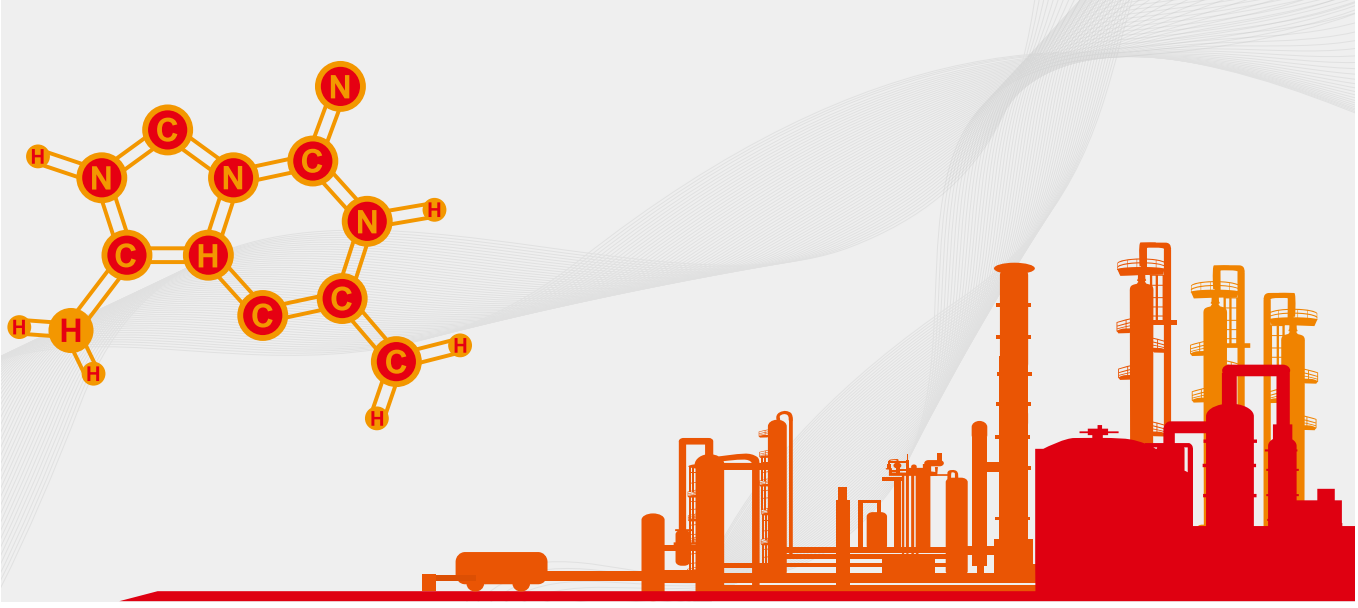


Technology

In 2015, CNPC continued to improve its technological innovation system and implement "Three Major Programs of Technical Innovation". Positive results were achieved in overcoming key technical bottlenecks constraining the development of our core business, massively deploying major technologies and equipment, building and running key laboratories and test bases, and promoting international exchange and cooperation in technology R&D. These led to further enhancement in our innovation capabilities and core competitiveness, rendering strong support to the steady development of the company.

Construction of Technological Innovation System

In 2015, we accelerated the reform of our technological research system and mechanism. Our science and technology infrastructure platforms, including 18 at national level, played a more important role in supporting technological innovation. National Research Center for Oil and Gas Drilling Equipment was completed on schedule. The setup of two key laboratories, one for the control and treatment of petroleum and petrochemical pollutants and the other for material service behaviors and structure safety of petroleum pipes and equipment, was approved by the Ministry of Science and Technology.

Policies for promoting the application of R&D achievements were further perfected. We issued and implemented *CNPC's Opinions on Promoting the Application of Major Technology and Equipment with Independent Innovation in Equipment Manufacturing Sector*. Moreover, we persistently improved the management over outcomes from major R&D projects and pushed forward with the initiative of achieving the tangibility of key technologies.

Major R&D Advancements

Exploration and Development

Breakthroughs were made in the theory and understanding of tight oil and gas geology, and key exploration and development technologies as well as a scale development model were developed, facilitating the E&P of tight oil and gas in the Ordos Basin and helping Changqing Oilfield maintain an annual output of 50 million tons.

With innovative exploration approach and geological theory on ultra-deep and super-large subsalt sandstone gas fields in Kuqa foreland thrust belt of Tarim Basin, we discovered a gas reservoir from over 7,000m-deep formations in the area.

New technologies were developed for the physical simulation of multiple components in the whole process of basin forming, hydrocarbon generating and hydrocarbon accumulating in petroliferous basins. These technologies enable the quantification, visualization and normalization of the simulation of hydrocarbon accumulation elements, providing a new approach for revealing reservoir-forming rules in complicated basins and guiding petroleum exploration deployment.

With deeper understanding on the mechanism of ASP flooding, we optimized and stereotyped six key technologies and set up and improved an integrated management mode. These make up a packaged ASP flooding technology system that has been industrially rolled out, yielding an oil output of more than 3.5 million tons in 2015. In fact, the packaged ASP flooding technology has become a strategic replacement technology for the ongoing development of Daqing Oilfield.

Assisted by an innovative simulation technology for lab test of heavy oil fire flooding, we uncovered the mechanism of fire flooding and tackled major technical difficulties in downhole high-power electric ignition and burning front control. The vertical well fire flooding technique has been put into industrial test on site, and will be a next generation technology for heavy oil development.

> Vigorously implementing the innovation strategy and adhering to the R&D concept of core business-driven, target-oriented and top-down design, we continued to build capabilities for proprietary innovation, integrated innovation and re-innovation, enabling a transit from a growth model driven by investment, capital and labor to the one powered by innovation.

Innovative core technologies for shale gas exploration and development powered the advancement of our shale gas operations. These technologies cover geophysical data acquisition, processing and interpretation, logging data acquisition and evaluation, comprehensive geological evaluation and development optimization, horizontal well drilling and completion, and SRV fracturing.

A methodology system for the evaluation of conventional and unconventional oil and gas resources worldwide has been developed, speeding up the evaluation of new projects and exploration of existing projects in Central Asia, Africa, Asia & Pacific, the Middle East, and South America. Major technological breakthroughs in developing large carbonate reservoirs enabled the efficient development of large bioclastic carbonate reservoirs in Iraq.

Refining and Chemicals

Major breakthroughs were made in the development and application of an internationally advanced technical package for 10Mt/a refineries, making CNPC capable of undertaking the overall design and the independent design of all major processing units for refineries of such a scale.

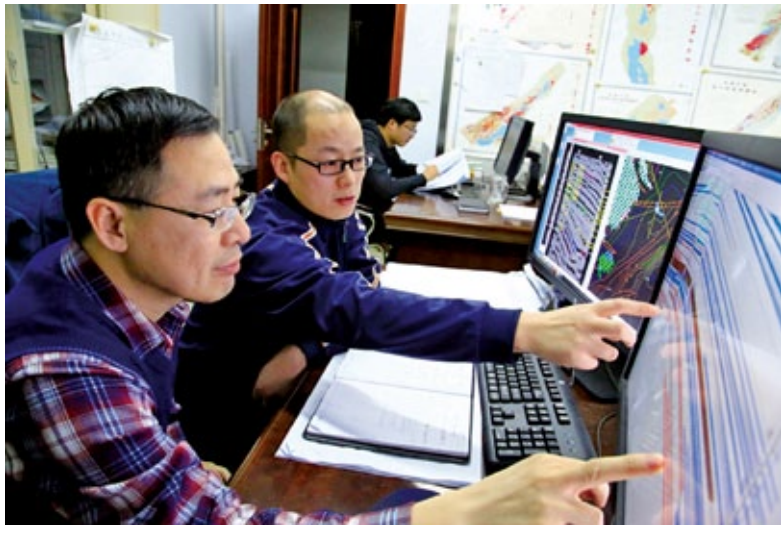
A technical package for the production of clean-burning gasoline meeting the National IV Emission Standard for Automobiles provided technical guarantee for us to upgrade our oil products. An industrial test for the steady production of National V Standard gasoline blending components proceeded steadily, with the blending products of gasoline pool meeting National V Standard.

Breakthrough was made in the development and industrial application of new polyolefin products. Polyolefin for gas pipes and additional 35 kinds of polyolefin products were developed and produced on an industrial scale. An innovative mode of product development and promotion that integrates "production, marketing, research and consumption" took shape, helping us increase the economic benefits of polyolefin production units.

Technical package for industrial production of NdBR was developed and tested successfully, making CNPC capable of producing a rare earth catalyst system of BR (cis-1, 4-polybutadiene rubber) and commercially producing NdBR.

Oilfield Services and Storage & Transportation

In geophysical prospecting, our research on seismic technologies for fine development saw significant breakthroughs in data acquisition and processing, providing effective technical support for fine adjustment and potential tapping in mature oilfield development. The world-leading technologies for precise seismic imaging and gas reservoir identification in complex mountainous structures were developed and widely applied in oil and gas exploration at seven basins in China and such structures in 12 countries, facilitating the discovery of four gas reservoirs with over 1tcm reserves each in Tarim Basin and Sichuan Basin.



In well logging, we developed the azimuthal resistivity imaging LWD tool, providing a new means for fast evaluation of complex reservoirs and geo-steering in horizontal wells. The technical package for ultra-deep carbonate imaging logging was widely deployed and much improved the interpretation coincidence rate.

Regarding drilling operation, high-performance water-based drilling fluids for horizontal shale gas wells were developed and would become an effective alternative to oil-based drilling fluid for shale gas development. The matching technologies for superior and fast drilling and completion of deep and ultra-deep wells helped us massively increase reserves and quickly ramp up production in key regions. Factory-like operations in horizontal well drilling and completion as well as reservoir stimulation became a major approach for the exploration and development of tight oil and gas, shale gas, and other unconventional resources.

In terms of storage and transportation, our innovative X80/Φ1422 pipeline construction technologies facilitated the building of the eastern route of the Russia-China Gas Pipeline. Sixteen categories of pipeline equipment such as high-power gas-driven compressor unit could be domestically manufactured, reducing the cost by more than 20%.

Technological Cooperation

We promoted technological exchange and cooperation in terms of EOR, unconventional hydrocarbons, and wastewater treatment and recycling both at home and abroad. With a mechanism in place for a variety of well-organized, targeted communication and cooperation, we made new progress in technology R&D and the nurturing of internationalized talent. Our work with Chinese Academy of Sciences (CAS) and China Aerospace Science & Industry Corporation (CASIC) drove organic integration between the innovation and industrial chains. We held a high-level forum with GE on technological innovation and management, and signed a MOU on R&D cooperation in CCUS, low carbon and environmental protection technologies, and development of unconventional hydrocarbons. We actively participated in the exchange activities held by international and industrial academic organizations and utilized international meetings as a platform to present our intelligent waterflooding, chemical flooding for EOR, sophisticated well drilling and completion and other new technologies.

Intellectual Property Rights

Our portfolio of intellectual property rights was further expanded and improved with a record number of 5,153 patents (2,778 of which were invention patents) applied for and 4,753 patents (1,145 of which were invention patents) granted in 2015. We had 391 registered computer software copyrights and 220 recognized know-hows. In particular, six of our patents were awarded National Patent of Excellence. The number and quality of our IPR achievements witnessed continuous improvement.

Science and Technology Awards

In 2015, four of our major R&D achievements won China's national award of science and technology. Particularly, "Theoretical and Technological Innovations for the Exploration and Development of Ultra-Low-Permeability Tight Oil and Gas Reservoirs" was awarded the first-class National Science and Technology Progress Award; and "Technology for Precise Seismic Imaging and Gas Reservoir Identification in Complex Mountainous Structures and Its Industrial Application" was awarded the second-class National Technical Invention Prize. Our Smart Driller Indicator (SDI) became one of the 16 winners of US E&P's 2015 Special Meritorious Awards for Engineering Innovation. This is the first time for CNPC to win the award.

Patents applied **5,153**

Patents granted **4,753**

Breakthroughs in geologic theories and technologies facilitate tight oil E&P in the Ordos basin

With new understandings on tight oil geology, CNPC innovated a series of key technologies for tight oil exploration and development, leading to major breakthroughs in tight oil E&P in the Ordos Basin and stable oil production of 50Mt/a in the Changqing Oilfield.

The theoretical and technological breakthroughs include: (1) establishing a semi-deep lake — deep lake "lobe + channel" gravity flow sedimentation model for continental lake basins, overcoming obstacles in hydrocarbon prospecting in deep zones and expanding the exploration scope of tight oil in the Chang-7 block of the basin; (2) discovering differences in the reservoir space and oil/gas microscopic occurrence state of tight reservoirs and low permeability reservoirs, and confirming that the seepage system of tight reservoirs is dominated by inter-connected cluster pore throats and SRV fracturing is an effective way to tap tight oil; (3) deepening the tight oil accumulation mechanism of "high intensity hydrocarbon generation, continually charging, proximal concentration" for large continental lake basins, and putting forward the physical property threshold for hydrocarbon accumulation in tight reservoirs; (4) setting standards and specifications for tight oil sweet spot prioritizing and resource/reserve evaluation, and bringing forward the "horizontal well + SRV fracturing" method for tight oil development; and (5) working out the quasi natural energy development mode for horizontal wells, well pattern form, the reservoir energy reestablishment approach and the R&D plan, and realizing scale development of tight oil for the first time in China.

These theoretical and technological breakthroughs have been successfully applied in the exploration and development of tight oil, as the exploratory success rate increased from 60% to 78%, output per single well increased by 4-6 times, and 13 favorable target zones ascertained. China's first 100-million-ton tight oil field — Xin'anbian — was discovered, and an annual production capacity of 1million tons has been built.