Development Technologies For Low-permeability Reservoir

Science & Technology Management Department

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CHINA NATIONAL PETROLEUM CORPORATION

We are ready to share the advanced technologies and successful experiences in low-permeability field development with the world!

Contents

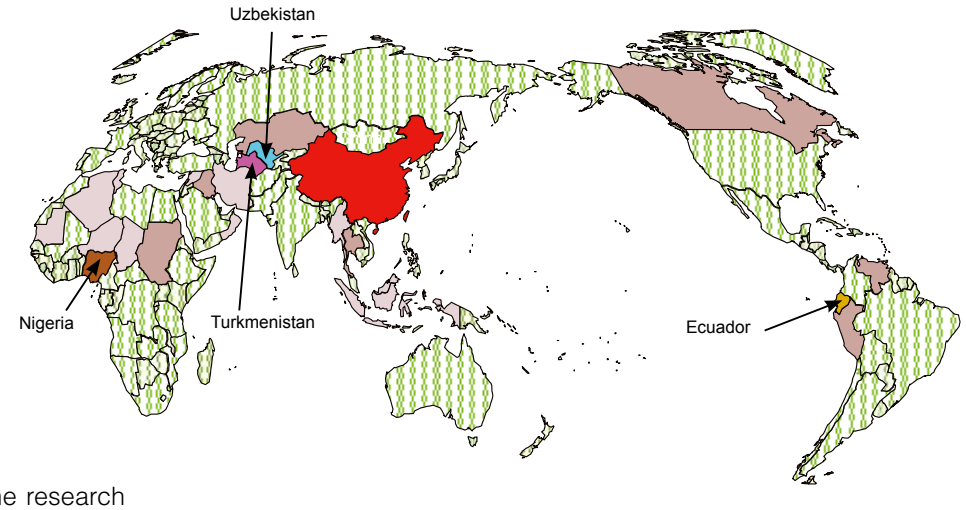
China National Petroleum Corporation (CNPC) is a state-authorized investment agency and a state holding company. As an integrated oil company of cross-regions, cross-industries and cross-countries, it adopts modern enterprise system to realize the integration of upstream and downstream operations, internal 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 of refined oil produts 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 10rd 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 Development Technologies For Low-Permeability Reservoir (LPRD) is just one of the typical major innovative achievements.

1 INTRODUCTION



Since 1970, CNPC has dedicated to the research of low permeability oil and gas field. Now CNPC has become an internationally well-known pioneer in the oilfield development of low permeability, low pressure and low abundance, and obtained application experiences and fruits in the drilling and completion, reservoir stimulation, ground engineering construction, and independently developed the low permeability characteristic technology series of leading level in the domain.

"Challenging the ultimate of low-permeability reservoir" is always CNPC's target. After about 40 years' exploitation and practice, CNPC has successfully solved three thorny problems of the world, complex landform, compact reservoir and low grade reservoir, cultivated 3 series and 10 items of engineering technical systems, and gradually realized the economic and effective development with the average permeability from less than 20mD to less than 1mD. Nowadays, CNPC is devoting itself to the reservoir development with the permeability of 0.3mD.

Since the end of 1990s, CNPC the characteristic technologies to the cooperation blockes of Shell and Total in China, as well as many oil companies in Central Asia, South America and Southeast Asia etc.

CNPC is ready to share the advanced technologies and successful experiences in low-permeability field development with the world.

Drilling/completion technology series for low-permeability reservoir	Stimulation technology series for low-permeability reservoir	Surface engineering technology series for low-permeability reservoir
Underbalance drilling technology	Development technology for low-pressure and low-permeability reservoir	Surface engineering technology for low-permeability gas reservoir
Drilling/completion fluid technology	Stimulation technology for low-porosity and low-permeability carbonate reservoir	Surface engineering technology for low-permeability oil reservoir
Cementing technology for long open hole in low-pressure, low-permeability and lost-circulation formation	Stimulation technology for bottom-water reservoir	Excellent surface gathering & transportation process units
	Fracturing fluid and preparation technology	
	Stimulation technology for old oilfield	

2 UNIQUE TECHNOLOGIES

Drilling/completion Technology Series for Low-permeability Reservoir

The technology is to improve the drilling velocity and to reduce the reservoir damage in the completion. Major technologies of underbalanced drilling, long open hole cementation of easy leaking and matching liquid system are developed to suit the complicated surface and low permeability reservoir.

Underbalanced drilling technology

CNPC has been applying underbalanced drilling technology in low-permeability reservoir since 1986. With rich theory and practice, CNPC can provide integrate underbalanced drilling technical service from underbalanced drilling design to various circulating mediums including air drilling, natural gas drilling, nitrogen drilling, mist drilling, foam drilling, aerated drilling and circulating foam drilling.

CNPC has possessed a complete set of underbalanced drilling equipment, including air compressor, booster compressor, rotating control head, atomizing pump, air forging hammer, nitrogen producing unit as well as patented drill pipe floating valve and casing valve. The independently developed underbalanced drilling software can assess the underbalanced drilling feasibility (including formation stability and water analysis) with the seismic, logging and drilling data and design the underbalanced drilling scheme.

In addition, field engineers can use the software to realize real-time analysis and optimize underbalanced drilling operation with the support of base technical center through Internet.

Five national patents builds CNPC's leading position in the domain of underbalanced drilling service:

Patent 1: Gas drilling equipment
Patent 2: Gas drilling rod floating valve
Patent 3: Gas drilling casing valve
Patent 4: Rotating control head
Patent 5: Air forging hammer

Drilling/completion Fluid Technology

Effective reservoir protection is one of the keys to achieving economical and efficient development of low permeability oilfield. CNPC always dedicates to the research on and application of reservoir protection technologies, and possesses experienced experts on reservoir protection, as well as complete laboratories to make evaluation and research pertinent to characteristics of specific reservoirs. Drilling/completion fluids appropriate to target reservoir can be designed, and an integrate service from design to operation on the basis of geologic characteristics of various regional reservoirs can be provided by CNPC.

Present drilling/completion fluid systems with good market reputation are listed as follows:

- Biodegradable temporary plugging drilling/completion fluid of bentonite-free and low-damage;
- Circulating micro-bubble drilling/completion fluid;
- Oil-soluble temporary plugging drilling/completion fluid appropriate to water-blocking or water-sensitive reservoir;
- Solid-free low damage drilling/completion fluid appropriate to reservoir protection;
- Low-density oil-based drilling/completion fluid system appropriate to original reservoir characteristics;

Cementing Technology for Long Open Hole in Low-pressure, Lost-circulation and Low-permeability Formation

After more than 20 years' research and 2000 wells' cementing practice, CNPC has obtained rich cementing experiences in long open hole in low-pressure, lost-circulation and low-permeability formation, and first cementing qualification rate exceeds 98%.

Currently, CNPC has owned cementing experts as well as advanced cementing design and simulation software. With independently developed low-density cement slurry systems, CNPC can select appropriate cement slurry system based on formation pressure-bearing capability.

Stimulation Technology for Low-permeability Reservoir

In order to improve the flow environment and the drainage area, CNPC has developed the matching operation tools and oil and gas well stimulation and old well production stabilizing technologies of patented fluid system in view of low permeability sandstone and compact carbonate reservoir. CNPC can provide service of fracturing geology and technical assessment and the design of overall block development and single well fracturing, undertake the operations of control bottom water fracturing, horizontal well fracturing, multi-fracture fracturing and expandable casing damage repair etc., and carry out whole course fracturing test and analysis and the matching tools development and fluid design.

Development Technology for Low-pressure and Low-permeability Reservoir

Development technology for low-pressure and low-permeability reservoir consists of 4 individual technologies, including development fracturing technology, staged fracturing technology of mechanical isolation for horizontal well, CO_2 foam fracturing technology as well as staged fracturing technology without pulling string. Development fracturing technology is appropriate for integrate fracturing of newly developed block in low-permeability reservoir. staged fracturing technology of mechanical isolation is used for staged fracturing in perforated horizontal wells and for acidizing of open horizontal wells. CO_2 foam fracturing technology is specially appropriate for low-pressure, low-permeability, water-sensitive and water-block reservoir. Staged fracturing without pulling string technology is appropriate for staged fracturing and commingled production in low-pressure, low-permeability and low-production reservoir.

Stimulation Technology for Low-porosity and Low-permeability Carbonate Reservoir

Stimulation technology for low-porosity and low-permeability carbonate reservoir involves hydraulic fracturing technology for carbonate reservoir and cross-linked acid sand fracturing technology. The former is appropriate for fracturing stimulation in compact acid-sensitive carbonate reservoir with 155μs/m $<\Delta t<$160μs/m, 2.6%$<\Phi<$4% and Sg<70%. The latter is appropriate to compact carbonate

reservoir of poor-free acid-sensitive with 2.6%<Φ<4% and Sg<70%.

Stimulating Technology for Bottom-water Reservoir

Stimulating technology for bottom-water reservoir includes water-controlled fracturing technology and high-energy gas fracturing technology. The former is mainly used for fracturing stimulation of middle/low-permeability bottom-water reservoir.The latter is appropriate for stimulation of bottom-water reservoir, blockage removal technologies for near borehole zones and augmented water injection.

Fracturing Fluid and Preparation Technology

Fracturing fluid and preparation technology includes continuous combined fracturing construction technology, low-molecular fracturing fluid (LMF) and acid fracturing fluid. The continuous combined fracturing construction technology is mainly used for field batch preparation of fracturing fluid and simultaneous preparation and injection fracturing operation. Low-molecular fracturing fluid is appropriate for reservoir fracturing lower 248°F. Acid fracturing fluid is appropriate for fracturing stimulation in low-permeability reservoir as well as non/poor acid-sensitive sandstone reservoir.

Stimulation Technology for Old Oilfield

Stimulation technology for old oilfields is composed of anodic/cathodic protection technology for deep well casings, multi-fracture fracturing technology and expansion pipe repairing technology for destroyed casing well. The anodic/cathodic protection technology is appropriate for external corrosion protection of casings in oil wells, water-injection wells and gas wells with the depth of less than 16,404ft, and it can obviously mitigate or eliminate electro-chemical corrosion resulting from high-salinity brine, H_2S, CO_2, microorganism, oxygen concentration, stray current and galvanic couple. Multi-fracture fracturing technology is appropriate for repeated fracturing of old low-permeability wells and commissioning of new wells in low-permeability reservoir. Expansion pipe repairing technology is appropriate to repair 5½in production casing of destroyed casing wells.

Ground Engineering Technology Series for Low-permeability Reservoir

Aiming at “simplification and optimization, economic and high efficiency”, CNPC develops a set

of transportation technologies of “Short (flow), Small (equipment), Simple (technique), Optimal (system)” that suit the complicated geomorphic features and low permeability oil and gas fields. And a batch of ground matching equipments is independently developed with high technical level. Combining with geomorphic and borehole features, advanced oilfield EPC engineering service as well as the design and the research of the special ground transportation equipment can be provided by CNPC.

Ground Engineering Technology for Low-permeability Gas Reservoir

Ground engineering technology for low-permeability reservoir is composed of high-pressure atmospheric-temperature gas gathering technology, high-pressure low-temperature gas gathering technology and gas gathering technology of low-medium pressure multi-well series. High-pressure atmospheric-temperature gas gathering technology is appropriate for gas fields with low permeability, low abundance, high formation pressure, low pressure drop, stable gas production and low single-well production, or for gas fields with H_2S, CO_2 and no or little condensate oil. High-pressure low-temperature gas gathering technology is appropriate for gas fields with low permeability, low abundance, high formation pressure, low pressure drop, and stable gas production as well as gas fields with little quantity of H_2S, CO_2 and some quantity of C_{6+} heavy component. Gas gathering of low-medium pressure multi-well series technology is appropriate for gas fields with low permeability, low abundance, low production and heterogeneous gas reservoirs as well as gas fields with rapid pressure depletion, and unstable gas production.

Ground Engineering Technology for Low-permeability Oil Reservoir

Ground engineering technology for low-permeability oilfields is composed of single-string unheated tight gathering technology for cluster wells, whole-process oil-gas tight gathering and transportation technology, processing technology for produced

water, and injection allocation, mobile well-flushing & water injection technology through dendritic single tube stable-flow valve set. Single-string unheated tight gathering technology for cluster wells refers to dynamic monitoring and metering well production through automatic acquisition, transmission and analysis of indicator diagram data. Whole-process oil-gas tight gathering and transportation technology refers to seal well head with constant pressure valve, and to separate oil, gas and water in combination station through tri-phase separation & dehydration technology. This technology can meet the requirements of 100% system closeness rate, 100% oil & gas processing rate and 100% utilization rate. Processing technology for produced water refers to removing oil firstly and then suspending material. The application of gravity coarse-graining inclined tube oil removal tank (Patent No. ZL 02 2 32889.0) can realize high oil removal efficiency and stable operation. Injection allocation, mobile well-flushing & water injection technology through dendritic single tube stable-flow valve set refers to optimizing water injection network and improving water injection efficiency through dendritic water injection network and multiple station joint injection. Its application can reach 55% or above water injection efficiency, 80% or above working efficiency of water injection pump, and 100°F re-injection rate of processed sewage.

High-performance Ground Gathering & Transportation Process Units

Skid-mounted TEG Dehydration Unit integrates into heating, dehydration and solvent regeneration functions. It applies air-driven gauge for automatic control, and takes differential pressure plunger pump as solvent circulating pump without external power supply. Water dew point is lower than 8.6°F.

Multi-well Heating Furnace can heat multi-well at the same time and automatically adjust the water bath temperature. The thermal efficiency is more than 85%.

Compact Light Hydrocarbon Recovery Unit can reclaim LPG and stable light hydrocarbon from associated gas or vent gas (including tank vent gas, crude stabilization gas, and gas from separating & buffer tank and casings). It can effectively improve comprehensive utilization of associated gas and prevent harmful gas into atmosphere to lessen potential safety hazard.

Vacuum Phase-changing Heater can apply phase change theory to exchange vapor or medium heat with 86%~90% of heat efficiency. It is characterized by small volume, safety and reliability, furnace body free of explosion. It adopts tight self-circulation heating system, which can automatically adjust water level based on changing load, especially appropriate for load fluctuation or unmanned situation. In addition, it applies full automatic monitoring & control system with compact structure and complete function, to heat single system or multiple systems.

Patented Technologies

As a pioneer in low-permeability reservoir development, CNPC has applied 16 patents of invention, 123 patents of utility model as well as 3 design patents. These pertinent products with patents have established its global high standing in low-permeability reservoir development.

Gas Underbalanced Drilling Apparatus & Method

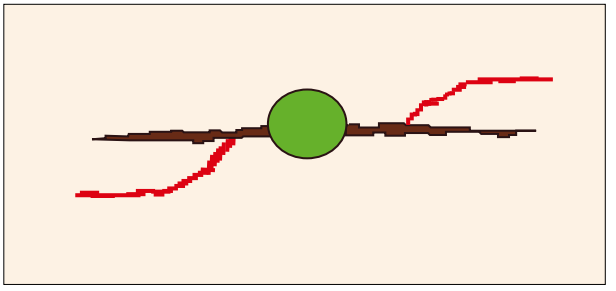
(Patent No. 02114438.9)

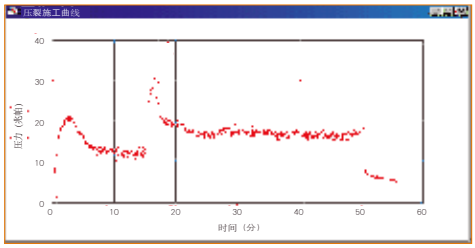
This patent especially involves gas underbalanced drilling apparatus and method that is mainly used for oil and gas drilling operation. The features are following: there is control transferring unit on the gas inlet pipeline to control the switch; the mid-way test unit is connected on the blowout drainage pipeline to drill the reservoir and evaluate the reservoir while drilling; the wellhead gas inlet pipeline is equipped with a short circuit unit to prevent potential ground explosion accidents as well as flame extinction of blowdown pipeline in case of emergency; and extinction of the blowout flame is always ready at the blowout mouth of the drainage pipeline.

Inducing New Fractures Method of Repeated Fracturing

(Patent No. 200510096443.6)

The invention concerns a method to produce new fractures of repeated fracturing in low permeability oilfield. The steering within the fracture produces new fracture branches or communicates more micro fractures in the major fracture, which improves the drainage area, employs the lateral “dead oil zone” in the original fracture, and improve water flood efficiency and single well production.





Applied Low-molecule Environmental Fracturing Fluid and Its Recovery Fluid

(Patent No. 200510042832)

The patent involves in a type of low-molecule environmental fracturing fluid and its recovery fluid. With stable rheological behavior and recoverable utilization, they can be recovered to be reused with the recovery rate of 50%, lessen the pollution of waste fluid and save lots of water and chemical addition agent.

Oil/gas Well Casing Patch Device

(Patent No. 200520079318.X)

The practical oil/gas well casing patch device can exclusively patch and repair the oil/gas well with corrosion penetration on the casing and keep max completion size. One patch can be tens or hundreds of meters long. The patch casing anchorage is reliable, and the compaction between the patch casing and the repaired casing is good. The casing intensity after repairing reaches steel grade J55 which meets the normal production demand.

Forced Cyclone-absorption and Adsorption Gas Liquid Separator

(Patent No. 02205023.X)

This gas liquid separator is usually used for oil-gas processing in oil & gas industry on the principle of gravitational separation, absorption separation, eccentric separation and coalescence separation. It can eliminate the counterforce of vessel wall on liquid drop due to gas centrifugal movement, weaken debunching action of liquid drop, and continuously separate oil and gas to improve gas-liquid separation probability and effect. The separation effect is better than the traditional separator, and the easy damage units are less. The separation efficiency of the liquid drop of above 5μm is more than 90%.

Multi-function Flash Dividing-liquid Water-sealing Blowoff Tank for Flammable Gas

(Patent No. 200620078546.X)

This tank is used for petroleum & petrochemical industries. It integrates with condensate fluid flash evaporation, flammable gas separation, and gas fire-resistant functions. Due to the application of one-tank multifunction structure instead of liquid separation tank, flash evaporation tank, and water sealing tank, it is characterized by material saving, simple structure, low cost and high efficiency.

Corrosion Inhibitor Preventing Associative Action of H_2S and CO_2

(Patent No. 200610105097.8)

This inhibitor can effectively prevent the associative corrosion of H_2S and CO_2 to production facilities during oil/gas field development and gathering and transportation. It is characterized by little dosage, low cost and high efficiency.

3 TYPICAL CASES

(1) Application of Underbalanced Drilling Technology

Since 1986, Changqing Petroleum Exploration Bureau has applied the underbalanced drilling and aerated mud with the medium of foam, natural gas, air etc. in many areas in China. In 2007, CNPC applied underbalanced drilling technology in Well Yuanba-102 of Puguang Gasfield. Total footage is 10,185ft, drilling time is 28.6 days that is 5.2 times of convenient mud drilling technology.

(2) Application of Fracturing Stimulation Technology in Changqing Oilfield

CNPC applied fracturing test in 3.73 mi^2 of area in well site ZJ60 of Changqing Oilfield in 1997. After the fracturing the injection-production result improves obviously. The drilling wells are lessened, but the average single-well production increases by 1.7%, and recovery ratio increases by 7%, and investment recovery period shortens by 2.6 years. Thereafter, this technology is applied in the whole Changqing Oilfield to provide technical support for low-cost and high-efficiency development of low-permeability reservoirs.

(3) Application of CO_2 Foam Fracturing Technology

In June 2000, we successfully applied CO_2 foaming fracturing technology in well Shan28 of

Shihezi Formation of Changqing Gasfield. The gas-bearing layer is 10,440ft deep in the well, and shows serious water-sensitive and water lock damage. During fracturing operation, the field engineers added 706.29ft^3 propping agent with the CO_2 foam quality is 58.4%. After fracturing operation, the fluid flowed back rapidly to ground, and the obtained open-flow capacity through gas production test is 19.8MMcf.

Up to date, more than 40 wells have applied the technology in low-permeability and low-pressure reservoir of Changqing Neopaleozoic sandstone gas field, where well depth is less than 12,139ft, well temperature is less than 266°F, permeability is less than 0.73mD, and pressure factor is less than 0.88MPa/100m. Operation success ratio is 100%, average flowback ratio is 98%, and fracturing effective rate is more than 90%.

(4) Application of Hydraulic Fracturing Technology in Carbonate Reservoir

Since 2005, the fracturing technology has been applied for 101 well-times, including 45 well-times in Uzbekistan Crook and Northern Urtabulak carbonate oilfields. Single-well production improves by 3-10 times, cumulative oil and gas production increases by 294Mbbl and 1.5bcf in six months after the commissioning.

(5) Application of Water-controlled Fracturing Technology

Oil-bearing layer Chang-2 of Changqing Jiyuan Oilfield is a typical bottom-water reservoir. Conventional fracturing technology may easily penetrate bottom-water layer and result in high water cut or water out, the reformation will be very difficult.

of 33.8Mbbl, and water cut is 10.5% after fracturing operation. The fracturing stimulation is always effective up to date. Therefore, this technology can be used to fracture the deep-penetration reservoir, control water cut after fracturing, and improve oil production.

(6) Application of Acid Fracturing Fluid

Acid fracturing fluid has been applied in Changqing Huachi and Suijin oilfields since November 2005. Aiming at the residue of fracturing fluid and calcium block within fracture, free-residue acid fracturing fluid can eliminate fracture block and improve productivity. When the technology is applied to 9 wells, the unplugging stimulation is realized, and incremental production is 2.6 times. Due to long-term plugging in well Yang 34-12, skin coefficient is 1.89, and oil production is decreased to 8.08bbl/d. After the application of acid fracturing fluid in April, 2007, oil production is increased by over 400% to 38.22bbl/d.

(7) Application of Multi-fracture Fracturing Technology

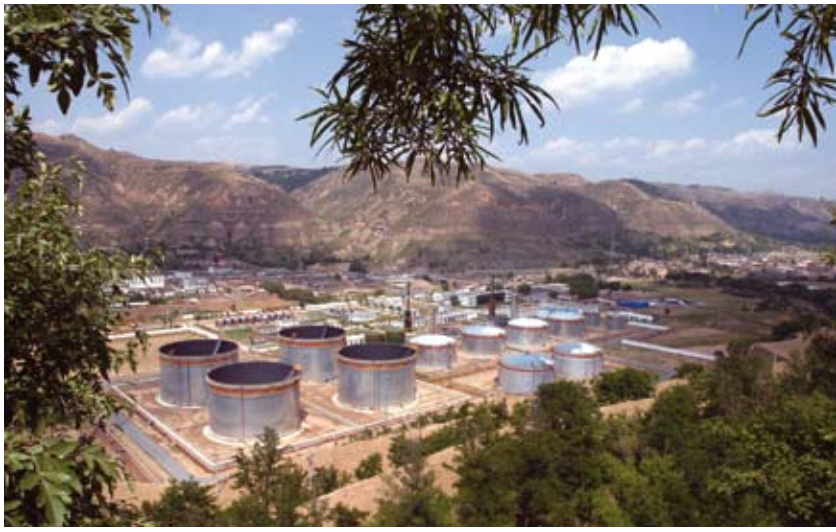
Multi-fracture fracture is successfully carried out in well Ping 33-33 of Changqing Oilfield in 2000. After fracturing the production improves from 9.85bbl/d to 21.68bbl/d. Up to now, the cumulative oil incremental production is 5416bbl, and cumulative effective period is 1231 days. And the technology is applied in over 520 wells in Changqing and Xinjiang oilfields.

4 SCIENTIFIC RESEARCH EQUIPMENT

CNPC can provide customers with integrate service of engineering consult, design and construction, and equipment manufacturing in the low permeability oilfield ground engineering domain. And special differential service for specific customer can be also provided.

Well drilling service. CNPC has more than 140 drilling rigs of Type 70D and 50D with 16.4MMf annual equivalent footage. In addition, it can provide various technical operations with the well depth of less than 22,965ft, including directional wells, cluster wells, horizontal wells, horizontal multilateral wells, slim directional wells, underbalanced wells, and cementing of natural gas well, sidetrack drilling of oil/gas wells. The whole course trace measurement and real-time control can be carried out. And CNPC can undertake the evaluation and drilling fluid design of particular reservoirs.

Reservoir stimulation and protection of acid fracturing. CNPC has over 100 sets of advanced Type SS-2000 fracturing pump vehicles with annual acid fracturing operation capacity of more than 5000 layer-times. In view of low permeability sandstone and carbonate reservoir, CNPC can provide fracturing geology research and technical assessment, overall block development and single well fracturing design and construction, undertake the operations with the well depth of less than 16,404ft of control bottom water fracturing, horizontal well fracturing, multi-fracture fracturing and expandable tube casing



damage well repair etc., analyze whole course fracturing test, and develop the matching tools and design the fluid.

Ground engineering construction. CNPC has 1028 sets of precision equipment. Annual design & construction capability is 22MMbbl of oilfield productivity, 18.87bcf of gas field productivity; large-diameter pipeline engineering is more than 621mi; crude oil processing is 11MMbbl, and the matching 36.75MMbbl productivity system is equipped; architectural engineering covers 270,200 square miles; the city distribution line covers about million consumers; the integrate exploration footage is 65,620ft; and the measured line is 1,553 miles. CNPC can design tall, grid and large-span light steel structure, combined with geomorphic and borehole features.

CNPC has 6 well-equipped laboratories and 2 test fields as follows:

Drilling/completion Fluid Laboratory
Rock mechanics Laboratory
Fracturing & Acidizing Laboratory
Well cementing Laboratory
Reservoir Damage Mechanism Laboratory
Mechanic & Electric Laboratory
Underbalanced Drilling/completion Test Field
Mechanics Test Field

5 QUALIFICATION AND STANDARD

Enterprise Qualification

Since CNPC passed the quality certification of International Standard Organization (ISO), it develops constantly, passes certification of ISO9001:2000 Quality Management System, ISO14000 Environment Management System, and first implements the HSE management system standard in China petroleum industry.

Technical standards

CNPC always provides a whole series of technical service. All tools and equipments are designed and manufactured according to API standard or other international standards. The techniques and products and equipments are connected with the international petroleum industry.

6 EXPERTS TEAM

Song Zhenyun has 25 years' research and field experience. He is a specialist in bottom water reservoir water control fracturing, CO_2 fracturing, low-permeability reservoir development and fracturing. He had published 2 papers in SPE and been awarded 2 national patents.

Sun Hu has 16 years' research and field experience in oil test fracturing and acidizing. He is a specialist in the fracturing and acidizing and testing, once in charge of fracturing of Uzbekistan Crook oilfield, integrate completion service of Shell Changbei Gasfield and Total Su'nan Gasfield. He had published 1 papers in SPE and been awarded 3 national patents.

Li Zhihang has 23 years' research and field experience. He is a specialist in CO_2 foam fracturing, acid fracturing and high temperature fracturing fluid.

Tan Ping has 25 years' drilling technical research and field experience, once in charge of the drilling project of Turkmenistan Ulaton Oilfield. He is a specialist of drilling equipments and direction well and horizontal well technologies.

Li Xiaoming has 17 years' experience of field drilling. He is a specialist in the drilling of cluster well, horizontal well and compound technical well and the fault treatment of complex well in low-permeability reservoirs.

Chen Zaijun has 20 years' research and field experience in drilling/completion fluid protection technology and conventional drilling fluid, once in charge of fluid technical service for Ecuador, Changbei Gasfield of Shell and Su'nan Gasfield of Total. He is a specialist in leaking protection and plugging, deep well and complex well condition treatment.

Liu Yi has 17 years' experience in designing natural gas ground engineering. He is skilled in gas field ground, gas pipeline and natural gas processing, once in charge of 629bcf ground engineering of Changqing Gasfield and 111bcf natural gas purification. He has got 2 "Copper Prizes" of excellent national design and 9 national patents.

Xia Zheng has 14 years' experience in ground engineering design, undertook the state key projects of Jing-Xian oil pipeline, Xifeng Oilfield productivity construction and refined oil pipeline of west oil, once in charge of ground engineering design and technical service of Ecuador AP Oilfield. He once won a "Copper Prize" of national excellent design.

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