Pipeline Additive Technology

Science & Technology Management Department

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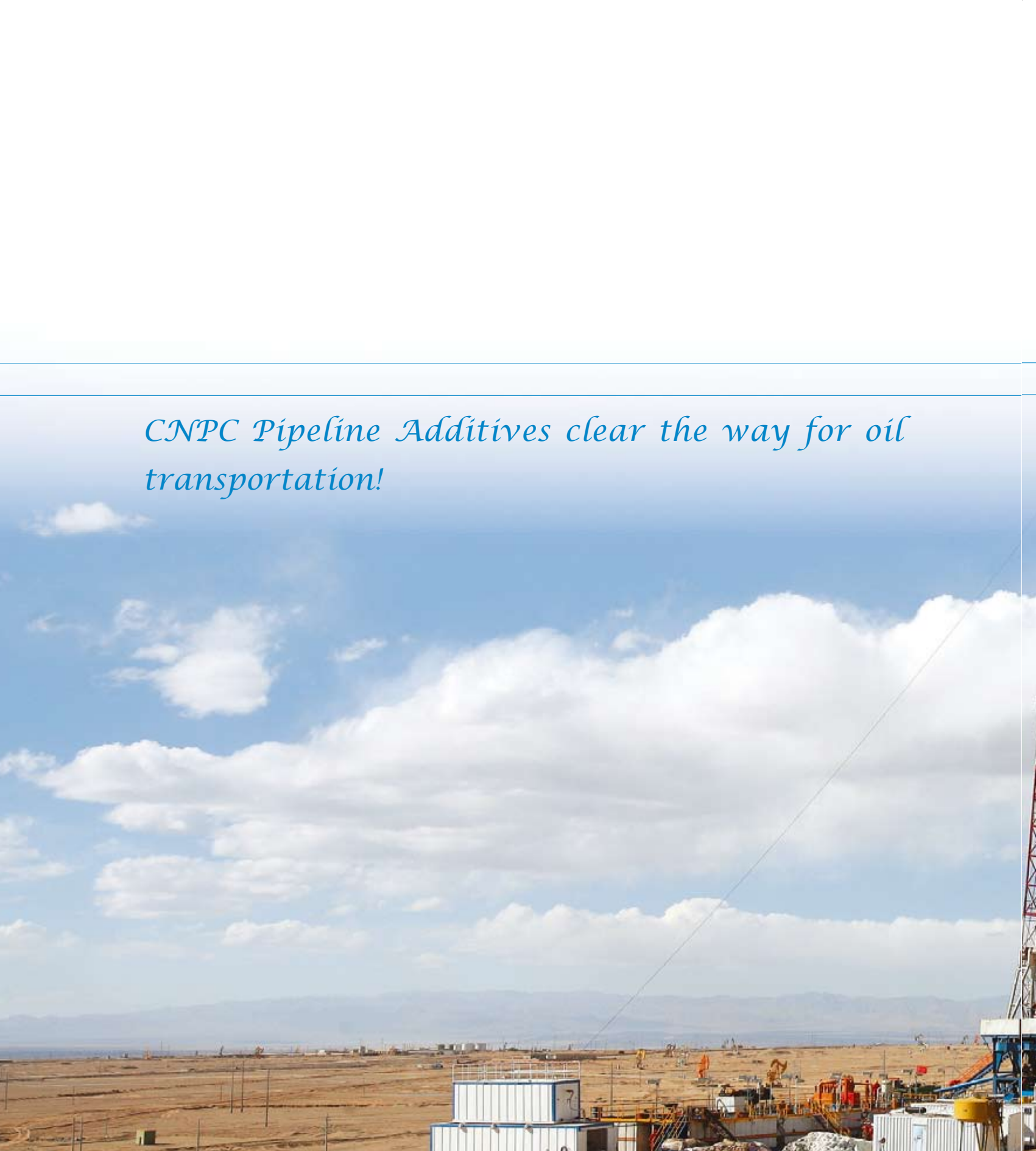
CHINA NATIONAL PETROLEUM CORPORATION

CNPC Pipeline Additives clear the way for oil transportation!



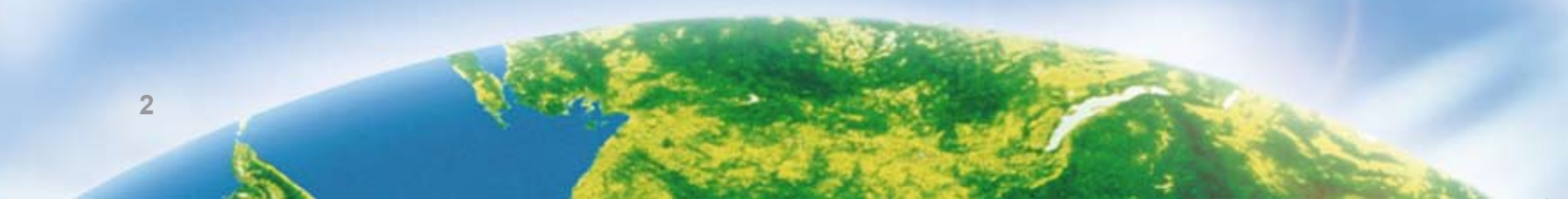
Contents

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 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 RMB 1,720 billion with a profit of RMB 172.7 billion had been achieved the same year. Its profit is among the highest of the domestic enterprises in China.

CNPC was ranked 10th 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 Pipeline Additive Technology is one of representatives for major innovations of CNPC.



1 INTRODUCTION

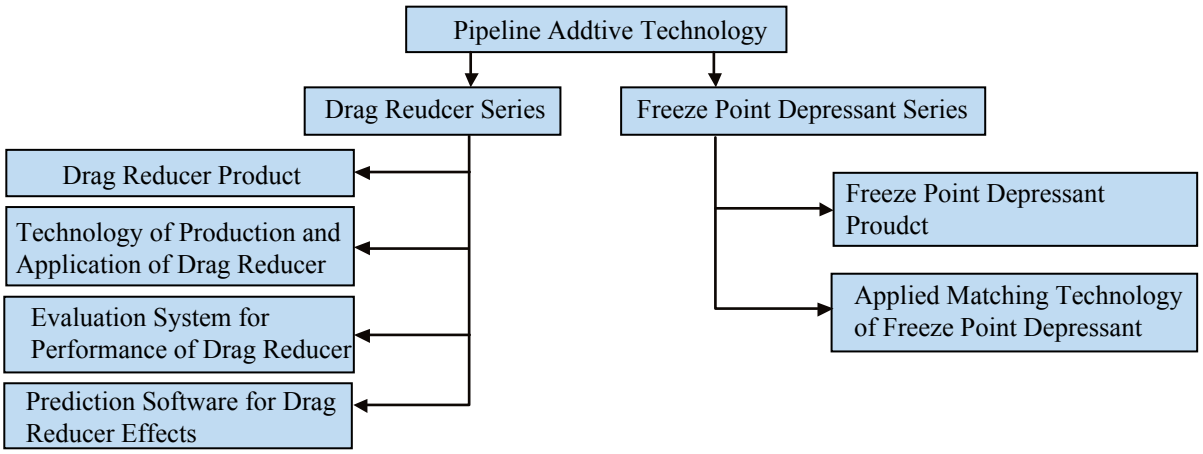
CNPC possesses mature research and development technologies related to Pipeline Additives with an annual production capacity of 5,000m3. As the representative product, Weipu EP Drag Reducer and Freeze Point Depressant can reduce pipeline transportation pressure, decrease the freeze point of oil products, improve the rheological property of oil products, increase pipeline transportation capacity and ensure the safety and efficiency of the pipeline operation.

Mature applied matching technology of freeze point depressant and advanced drag reducing performance prediction and evaluation technology can deliver most appropriate freeze point depressant products and additive solutions based on customer requirements.

Pipeline Additives of CNPC are widely used in a number of domestic and foreign crude oil and refined oil product pipelines, as well as gathering line network at oil fields and submarine oil pipelines. The products are widely sold to foreign countries including UK, Norway, Iran, Sudan, Indonesia, and Algeria, etc.

Samples of EP Pipeline Additives

Map of Market Distribution



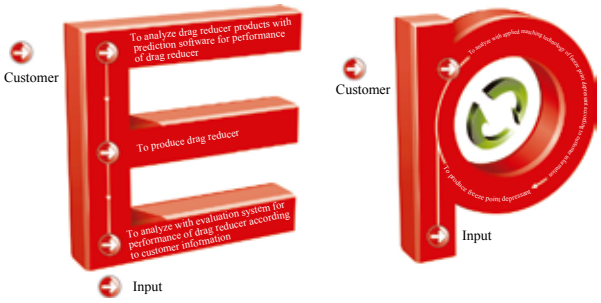
2 Unique Technologies

(—) Drag Reducer Series

1. Compoun

Drag reducer is an ultra high molecular weight polymer which can reduce turbulent flow friction of piped fluid.

EP Series Drag Reducer is a well known brand, applicable to severe environment such as extreme high and low temperature. The advanced industrial production line for α-olefin drag reducers generates an annual yield up to 5,000m^3. EP-W, EP-A, EP-O, EP-P and EP-S series oil drag reducers researched and developed independently by CNPC can enable the increase of transportation capacity of crude oil pipeline by 15%~35%, and that of refined oil product pipeline by 30%~50% with a dosage of 15~30ppm.



Field Application of EP Pipeline Additives

2. Technology of Production and Application of Drag Reducers

The production process of EP drag reducers includes material refining, polymer synthetization and polymer dispersing.

In addition to molecular structure, molecular weight of drag reduction high polymer and its content in fluid pipeline, drag reduction and increased transportation effects by drag reducer are also related to the physical properties and flow conditions of fluid in pipeline.

3. Prediction Software for Drag Reduction Effects of Drag Reducer

The Drag Reduction Effect Prediction Software allows to customize plans, optimize solutions and utilize drag reducers rationally and economically, as well as to predict drag reduction effects based on laboratory loop test so as to select and evaluate different drag reducers. The software is pleasant in appearance and easy in operation with the prediction error less than 15%. The reliability of evaluation on drag reduction effect decreases the required field tests and greatly saves the manpower and investment.

Drag Reduction Effect Prediction System

Drag Reducer Performance Prediction System

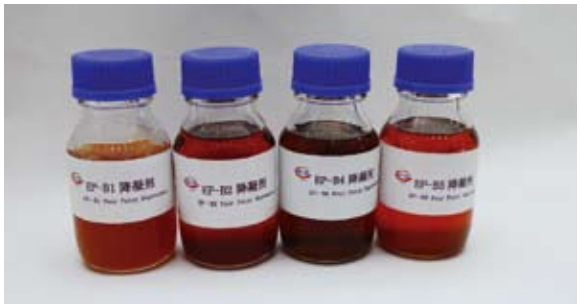
4. Evaluation Software for Performance of Drag Reducer

The well developed Evaluation Technology for Performance of Drag Reducers is the first and currently the most advanced evaluation system for performance of drag reducers. The testing loops with three kinds of pipe diameters are designed, and each testing loop is 33m long and equipped with five sets of pressure sensors which can evaluate application performance of the drag reducer in different operation conditions. The supporting data acquisition system and calculation software can precisely calculate drag reduction rate and transportation capacity increase rate by the drag reducers to allow performance evaluation.

Production Units of EP Drag Reducer

EP Drag Reducers

Loop of Oil Drag Reducer



Samples of EP Freeze Point Depressants

Selecting Matching Method

Freeze Point Depressant Series

1. Freeze Point Depressant Product

Freeze Point Depressant is a chemical additive which can change structure of the wax crystal precipitated in wax bearing crude at dropped temperature.

EP and KS Series Freeze Point Depressants can significantly reduce the freeze point and viscosity of wax bearing crude. Additives in pipeline can allow pipeline operation at normal temperature, decrease the minimum transportation capacity and pipeline operation pressure, and increase the operation flexibility of crude oil pipeline with low transportation capacity while improving the quality of crude oil and restraining wax precipitation. These are powerful support for the safety, reliability and low consumption of pipeline operation. The additives can reduce freeze point of crude oil by up to 25°C, viscosity by up to 70% and are suitable for long-distance crude oil pipeline, gathering pipeline for crude oil within the oil field and production wells of crude oil with high freeze point.

2. Applied Matching Technology of Freeze Point Depressant

The supporting applied matching technology can be used to determine the key technical parameters related to field application of freeze point depressant, such as types of freeze point depressants, amount of additives, handling temperature of additives, quenching rate, outbound and inbound temperatures of crude oil with additives. These parameters are critical to determine whether the freeze point depressants exert optimum effects, satisfy production requirements and allow maximized economic results. This applied matching technology provides the users with most favorable products and additive workmanship.

3 Typical Cases

1. Successful Application of EP Pipeline Additives in Sudan Pipeline

EP-W Drag Reducer developed by CNPC in 28in. pipeline from Heglig to Port Sudan of Sudan Greater Nile Petroleum Operating Co. Ltd. improved transportation capacity from 214,900 b/d to 240,000 b/d, the crude oil delivered is increased by 8.395 million barrels in one year and the additional income reaches $ 184.69 million while the operation cost of drag reducers is only $ 8 million. Meanwhile, to deliver the crude oil with high freeze point in this pipeline, the Freeze Point Depressant CNPC No. 9A was accordingly developed to reduce the freeze point of commingled crude (i.e. that Sudan exports) from 33°C to 19°C and reduce the viscosity by 93.7% (25°C, 10s-1), which enabled the condensative crude oil with high viscosity in Sudan to be only initially heated without intermediate heating station during transportation process. This transportation process saved the construction investment cost of $ 60 million for 4 heating stations and annual $ 6.2 million for operation cost and ensured startup safety after every pipeline turndown since the commissioning of the pipeline.

Successful Application of EP Pipeline Additives in Sudan Crude Oil Pipeline

2. Successful Application of EP Drag Reducer in Lanzhou–Chengdu– Chongqing Refined Oil Product Pipeline

The EP-A Drag Reducer was applied in Lanzhou-Chengdu-Chongqing Refined Oil Product Pipeline to improve transportation capacity. The additive concentration of 5ppm can increase transportation capacity by 10%. This effectively satisfied the demanding for refined oil product by downstream market while ensuring the safety of the pipeline operation.

Successful Application of EP Drag Reducer in Lanzhou-Chengdu-Chongqing Refined Oil Product Pipeline

4 Qualification and Standard

CNPC Pipeline Additives and its R&D technologies possess 38 patents of invention, one of which was obtained in US, establish 2 industrial standards of additives, have passed DNV ISO 9001 and are certified by 2000 Quality System. In 2009, the second prize of “National Award for Technological Invention” was awarded to CNPC Pipeline Additives.

SY/T 6578-2003	Laboratory Testing Method for Drag Reduction Effect of Drag Reducer for Oil Pipeline
SY/T 5767-2005	Specification for Technical Conditions and Transportation Process of Freeze Point Depressants for Pipeline Oil

US Patent Granting

Certificate of Management System Certification

Certificate of National Award for Technological Invention

5 R&D Equipment

The National Engineering Laboratory for Transportation Safety of Oil and Gas Pipeline of CNPC has introduced a large number of precision instruments and advanced equipment and built a pipeline additives R&D and production base with an area of about 20,000 m2. In addition, long-term corporation has been established with universities and research institutes such as Chinese Academy of Sciences, Shandong University and Tianjin University.

R&D and Production Base for Pipeline Additives

6 Expert Team

Li Guoping Professor, doctoral supervisor and senior technical expert excelling in oil &gas storage and transportation. He has long been engaged in the research of chemical additives for pipeline, and undertaken projects relating to the safe operation & storage technology of oil & gas pipeline, pipeline drag reducer and freeze point depressant and so forth. He once was awarded the second prize of “National Award for Technological Invention”. He published over 10 academic papers.

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Ai Muyang Professor, doctoral supervisor, senior technical expert excelling in oil & gas storage and transportation and granted with special governmental subsidy. He for long time has been engaged in the research of technology of oil & gas storage and transportation. He once directed the major and key technology research project relating to China’s 2nd line of West-East Natural Gas Transmission Project. He published over 10 academic papers.

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Zhang Xiujie Senior engineer. He has for long time been engaged in the research and application of oil & gas pipeline storage and transportation technology and chemical additives for pipeline, and ever took part in several major research projects relating to the safe operation & storage of oil & gas pipeline, pipeline drag reducer and freeze point depressant and so forth. He once was awarded the second prize of “National Award for Technological Invention”. He published over 20 academic papers.

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Liu Bing enior engineer. He has been long engaged in the research and application of chemical additives for pipeline, and ever took part in the research of safe operation & storage of oil & gas pipeline, and directed the research of pipeline drag reducer and its performance improvement as well as industrialized production. He once was awarded the second prize of "National Award for Technological Invention" and published over 10 academic papers.

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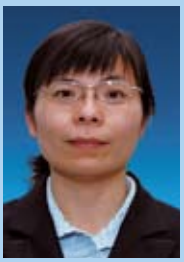

Li Chunman Senior engineer. She has been long engaged in the research and application of pipeline additives, and ever took part in several major research projects relating to the safe operation & storage of oil & gas pipeline, pipeline drag reducer and freeze point depressant and so forth. She once was awarded the second prize of "National Award for Technological Invention" and published over 10 academic papers.

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Zhang Zhiheng Senior engineer, doctor. He carries on the research and application of pipeline chemical agents and oil & gas pipeline drag reducer. He has published over 20 academic papers, over 10 of which were filed by SCI.

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