnpc.com.cn

Contact: Mr. Diao Shun
Tel: 59986059
Email: sdiao@cnpc.com.cn