

Winning Trust with Technology





Gong Bencai

Vice President of CNPC America Ltd.

President of SAPET Development Peru Inc.

Block 6/7 of the Talara Oilfield in Peru are both old fields with a development history of more than 100 years, where a total of five oil companies once operated with all kinds of technologies applied. Some experts claimed that the oil-producing potential of the two blocks had been exhausted. Since CNPC became the operator of the blocks, its proven technologies for releasing the potential of mature oilfields have been given full play, with impressive results achieved.

First, measures were taken to rebuild long shut-in wells. When the Chinese side took over Block 6 and Block 7, there were around 5,000 wells drilled, with only 509, or 1/10 of the total, producing oil. Most of the remaining wells had long been shut in and covered by weeds and sands. With a daily oil output of only 1,700 barrels, or an average per well yield of about three barrels, the oilfield was about to be abandoned. After conducting rounds of discussion and in-depth research, CNPC's technical team was confident of rebuilding the shut-in wells and rejuvenating the moribund oilfield.

To this end, the technical team has drawn on China's sophisticated theories on continental facies fault-blocks and leveraged CNPC's technical edge in integrated exploration and development to study reservoir distribution pattern, the ratio of total oil produced to OOIP, and the distribution law of remaining oil based on geophysical, well logging and cutting logging data. Efforts were focused on rebuilding those long shut-in wells located in favorable oil zones to ensure the success rate. Meanwhile, timely monitoring was made on the production dynamics of successfully restored wells in order to provide the basis for further stimulation measures to maximize their production capacity.

Facts proved that our measures worked. Over the past 20 years, 736 long shut-in wells have been restored in Block 6/7, 17.42% of the total number of shut-in wells, achieving an additional oil output of 3.30 million barrels, 14.36% of the blocks' total production achieved since CNPC's takeover. The restoration of the long shut-in wells has made up for the old wells' production decline, and effectively helped to maintain stable production and achieve production growth.

Second, efforts were intensified to activate the oil-producing potential of old wells. In view of the fact that Block 6/7 host a multiplicity of old wells, stimulation measures were widely implemented. Priority was given to favorable pay zones and an in-depth study on the distribution pattern of remaining oil was made to prioritize candidate wells. For different oil-bearing formations, conventional measures were taken such as re-perforating, acidizing and fracturing. In addition, we also actively introduced new output-boosting approaches. At Block 6/7, attention was previously attached to major oil-bearing layers, with relatively shallow oil layers usually being ignored and remaining un-cemented. In 2009, by introducing secondary cementing technology, these shallow reservoirs have been optimally stimulated, resulting in remarkable production growth. Particularly for well J74, its daily additional oil output reached 505 barrels at early stage since its reworking in 2011, the best result achieved in the past decade. In 2012, we introduced China's advanced "secondary deflection fracturing" technology to Talara and conducted pilot tests at five wells, with varying degrees of success seen in boosting oil output. The success of this technology was significant for oil producing potential release in Block 6/7 and even the entire Talara Oilfield.

The effective application and implementation of appropriate technologies has achieved impressive results. First, crude output was significantly boosted. In just three years, a dying oilfield had been revived, with its annual output increased from 600,000 barrels to 2.2 million barrels, leading the Peruvian media to hail the project's success as the most impressive news in Peru's oil sector. Second, a breakthrough was made in new well drilling. Since CNPC's takeover,

more than 200 new wells have been drilled, including a number of 1,000-barrel-per-day wells and Peru's first horizontal well. And third, expertise and experience has been gained in the progressive exploration and development of complex fault-block fields and the exploration and development of depleting fields. These achievements have fully reflected CNPC's technical advantage and capacity, winning us trust and respect from Peru's oil sector.



Exploration and Development Achievements in Peru:

- 3D seismic explorations were conducted for the first time in Block 7 of Talara Oilfield, discovering the northern San Juan Oilfield with an annual oil output of 576,000 barrels;
 - Breakthroughs were made in identifying new oil reservoirs, with multiple 1,000-barrel-per-day wells successfully drilled;
 - Drilling was extended to deeper zones, hitting a high-yield oil-bearing layer nearly 10,000 feet underground, debunking a mistaken claim long upheld in the Western geological community that "there are only aquifers 8,700 feet underground";
 - By innovatively applying layer dividing and re-perforating to stimulate old wells, a record high daily output of 3,300 barrels has been achieved;
 - Exploratory oil wells were drilled in "untouched" or "ruled-out" zones, with off-angle drilling techniques being used to extend the reach to offshore areas. All 31 new wells have encountered oil layers, with an average initial oil output of 118 barrels per day.
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Since engaging in international oil and gas exploration and development activities 20 years ago, CNPC has given full play to its advantages in integrated operation and actively promoted technological advances and innovations in overseas projects, obtaining impressive achievements and standing out in the world oil industry. The company's "Key Technologies for Effective and Efficient Development of Overseas Oilfield" won the first prize of China National Science and Technology Advancement in 2011. CNPC's technological R&D and comprehensive integration of domestic and foreign technologies have achieved mutual benefits with host countries in Latin America, with its core technical competence and brand image considerably enhanced.

After decades or even more than a century of exploitation, most oilfields in Latin America have

entered their later stage of development, posing increasingly tough challenges for boosting oil production. Since taking over some marginal oilfields in Peru, Venezuela and Ecuador, CNPC has managed to rejuvenate these old oilfields and increase their oil output, by using applicable technologies and rich experience in mature reservoir stimulation, heavy oil exploitation and horizontal well drilling, based on fine reservoir description, study of remaining oil distribution and reasonable technical solutions. CNPC's "Technologies and Their Application for Tapping Potential of Marginal Oilfields in Venezuela" won the second prize of China National Science and Technology Advancement in 2002. The company's EOR technologies have also greatly impressed Latin American counterparts and won widespread recognition.

Talara Oilfield in Peru

Situated in the coastal desert to the west of the Andes in northwestern Peru, Talara Oilfield is one of the earliest developed oilfields in South America. Its Block 7 and Block 6 were put into development in 1874 and 1903, with peak annual output of more than 10 million barrels and 5 million barrels, respectively. In the early 1990s, the two blocks had reached their later stages of development, with 98% of the recoverable reserves already produced. Annual production plummeted to 650,000 barrels, and the two blocks were on the verge of being abandoned.

In October, 1993, SAPET Development Peru Inc. (SAPET), a subsidiary of CNPC, signed an EOR service agreement with the Peruvian Ministry of Energy and Mines and became the operator of Talara's Block 7 and Block 6 in January 1994 and October 1995, respectively. This marked CNPC's debut in overseas oil and gas operations.

Talara is a typical complex fault-block oilfield, featuring well-developed fractures and complex



Working Site of Block 6/7, Talara Oilfield, Peru

geological conditions. After more than 100 years of exploitation, drastic changes had occurred to its original oil and gas distribution pattern and features, making the controlling factors to oil/gas/water distribution more complicated, and the exploiting condition much more challenging.

In view of the fact that Talara Oilfield is quite similar to China's Bohai Bay Basin in geological characteristics, we conveyed our experience in progressive exploration and development of China's complex fault-block oilfields to Talara. By taking measures including comprehensive development evaluation, re-perforating of old wells, low-permeability reservoir stimulation, restoring shut-in wells, swabbing, and secondary oil recovery by water flood, production at the Talara field has increased and remained stable.

In order to develop the oilfield in a more efficient manner, maintain its stable production and continuously enlarge its resource base, CNPC decided to carry out progressive exploration and development in Talara as it has done for years in China. Based on in-depth and comprehensive studies of geological conditions of the oilfield, more targeted technical solutions were worked out, resulting in the discovery of 11 new oil-bearing fault blocks and four new gas-bearing fault blocks in Block 6/7, with substantial high-quality reserves. By drilling new wells and stimulating and restoring old wells, the oilfield's crude production has been significantly boosted. Since 1996, its annual output has remained above 1 million barrels and peaked in 1997 at 1.96 million barrels. In addition, the success rate of new wells has been greatly increased, especially in Block 6, where the success rate has reached 70% and a series of 1,000-barrel-per-day wells were drilled, causing a sensation in the local oil sector.



Caracoles Oilfield, Venezuela

Caracoles Oilfield in Venezuela

Located in the south of the Eastern Venezuela Basin, the marginal Caracoles Oilfield features a monoclinic structure complicated by a large number of faults. Its oil reservoirs are characterized by small reserve volume, quick-declining output in single layer, deep burial depth, and high pressure coefficient. Most of the heavy oil reservoirs are edge-bottom water driven and flooded, with a water cut of more than 70%. Before being included in third round of international tenders by the Venezuelan government, Caracoles had been exploited successively by the Venezuelan private oil companies, US based oil companies and PDVSA for more than 50 years, and annual production once peaked at 4.85 million barrels. In February 1998, when CNPC took over the oilfield, there were only 43 producing wells yielding 221 tons per day. Most of its reservoirs had been already substantially exploited, flooded or depleted.

There are many foreign oil companies operating in Venezuela. We believe that a good partner shall have advantages in oilfield operations, technology and management. After working with CNPC for nearly 10 years, we've been quite satisfied with the results. We look forward to working with CNPC on more projects in following decades.

Victor Moreno

Former president of PDVSA-CNPC joint venture PETROSIVEN

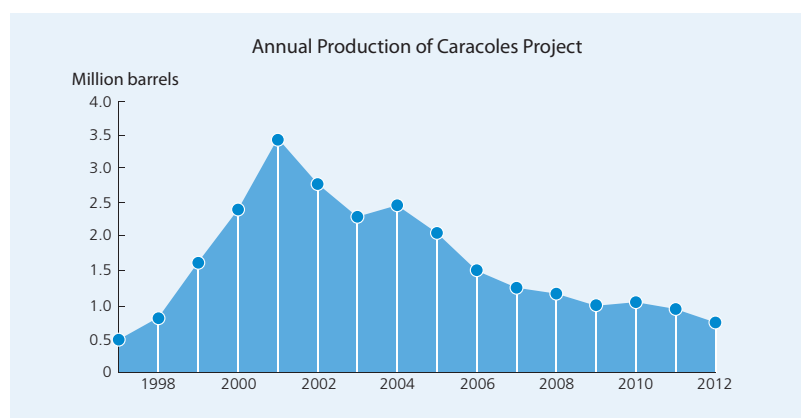


Since becoming the operator, CNPC has made a fine description of the field's tectonic features and reservoir distribution by integrated use of high resolution seismic data processing technology, multi-attribute fusion technology and high precision reservoir prediction technology, thereby laying a solid foundation for reservoir potential tapping and progressive exploration. In oilfield operations, fine reservoir description, low-resistivity reservoir identification and study of remaining oil distribution laws were made based on seismic and logging data, and research results were achieved in oil layer correlation and numerical simulation. By taking technical measures such as expanding edges, re-perforating old wells, extracting liquid by electrical submersible pumps, restoring shut-in wells, optimizing gas lift and heat-washing oil wells, both the reserves and production of the field were increased. In addition, satisfactory profit was achieved by using applicable drilling techniques, improving recovery techniques, and optimizing ground works. In less than three years, the oilfield's annual output was restored to 3.5 million barrels, close to its historic peak level. In the third round of international tenders, Caracoles ranked seventh among all the bidding fields in term of average daily output, winning CNPC recognition and acclaim from PDVSA and other industrial peers.

Thanks to the EOR program at the Caracoles Oilfield, CNPC has developed a package of sophisticated

technologies to further tap the potential of complex mature fields and integrated management of oil reservoirs, worked out a set of measures for effective well-site allocation and potential release of old wells, and integrated and innovated relevant support technologies to develop marginal fields.

In August 2006, CNPC signed a joint venture agreement with PDVSA, whereby PDVSA took over the operation of Caracoles Oilfield. CNPC, as a sincere partner of PDVSA, continued to implement the above mentioned measures to help maintain the oilfield's annual output at more than 1 million barrels.





“We’ve been working with CNPC for four years, with considerable progress made together, on the strength of which our daily output has achieved an impressive four-fold increase to 120,000 barrels and is still steadily increasing. Enjoying tremendous advantages in technology and development experience, the CNPC team is simply irreplaceable. Although there are some cultural differences between us, we nonetheless help and support each other, sharing the same goal of further development in oil production.”

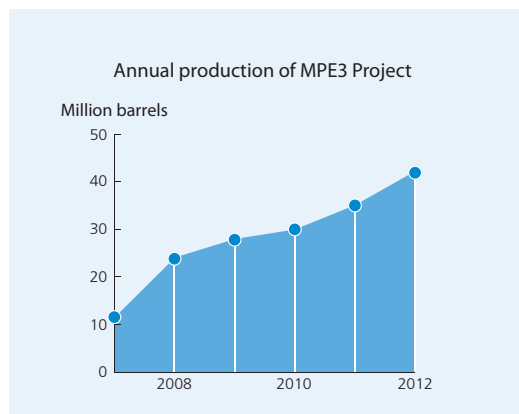
Erwin Hernández
President of PDVSA-CNPC joint venture SINOVENSA



Ultra-heavy Oil Development at MPE3 Project in Venezuela

The Orinoco Oil Belt (OOB), located along the southern margin of the Eastern Venezuelan Basin, is the world’s largest heavy oil enriched area with tremendous resource potential. As unconventional oil resources attract ever-increasing attention globally, the Orinoco Oil Belt is of great significance to global petroleum development.

The MPE3 project is located in the east end of OOB and was formerly known as the Orimulsion Project. CNPC and PDVSA established a joint venture for the Orimulsion Project in 2001, and later signed an upstream and downstream integrated cooperative agreement in March 2007. In February 2008, a Venezuelan-Chinese joint venture, SINOVENSA, was



Orinoco Oil Belt

established for the operation of the MPE3 project, which is CNPC's first major overseas ultra-heavy oil project.

The ultra-heavy oil in OOB features high density and high content of sulfur, heavy metal and asphaltene. Oil reservoirs in MPE3 are of unconsolidated sandstones lithologic structure and hard to tap by cold production due to the difference in their maturity level and the variation trend of their internal sand bodies, with oil recovery of 5%-10% generally. CNPC has sent a number of expert taskforces to the joint venture project to offer technical support and guidance focusing on key technologies such as the optimization of development well parameters, sand control, and break prevention of screw pumps. Chinese technical staff working at the MPE3 project actively introduced CNPC's sophisticated and proven technologies to their Venezuelan colleagues,

and widely applied a technical package of cold heavy oil production with sand in horizontal wells, successfully solving some technical problems caused by the unconsolidated sandstone formations and the rapidly rising gas-to-oil ratio. All the production wells at the oilfield are cluster horizontal wells, boosting the daily output from 30,000 barrels in 2007 to 130,000 barrels today. The project has built an annual production capacity of 7 million tons, achieving good development results and economic benefits.

Having been proven successful at the MPE3 project, CNPC's technologies for ultra-heavy oil development have been fully affirmed by the Venezuelan side, winning CNPC respect and greater influence in the joint venture. In addition, a working atmosphere has been fostered in which technical problems are always referred first to Chinese experts for solutions.

Andes Project in Ecuador

The Andes project is located in the hinterland of the Amazon rain forest, with more than half of its oil zone overlapping with a national natural reserve. Its unique geographic location and diverse, fragile ecological environment imposed great challenges on the oilfield development technology. In the Oriente Basin where Block Tarapoa and Block 14 are located, the major pay zones are Cretaceous sediments entrapped in subtle lithologic traps dominated by low amplitude structures. With over 30 years of development history, most oilfields in the area have entered into the middle and later development stage, featuring a high recovery percentage, rapidly rising water cut, low reserve-production ratio, fast natural decline in old wells, and irregular distribution of residual oil. These result in considerable difficulties for reserve replacement and production enhancement.

In August 2005, Andes Petroleum Ecuador Ltd., a joint venture between CNPC and China Petrochemical Corporation (Sinopec), purchased Encana's oil and gas blocks in Ecuador and served as the operator. After taking over the project, in spite of stringent environmental protection requirements and tremendous technical challenges brought about by the complex local geological conditions,



AndesPetro won the award of Excellent Work in Technology Transfer and Development Oil Industry in Ecuador.

the Chinese technical staff fully exploited their rich experience in mapping remaining oil distribution and tapping residual oil in the mature fields. Based on seismic, logging and drilling data, in-depth analysis on the low-amplitude structure and subtle traps, and fine description of key sections and formations, the distribution, morphology and hydrocarbon potential of the sandstone reservoir were effectively identified and predicted. Then, by optimizing the deployment and structural

design of the horizontal wells, the technical team has successfully solved drilling problems such as formation collapse and lost circulation, and also successfully applied and promoted technologies for completing horizontal wells in complex and subtle traps, with a string of high-yielding wells drilled. For example, Block Tarapoa's average daily output during the test runs of horizontal wells exceeded an impressive 900 barrels. In 2011, AndesPetro achieved a reserve replacement rate of more than 100% for the first time at the old oil zone, with the output of new wells accounting for 12% of the oilfield's total. In 2012, the Andes project's output reached 2.63 million tons of oil equivalent.

In 2011, Andes Petroleum Ecuador Ltd. received the award for Excellent Work in Technology Transfer and Development Oil Industry in Ecuador from the Ecuadorian Ministry of Non-renewable Natural Resources and SPE Ecuador Section.

Oilfield Services

CNPC's presence in Latin America could be traced back to the early 1990s when BGP first entered the geophysical prospecting market in the region. To date, CNPC provides a wide range of oilfield services in Latin America, including seismic data acquisition and processing, drilling, logging, formation test and well intervention, with 179 crews working as the contractors of local oil companies in Venezuela, Ecuador, Cuba, Peru, Colombia, Brazil, and Mexico etc.

BGP, boasting proven expertise and rich experience in geophysical prospecting operations in mountainous areas, shallow seas and rain forests, has become one of the most important onshore and offshore seismic data acquisition and processing service providers in Latin America. It provides relevant services to its clients through a seismic data processing center it established



Drilling Operation by Greatwall Drilling Company in Venezuela



Cuban Minister of Basic Industries Tomas Benitez Hernandez praised GWDC as a role model for Sino-Cuban cooperation.

in Caracas, Venezuela. On its 3D seismic data acquisition missions using towed-streamers in the Gulf of Venezuela, the company's offshore fleet successfully fulfilled the task. Although there were many unfavorable factors such as deep water, rapid changes of ocean currents, complex weather conditions, and the limited scope of the permitted work area, the quality of acquired data was highly commended by its client, PDVSA.

CNPC Greatwall Drilling Company (GWDC) is one of the most important drilling engineering service providers in Venezuela and Cuba. In Cuba's Guanabo Block, which extends from the coast to the sea bed, the reservoirs are subsea carbonates interbedded with large segments of mudstone with a high level of hydration activity. These are inducing factors of borehole shrinkage, borehole purification trouble, and intractable mud situations. Due to the frequent sticking of drilling tools, this area is called the "restricted zone for drilling" in Cuba. In drilling well GBO-103 in the block, GWDC adopted applicable techniques to control borehole shrinkage, and ensured smooth drilling operations by optimizing drilling displacement, mud parameters, drilling

parameters and the BHA. Well GBO-103 measures 4,470 meters in total depth, 3,384 meters in horizontal displacement and 1,854 meters in vertical depth, making it the only extended-reach horizontal well fulfilling its drilling purpose in the whole Guanabo Block. The integrated technologies adopted in the drilling have also become a standard operating procedure for drilling extended-reach horizontal wells in this block, winning the praise of the project client, CUPET.

CNPC Chuanqing Drilling Engineering Company Ltd. (CCDE) mainly provides well drilling, completion and workover services to Petroecuador, in a bid to further enhance oil recovery efficiency of the fields located in the Amazon area. In SACHA Oilfield's turnkey project in Ecuador, CCDE delivered impressive performance by improving its applicable technologies and optimizing its drilling tools. Six of the eight completed wells obtained high yield, with the highest single well output reaching 8,000-9,000 barrels per day. Well SACHA-331D was completed within 18.5 days, the record short single well drilling cycle.