



Technology and Innovation

In light of its business development program, the company has deepened R&D reforms and stepped up talent development in a bid to foster innovation on all fronts and create a new engine for growth.

Technological innovation is the key driver behind the company's high-quality growth on its way to build an integrated international energy company. In 2019, driven by a focus on business needs, we continued to unleash the power of innovation through increased R&D spending, key R&D programs and R&D reforms, with the principle of "business orientation, indigenous innovation, strong incentives, openness and sharing" at the heart of our efforts. These efforts brought important high-quality R&D achievements and prestigious technology awards to provide a strong support to our business growth.

Construction of Technological Innovation System

We have further strengthened an innovation-driven system for technological innovation by introducing a multi-tier, multi-faceted R&D system to support the growth of our business units. A supporting system is in place to secure funding, streamline processes and facilitate team building. In 2019, we implemented the *Guidance on Advancing Technological Innovation for High-Quality Growth* and introduced a series of institutional frameworks for deepening reforms, regulating incentives, and motivating R&D teams and talents to provide a better environment for technological innovation.

By the end of 2019, the company has 82 research institutes, 55 key laboratories and testing centers, and 19 national R&D platforms covering upstream, midstream and downstream activities. We have 30,968 scientists and researchers, including 22 academicians, 289 senior technical experts and chief experts.



Major R&D Achievements

In 2019, our R&D efforts were focused on oil and gas exploration, production efficiency, eco-friendly oil products and high-end petroleum equipment manufacturing etc. We made significant headway in know-how, core technologies, and equipment independent R&D and owned a series of technologies with independent intellectual property rights.

Exploration and Production: The reservoir forming theories and evaluation methods for subsalt, ultra-deep natural gas reservoirs were studied and the EOR techniques such as air/foam flooding for low-permeability oil reservoirs were developed to provide technical support for achieving breakthrough discoveries and production growth, operating overseas projects, and managing production operations.

Refining and Petrochemicals: Our proprietary catalysts for National VI-compliant gasoline were developed for commercial applications. The R&D programs for refinery upgrades, refining catalysts, and polyolefins etc. were implemented. New polyolefin grades were launched, and production processes and technological packages for polyolefin catalysts were improved to provide technical support for the sustained growth in the refining and petrochemicals business.

Oilfield Services: A range of new techniques and systems were launched, including fiber-based borehole geophysical data acquisition system, ocean bottom node (OBN) seismic acquisition system, high-performance rotary steerable system (RSS), 10,000-meter formation micro imager (FMI), and smart pipeline construction system for alpine regions, to enhance greatly our capabilities to deliver oilfield services under complex and extreme conditions.



Frontier Technology: New headway was made in nano oil displacement, with the mechanism for the use of nanofluids in EOR closely investigated. These nanofluids were commercialized and tested for single/clustered wells, which proves the effectiveness of the nanofluids.

Application of Information Technology

Information technology has been extensively integrated with our production and operation in the form of digital oilfields, intelligent refineries, intelligent pipelines and smart service stations etc. A centralized R&D information platform is in place to support ERP integration and R&D information management. Meanwhile, information systems for professional areas have been improved to facilitate the construction of IoT systems for oil and gas production, engineering technology, refining and petrochemicals, equipment manufacturing etc. that enable integrated operation from real-time data collection, remote monitoring to decision

support. An expert sharing mechanism has been introduced to provide supports and solutions to engineering and production issues through online technical support centers. The cloud-based platforms for business scenarios, e-commerce and scientific computing are expanded to provide cloud computing resources for R&D and engineering design activities.



Industrial robots on patrol at the Changqing Oilfield

Technological Cooperation

We have been actively involved in exchange and cooperation with IOCs, NOCs, international academic bodies, industrial organizations and research institutes from home and abroad in a bid to promote theoretical and technological innovations.

In 2019, we continued to deepen collaborative efforts in R&D under a wide range of strategic partnerships through working groups and technical seminars with oil companies such as Equinor, Gazprom, Rosneft and Total etc. to promote cooperation over EOR techniques and collaborate on frontier technologies in digital technology, big data, carbon emission reduction, shale oil and intelligent refinery etc.

We have been partnering with domestic research institutes and universities to carry out technical research and personnel training in the field of oil and gas. We worked closely with the Chinese Academy of Sciences at the frontiers of E&P, renewable energy and new materials in 2019. Meanwhile, the strategic cooperation with China University of Petroleum, Southwest Petroleum University and other universities was advancing robustly.

S&T Awards and Intellectual Property Rights

In 2019, our "100-million-ton production capacity and high efficient development for extremely-thick and complex carbonate reservoirs in the Middle East" received the First Prize of the State Science and Technology Progress Award from the National Science and Technology Progress Award Committee. In addition, the company was in charge of the preparation and amendment of seven international standards, i.e. *Life-Cycle Integrity Management for Onshore Pipeline*, *Life-Cycle Integrity Management for Offshore Pipeline* and *Geological Hazard Risk Management for Onshore Pipeline* etc.

Our patent applications have seen rise in terms of both quantity and quality. In 2019, the company applied for 5,537 patents (including 3,045 patents for inventions) at home and abroad and was offered 4,340 patents (including 1,600 patents for inventions). In particular, "A Well Logging Method and Apparatus for Rock Brittleness Evaluation" and "A Method for Determining the Source of Highly Mature Gas Condensate" won the China Patent Gold Award and Silver Award, respectively.

