

"Turning Harm into Value: Green Carbon Reduction", Gas Surface Extraction and Efficient Comprehensive Utilization Project of Coal Mine Gas

Pingmei Shenma

PROJECT OVERVIEW

As the second largest greenhouse gas, methane has a global warming potential 29.8 times that of carbon dioxide according to the IPCC Sixth Assessment Report. The Ministry of Science and Technology and other departments have formulated the Implementation Plan for Science and Technology Support for Carbon Peak and Carbon Neutrality (2022–2030), listing the enhancement of technologies for reducing non-CO₂ greenhouse gases such as methane as one of the ten key actions.

China Pingmei Shenma Group launched the "Green Carbon-Reduction Surface Gas Extraction and Efficient Comprehensive Utilization" project, focusing on the characteristics of high-viscosity, low-permeability coal reservoirs in Henan Province, and conducting research and application of key technologies for coalbed methane exploration, development, and utilization. The related technologies serve as an interim solution, aiming to bridge the gap while preparing for a full transition to clean energy.

COMPANY/ORGANIZATION PROFILE



China Pingmei Shenma Energy & Chemical Group Co., Ltd. (hereinafter referred to as China Pingmei Shenma Group) was established through the restructuring of two Chinese Fortune 500 enterprises, the former Pingmei

Group and the former Shenma Group. In recent years, the Group has fully, accurately, and comprehensively implemented the new development philosophy of "innovation, coordination, green development, openness, and sharing," firmly taking safety and sustainability as the foundation, and advancing coordinated progress in carbon reduction, pollution control, ecological enhancement, and growth. For four consecutive years, it has been listed among the "Top 50 Contributors to China's Carbon Neutrality." With coal and salt resources as its source, the Group has gradually developed multiple distinctive green industrial chains and grown into a state-owned super-large enterprise operating across regions, industries, and ownership systems.

PROJECT OUTCOME

1. This project established a "three-zone collaboration" surface coalbed methane extraction model in Pingdingshan of Henan Province. Through technological breakthroughs, it achieved efficient coalbed methane extraction and became the first to realize commercial coalbed methane development in Henan Province.
2. In terms of pipeline transportation, the project adopted a dual-loop pipeline system for high- and low-concentration coalbed methane, forming a model of separate transmission and efficient tier utilization of coalbed methane with methane concentrations above 30%. The comprehensive utilization rate of surface well extraction has gradually increased to over 90%.
3. The project set a new record with a total surface well coalbed methane extraction volume of 114 million m³, achieving a cumulative comprehensive utilization of approximately 117 million m³ of surface well coalbed

methane and about 494 million m³ of low-concentration gas, equivalent to reducing approximately 9.9 million tonnes of CO₂ emissions. It has successfully built the largest coalbed methane development and comprehensive utilization base in Henan Province.

4. The successful application of this project in Pingdingshan area has significantly reduced gas concentration in underground working faces, achieving multiple benefits in safety, environmental protection, and economic performance.

5. The project established a full-chain system of "gas extraction–pretreatment–efficient power generation–carbon reduction". A total of 12 gas power plants have been constructed, with a total installed capacity exceeding 59 MW, and a cumulative supply of approximately 770 million kW·h of clean electricity. It successfully addressed the issues of poor adaptability of low-concentration units and gas resource waste, achieving safe and efficient conversion of high-concentration gas while delivering both economic and carbon reduction benefits.

6. The core of the project's end-stage is the utilization of waste heat from low-concentration gas oxidation, aimed at maximising the residual value of gas. Statistics show that the annual oxidation and utilization is equivalent to 10 million scf of pure gas, saving about 15,000 tonnes of standard coal and reducing CO₂ emissions by 150,000 tonnes annually. To further enhance both environmental and economic benefits, the Group is actively advancing the upgrade of instruments and equipment, striving to incorporate the project's emission reductions into the national voluntary carbon market, thereby achieving market-based conversion of emission reduction value.

PROJECT HIGHLIGHTS

1. The project was selected by the National Energy Administration as one of the first demonstration projects for efficient gas extraction and utilization (utilization category).
2. The project has received continuous attention and special reports from authoritative media outlets such as the official website of the State-owned Assets Supervision and Administration Commission of Henan Provincial People's Government, China News Service Henan Channel, and Pingdingshan News Broadcast, generating broad social influence.
3. The project has achieved substantial intellectual property outcomes, with a total of 30 applications filed, including 12 authorized invention patents, 4 utility model patents, and 6 software copyrights.
4. The project outcome was appraised, which confirmed that its overall technology has reached the international leading level. Its innovativeness and advancement have also been highly recognised by Academician Zhang Tiegang of the Chinese Academy of Engineering.
5. The project has won multiple honours, including the First Prize of the Science and Technology Progress Award of the Zhongguancun Industry Alliance, the Third Prize of the Science and Technology Progress Award of the China Association of Work Safety, and the Third Prize in the Henan Division of the 14th China Innovation and Entrepreneurship Competition.

PROJECT IMPLEMENTATION

1. Realization of Commercial Development of Coalbed Methane in Soft and Low-Permeability Reservoirs

In response to the soft and low-permeability geological conditions in the Pingdingshan area, the project has established a full industrial chain system of coalbed methane (coalbed methane) encompassing "upstream resource development, midstream pipeline transmission and storage, and downstream consumption and utilization." A gathering and transmission pipeline network of 94 km has been completed, enabling direct supply to China Nylon City. This has allowed China Nylon City to utilise "locally sourced gas," thereby laying a solid foundation for regional energy transition.

2. Efficient Integrated Utilization Model for Coalbed Methane (Gas)

The project innovatively adopted dual-loop pipeline technology. Through precise gas distribution and cascade utilization, harmful gases that would otherwise be directly vented are converted into high-value clean energy. As a result, the utilization rate of surface-extracted gas has increased from 60% to over 90%, achieving a leap-forward transformation of coalbed methane resources from "harm to value" and significantly improving both utilization efficiency and overall economic benefits.

3. Multi-Functional Coalbed Methane Integrated Utilization Station

The station is designed with three major process units: gas-fired power generation, coalbed methane purification, and coalbed methane compression, enabling high-efficiency cascade utilization of coalbed methane with a concentration above 30%. Gas with concentrations of 30–50% is used for power generation and fed into the grid; gas with concentrations of 50–90% is purified to above 90%; and gas with concentrations exceeding 90% is compressed for sale. Through interconnection

and complementarity among gas sources of different concentration ranges, the comprehensive utilization efficiency of coalbed methane (gas) from surface wells is maximized. Meanwhile, the station adopts a self-generation and self-consumption model for power supply, realizing green, environmentally friendly, and efficient cascade utilization.

4. Waste Heat Utilization from Low-Concentration Gas Oxidation

For low-concentration gas, the project applies vertical dual-bed thermal regenerative oxidation technology. Based on regenerative thermal oxidation, extracted gas with a concentration below 8% is mixed with air or ventilating gas (with concentration above 0.2%) and diluted to below 1.2% for oxidation. The oxidation unit is initially heated and started by a diesel burner, and a high-temperature environment required for gas oxidation is established within the regenerator and oxidation chambers. Mixed ventilating gas is then introduced for oxidation. Part of the oxidation heat maintains the high-temperature oxidation environment, while the remainder is discharged via the high-temperature flue gas outlet. The flue gas, at approximately 950 °C, is supplied to a waste-heat boiler to generate saturated steam for heating purposes.

PROJECT IMPACT & SUSTAINABILITY

(I) Project Impact

With "harm to value" as the core concept, this project has achieved significant impacts through surface coalbed methane (coalbed methane) extraction and efficient integrated utilization:

1.Enhanced Energy Self-Sufficiency: Effectively increased the self-sufficiency rate of natural gas in Henan Province, alleviating the current external dependency pressure as high as 96%.

2.Fundamental Improvement in Safety: Transformed gas control from "passive prevention and treatment" to "proactive extraction," fully implementing the national safety production policy of "extraction before mining."

3.Contribution to Dual-Carbon Targets: Significantly reduced direct methane emissions, with notable carbon dioxide emission reduction benefits from cumulative coalbed methane utilization, making the project a benchmark for promoting green and low-carbon transition in Henan Province.

4. Formation of an industry demonstration effect: Successfully explored a large-scale development path for tackling the challenges of soft and low-permeability geological formations, providing replicable and referential technical and engineering experience for similar geological conditions nationwide. Established a complete technical solution integrating "equipment selection – system design – problem solving – benefit transformation," offering an operable practical path for regions such as Shanxi, Chongqing, and Guizhou with similar geological conditions.

(II) Replicability and Sustainability

1.Strong universality of the technical system: The extraction, fracturing, and utilization technologies developed to address the challenges of fractured, soft, and low-permeability geological formations are applicable to enterprises in regions such as North and East China, where similar geological conditions are widely distributed. These technologies feature low promotion thresholds and strong adaptability.

2. Mature and Replicable Business Model: The project has formed integrated models such as "three-zone collaboration" and "three-dimensional extraction," enabling simultaneous gas control and resource utilization. Other coal enterprises can directly adopt these models to achieve synergistic improvements in both safety and benefits.

3.Dual drive of policy and industry: The project is highly aligned with national policies on clean energy development and safe production, demonstrating strong policy compatibility and a solid foundation for industrial promotion.

On December 27, 2024, an expert panel led by Academician Zhang Tiegang conducted a technical achievement appraisal of this project. The panel concluded that the project had successfully overcome the technical challenge of "difficult gas extraction" caused by the high-viscosity and low-permeability geological characteristics of the Pingdingshan area, and that the technological achievements have reached an internationally advanced level. The project has been effectively applied in multiple enterprises in the Pingdingshan region, generating significant economic and social benefits.

Expert Comments

China Pingmei Shenma focuses on methane reduction by advancing its "Surface Gas Extraction and Efficient Utilization" project, specifically addressing the high-viscosity and low-permeability geological conditions in Henan Province. The company has established a "three-zone linkage" extraction model and a complete "extraction-pretreatment-power generation-emission reduction" chain. To date, it has extracted 114 million cubic meters of coalbed methane and comprehensively utilized over 610 million cubic meters in total, equivalent to a carbon reduction of approximately 9.9 million metric tons. Through technological innovation, the project effectively overcomes the challenges of developing gas resources in soft and low-permeability geological formations. Its "turning hazard into value" model simultaneously ensures safety, environmental protection, and economic benefits, achieving significant results. This case offers a transitional solution that makes time and technical readiness for gradually reducing coal dependence and completely shifting toward clean energy.