



Casing Drilling Technology

Science & Technology Management Department

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CHINA NATIONAL PETROLEUM CORPORATION

*CNPC wishes to provide you with
a complete set of premium Casing
Drilling Technology services!*



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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 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 Casing Drilling Technology (CDT) is one of representatives for major innovations of CNPC.

CLEAN ENERGY SUPPLY FOR BETTER ENVIRONMENT

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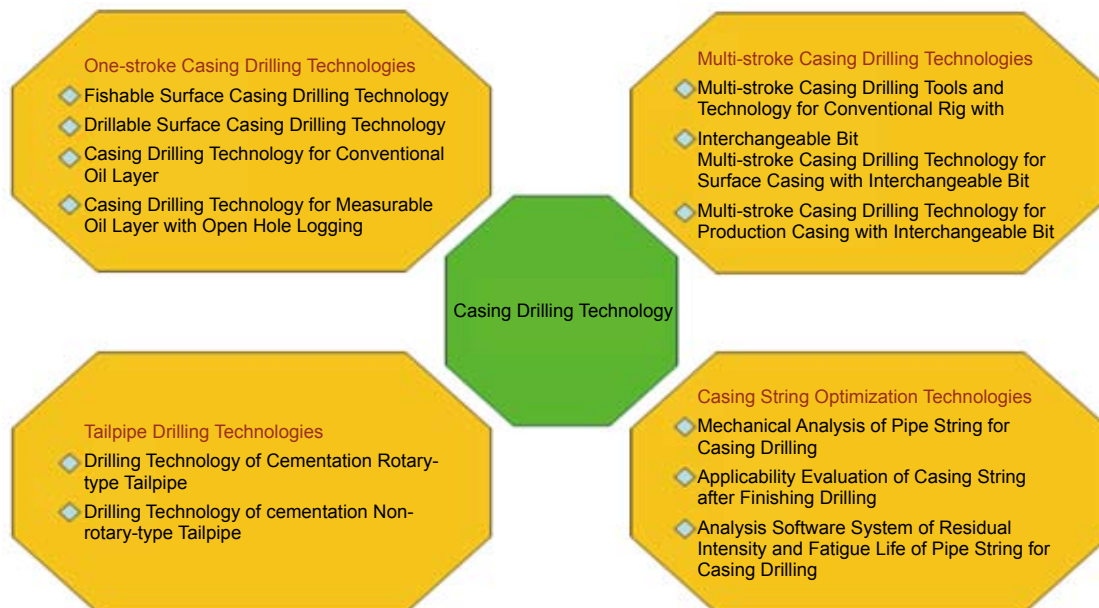
INTRODUCTION

Since 2000, CNPC, which indeed carries forward tackling key problems and practising the Casing Drilling Technology with table driving means, has developed many unique technologies. Casing drilling refers to the technology that in the process of drilling, the conventional drill stem of transferring torque and drill pressure to downhole is directly replaced by casing; running casing is proceeded while drilling; after drilling is finished, the casing which used to be drill stem is remained in well to be used for well completion. Casing Drilling Technology can finish drilling and running casing in one operation procedure, without the need of the conventional tripping operation.

CNPC has independently researched and

developed 12 unique technologies of four series in aspect of Casing Drilling Technology. The 4 main series are One-stroke Casing Drilling Technologies, Multi-stroke Casing Drilling Technologies, Tailpipe Drilling Technologies and Casing String Optimization Technologies. Equipped with many technical experts and complete sets of advanced casing drilling tools and equipment, CNPC is able to provide a complete set of premium total solution and technical service on casing drilling.

CNPC's Casing Drilling Technology has been promoted and applied in more than 40 wells in Jilin Oilfield, Daqing Oilfield, Dagang Oilfield and Henan Oilfield, and has won high praise for its favorable application effects.



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UNIQUE TECHNOLOGIES

2.1 One-stroke Casing Drilling Technologies

Casing drilling refers to that in the process of drilling, the conventional drill stem of transferring torque and drill pressure to downhole is directly replaced by casing; running casing is proceeded while drilling; after drilling is finished, the casing that used to be drill stem is remained in well to be used for well completion. Casing Drilling Technology can finish the drilling and running casing in one operation procedure, without using the conventional tripping operation again. The so-called One-stroke Casing Drilling Technologies refer to the technologies that use a bit to finish the designed footage, without tripping and bit-change operation in midway. The technologies are fit for surface casing (protector casing) drilling and through-reservoir shallow development well drilling.

2.1.1 Fishable Surface Casing Drilling Technology

Fishable Surface Casing Drilling is the technology that after the completion of surface casing drilling, fishing tool is laid down to fish for downhole tools and bit in surface casing with fishable bit device. Fishable Surface Casing Drilling could solve different kinds of complication met in surface drilling, thus obviously shortening the drilling periods and saving drilling cost.



2.1.2 Drillable Surface Casing Drilling Technology

Drillable Surface Casing Drilling is the technology where the drillable bit is jointed with the undermost casing to conduct the drilling operation with conventional mode and after drilling to the designed well depth, well cementation can be conducted. Drilling Technology of Drillable Surface Casing can save drilling time and operational cost.



2.1.3 Casing Drilling Technology for Measurable Oil Layer with Open Hole Logging

Casing Drilling Technology for Measurable Oil Layer with Open Hole Logging is the technology where after finishing drilling of production casing, the bit is discarded at the bottom of a well via a connecting-tripping device and then according to the height of casing string needing to be upward strained, open hole logging for main target zone is proceeded. This technology can provide accurate well logging data for geological departments.



2.1.4 Casing Drilling Technology for Conventional Oil Layer

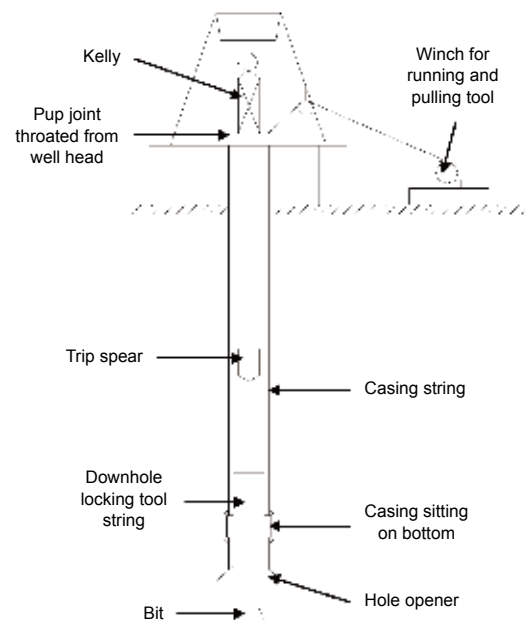
Casing Drilling for Conventional Oil Layer refers to the technology where under the table driven mode, Kelly and casing string are jointed together with a casing holder or a torque limiter, underpart of casing string and bit are jointed by a completion connector and after finishing drilling the bit is stayed in the well and then cementation completion is directly proceeded. The technology, which is fit for developing shallow layer wells, can reduce drilling cost, decrease occurrences of downhole accidents, shorten construction cycle, decrease reservoir damage and enhance deliverability of a single well.



2.2 Multi-stroke Casing Drilling Technology

Multi-stroke Casing Drilling refers to the casing drilling technology where particular tripping device and downhole tool system are adopted to attain the aim of bit change. The technology can be applied in the drilling operation which is aimed at increasing drilling speed and solving complicated issues.

The tool system of multi-stroke casing drilling is mainly composed of three parts, including running and pulling tool, downhole locking tool string and casing sitting on bottom. While drilling with casing is proceeded, downhole locking tool string is locked on casing sitting on bottom, locking between the bit and casing string is achieved, and transmission of drilling torque and drill pressure is finished. If needed, the fishing tool connected with wire rope is used to proceed trip downhole locking tool string in the casing, and a pup joint and a wire line preventer are throated from well head to ensure the normal circulation of drilling fluid in the course of tripping.



2.2.1 Sealing device of wire rope

The device is mainly composed of tapered bore screw, packing unit and outer cylinder, etc. It plays the sealing role for wire rope in the course of casing drilling. Sealing device of wire rope has the advantages of good sealing result, long service life and convenience to change obturator, etc.

2.2.2 Pup joint throated from well head

The pup joint is mainly composed of main shaft, sealing device of wire rope, leather cup and locknut, etc. While running and pulling tool in well, wire rope passes through the sealing device, the wire rope is sealed with packing unit in the sealing device to guarantee the normal cycle of drilling fluid. The pup joint throated from well head has the advantages of good sealing result, long service life and simple construction, etc.



2.2.3 Casing sitting on bottom

In the tool there is a locking pup joint, and in the underpart of the pup joint there is a carbide tipped casing shoe. If it is needed for multi-stroke casing drilling, the locking and unlocking between downhole tool string and casing sitting on bottom are carried out with special tools like trip spear. The casing sitting on bottom has the features of simple construction, reliable locking and dependable unlocking.



2.2.4 Hole opener while drilling

The tool is mainly composed of shell body, rack shaft, spring, nozzle, circlip, blades of hole opener and wrists, etc. PDC cutting granules are inlaid on the blades of hole opener. During casing drilling, the well bore drilled with pilot bit can be expanded to design size. Hole opener while drilling has the advantages of resistance to wear, high hardness, fast drill speed and long service life, etc.



2.3 Tailpipe Drilling Technologies

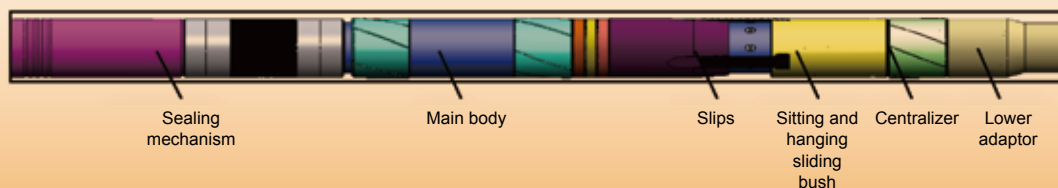
Tailpipe Drilling Technologies refer to the drilling technologies where drill stem is connected with tailpipe drilling system by a special mechanism, drilling is conducted through the system, after finishing drilling cementation is done and then drill stem is pull out while casing stays downhole. The technology provides an effective drilling method for drilling construction in the depleted reservoir, formation with high differential pressure and fractured formation having the features of unknown depth and large pressure difference.

2.3.1 Rotary mechanism

The device, mainly composed of overcoat, bearing, dynamic rotary seal assembly and mandrel, is connected between the conventional casing cement head and the kelly to keep relative rotation between cement head and kelly to improve the quality of well cementing.

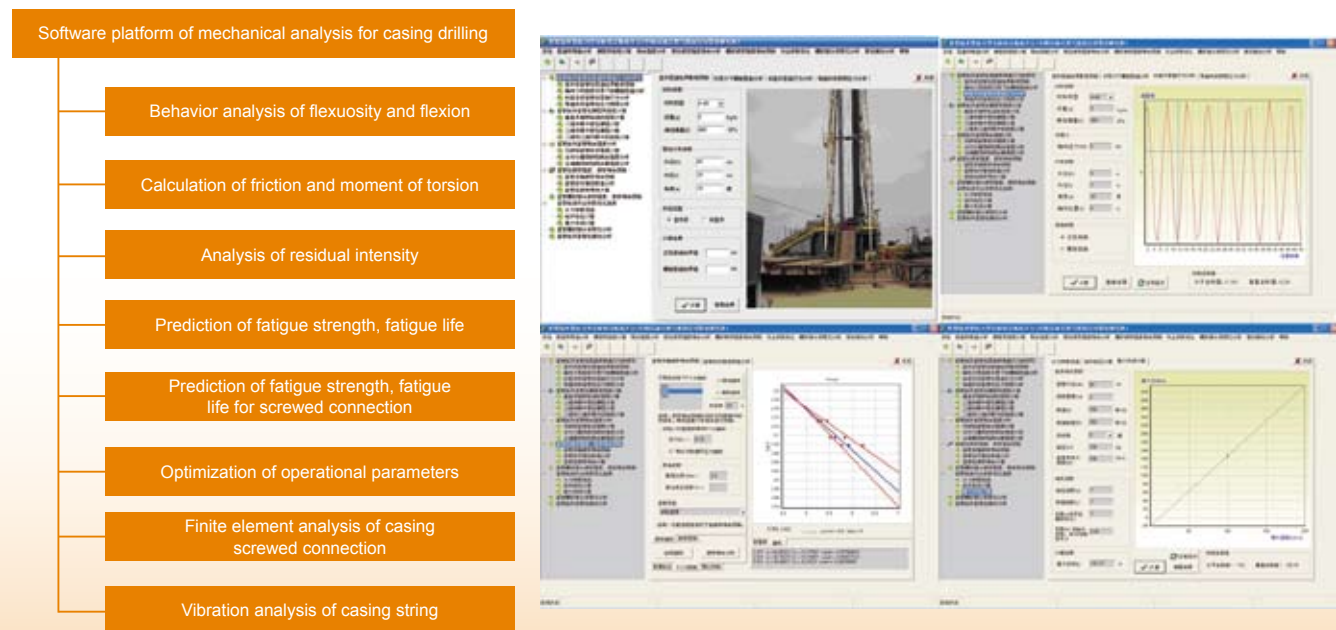
2.3.2 Rotary extension hanger

The tool is mainly composed of running tool, hanger and cementing adjuncts. It can be used not only in drilling but also for rotary cementation. The rotary extension hanger has the features of drilling reliability, operational safety and excellent quality of well cementing, etc.



2.4 Casing String Optimization Technologies

On the basis of mechanical property analysis of casing string under the conditions of different downhole operational modes, with these technologies, mechanical model of casing drilling pipe string is established and software platform of mechanical analysis for casing drilling is integrated. The platform can be used for behavior analysis of flexuosity and flexion for pipe string in casing drilling, and calculation of friction and moment of torque, analysis of residual intensity of pipe string and prediction of fatigue strength, fatigue life, and optimum design of operational parameters, etc.



2.5 Provided with Multiple Patented Technologies

As the diligent and persistent explorer and practitioner in Casing Drilling Technology, CNPC owns 6 patents for inventions and 30 patents for utility model. These patents and relevant products have settled the leading position of CNPC in casing drilling domain.

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TYPICAL CASES

3.1 Application Case for Fishable Surface Casing Drilling Technology

In the course of drilling surface layer in Blocks of Jilin Oilfield, such as Xinmin and Fuyu, there often occur sloughing, leakage loss, rock mass falling and pressure anomaly, etc. which make tripping in surface casing difficult. Therefore, the operations like pulling the casing and hole redressing had to be performed, hence a waste of time, capital, manpower and resources. In 2006, the application of Fishable Surface Casing Drilling Technology in Xinmin and Fuyu Areas solved the above problems. The penetrate rate is increased by 4% and the drilling cycle is shortened by 10%. The technology has become the typical method of surface stratum drilling in complex areas in Jilin Oilfield.

3.2 Application Case for Drillable Surface Casing Drilling Technology

In 2007, Drillable Surface Casing Drilling Technology was applied in tidal zones and shallow water areas of Dagang Oilfield where a total of 7 wells were finished. Compared with those wells by the conventional drilling, its penetrate rate is increased by 10% and completion cycle is shortened by 50%. The utilization of drilling rig and drilling efficiency are improved and the drilling cost is effectively declined.

3.3 Application Case for Casing Drilling Technology for Measurable Oil Layer with Open Hole Logging

In 2005, in the site operation of Fuyu Area in Jilin Oilfield, the open hole logging in main reservoir was achieved with connecting-tripping device of bit, including 5 items of series logging, i.e. dual lateral, sonic, gamma, electrode system, continuous well deviation, which satisfied the requirements of geology for collecting stratigraphic information.

3.4 Application Cases of Casing Drilling Technology for Conventional Oil Layer

The technology with the same well structure as the conventional drilling was applied in Jilin Oilfield, Daqing Oilfield and SinoPec Henan Oilfield, where totally 23 wells were finished. Compared with those generated by the conventional drilling in the same area, the penetration rate is increased by 9%, the well completion cycle is shortened by 26%, the drilling cost is declined by 11%, and excellent trend is displayed in respect of protecting reservoir and improving deliverability of a single well.

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R&D EQUIPMENT

CNPC owns high-level research and development ability and service teams for Casing Drilling Technology, and owns 2 laboratories with superior equipment and all kinds of special installations.

Petroleum Pipeline Engineering Laboratory

It is the key laboratory of CNPC, going in for the research of cutting-edge technical reserves and application base of petroleum pipeline engineering, and is the base of scientific research,

technological innovation and personnel culture for petroleum pipelines. A series of researches can be conducted in the laboratory, such as mechanics of oil well pipe and pipe string, mechanics of gathering line and pipeline, technology of security and integrity of piping, diagnosis, prediction and prevention technology for invalidation of oil country tubular goods, corrosion and protection technology of oil country tubular goods.



Petroleum Engineering Laboratory

It belongs to the key laboratory of CNPC, has qualification certifications of CMA (China Metrology Accreditation) and CNAS (China National Accreditation Service for Conformity Assessment). The laboratory can provide the pilot test means for petroleum drilling and production and new products of downhole tool before being put into field use, thereby increasing the reliability of research and development for tool products.

Wear Testing Machine

Experimental investigation of the wear conditions for typical rocks and casings of different steel grades that are used for casing drilling can be carried out with wear testing machine. The experimental results can be used to confirm the wear and tear defects of exterior surface of casing when casing drilling operates to a certain depth or after finishing drilling, and can provide necessary theoretical and data preparation for experimental simulation of substances that simulates properties (i.e. crumpling resistance, pull resistance, resistance to internal pressure) of the casing having defects on the external surface. Thereby it confirms the residual life of the casing after finishing casing drilling much more exactly, and the reliable drillable depth of casing string under the given condition of casing and operational parameters.

Multifunctional Testing Machine

Via hydraulic control, the tests (i.e. pressurization, rotation and circulation) for functional properties of correlative tools with casing drilling can be carried out with multifunction testing machine to ensure the reliability of tools.



Electronic Universal Testing Machine

Electronic universal testing machine is mainly used for static tension test of casing which has different steel grades and is used for casing drilling, thereby getting parameters of static tension properties of casings with different steel grades and providing scientific foundation for more reasonable casing selection.



Universal Material Testing Machine

Universal material testing machine is used for multi-shaft protracted test of casing which has different steel grades and is used for casing drilling, so as to test the variation of lifetime for casing under the conditions of different stress levels, different torque loads and different tension loads, etc., thereby getting the fatigue mechanism and failure law of casing and then providing scientific foundation for the optimization of casing string.



5 QUALIFICATION AND STANDARD

5.1 Enterprise Qualification

CNPC has 14 items of national Grade “A” qualification and first-grade construction qualification of Ministry of Construction and Ministry of Transport (including qualification for EPC and engineering exploration design), has obtained National AAA Credit Grade Certificate and passed the certification of GB/T19001 Quality Management System. 34 units carry into execution of HSE Management System, among which 20 have passed HSE System Certification.



5.2 Technical Standard

CNPC constantly strives for the perfection of the full line of technical services that it provides to the customers as per API international industry standard, and its technical processes and production equipment are fully aligned and integrated with those within the industry.

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EXPERT TEAM



Su Yinao (Professor, Member of China Engineering Academy, Director of State Engineering Laboratory of Oil and Gas Drilling)

He has long been engaged in technical research and application of drilling engineering, with many innovations in the research of drilling mechanics, path control and downhole tools reaching the internationally advanced level. He has proposed the frontier of “Downhole Control Engineering” and presides over tackling key problems of associated cutting-edge technology. He has obtained 1 second prize of National Technology Invention Award, 1 first prize and 2 second prizes of National Science and Technology Progress Award and 18 national patents for invention. He has published 7 monographs and more than 150 research papers.

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Zhang Fengmin (Professor-level senior engineer)

He has gone into technical research and deployment application of new techniques and processes for well drilling for a long time. He has obtained 2 first prizes, many second prizes of CNPC Technology Innovation Award and more than 10 patents. He has published over 20 research papers.

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Wang Hui (Senior engineer)

He has gone into the research of mechanical equipment and materials in petroleum engineering and organized the development of Casing Drilling Technology for a long time. He is in charge of many scientific researches to tackle key problems of state or CNPC-level. He has made 5 provincial and ministerial-level achievements, obtained 19 patents and published 15 research papers.

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Wang Li (Senior engineer)

He has gone into the research of drilling technique and deployment work, presided over and finished the research of Casing Drilling Technology and its field test work. He has obtained Sun Yueqi Energy Resource Award. He has undertaken many scientific researches of state and CNPC-level. He has made 5 provincial achievements, obtained 16 patents and published over 30 research papers.

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Zhang Jinan (Professor-level senior engineer)

He has gone into technical research and deployment application of new techniques and processes for well drilling. He has undertaken multiple scientific researches of state or CNPC-level. He has made 2 provincial and ministerial-level achievements, obtained 12 patents and published 25 research papers.

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Zheng Wanjiang He has undertaken drilling engineering for 28 years, being good at the research of drilling techniques and instruments. He now takes charge of site technical services on casing drilling. He has undertaken many scientific researches of state and CNPC-level. He has made 3 provincial and ministerial-level achievements, obtained 16 patents and published 8 research papers.

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Song Shengyin (Researcher)

He has mainly undertaken scientific research in drilling and oil well pipe. He is in charge of optimum design work of casing string. He has obtained Sun Yueqi Energy Resource Award, presided over and undertaken the aiding project of United Nations Development Program (UNDP), technical exchange project of China and UK, over 20 major national science and technology research projects and provincial and ministerial-level projects. He has obtained 7 state, provincial and ministerial-level science and technology progress awards, published more than 40 research papers, co-authored 2 monographs and obtained 9 patents, including 2 patents for invention.

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