

Research on The Ecological Treatment of Waste in The Process of Shale Gas Exploration and Exploitation

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Abstract

Promoting the healthy and orderly development of the shale gas industry is of great significance for alleviating the contradiction between natural gas supply and demand in China and optimizing the energy consumption structure. Based on the concept of green development and sustainable development, this paper sorts out the problems in the current shale gas industry from the guiding ideology, development model to ecological governance. The study finds three significant contradictions in the present "pollution first, treatment later" development model: firstly, the leading idea contradicts the concept of green development. Secondly, the development model rejects the idea of sustainable development. Thirdly, the waste disposal capacity contradicts the actual needs. For this reason, according to the current exploration progress and development status of China's shale gas industry, this paper considers the construction path of the shale gas industry ecological governance system from three aspects: the leading idea, the development model and the technical level according to the above contradictions.

Keywords

Shale gas industry; Green development concept; Sustainable development.

1. INTRODUCTION

China is a country with large reserves of shale gas resources, excellent development potential, good commercial conditions and broad development prospects. Among them, the proven shale gas reserves in western China reach $7.77 \times 10^{13} \text{m}^3$, accounting for 71% of the national total[1]. The Sichuan Basin is China's main battlefield for shale gas commercial development. However, since China is still in the initial stage of shale gas development, the development model of "pollution first, treatment later" is currently adopted. That is, at the expense of destroying the environment and sacrificing resources by investing in many production factors to promote rapid economic growth and steady improvement in GDP values. While this simple and brutal development model reaps excellent success, it also increases the degree of division between man and nature, causing developers to drift further away on this black development road that goes against the innate nature of human beings. As Engels said: "Do not be too intoxicated with our victories over nature. For every such victory, nature has avenged us." [2]

It is precisely because of the profound awareness of the serious dangers of the development path that the 19th Party Congress report clearly states, "The modernisation we want to build is a modernisation in which people and nature live in harmony, creating more material and spiritual wealth to meet people's growing needs for a better life, and also providing more quality

ecological products to meet people's growing needs for a beautiful ecological environment." [3] To promote the construction of a beautiful China, we urgently need to reverse the current black way of development that recklessly plunders nature and open up a path of green development. Green development is a development strategy based on Marx and Engels' environmental ethics, the core of which is that human beings must pursue development, and the essence of development is the "green" gene and let green blood flow in the development [4].

As socialism with Chinese characteristics has entered a new era, the current central contradiction in our society has turned into the contradiction between the people's ever-growing needs for a better life and unbalanced and inadequate development. Although "pollution first, treatment later" can achieve a great leap forward in the economy, this development model is contrary to our country's beautiful vision, and social development will eventually be in trouble. In the context of national conditions where resources and the environment constrain economic and social development, the road to green development is long and complicated. The development subjects of shale gas resources should conform to the trend of the times and take the initiative to assume the corresponding green responsibilities. That is, while pursuing the maximization of interests, each subject should be fully aware of the external diseconomies caused by their actions and take responsibility for protecting the environment. In the face of a riddled ecosystem, China urgently needs to reverse the development idea of "pollution first, treatment later" in developing the shale gas industry and embark on a path of green development in which humans and nature coexist in harmony.

2. CURRENT STATUS AND ISSUES OF ECOLOGICAL GOVERNANCE IN THE SHALE GAS INDUSTRY

The contradiction between the national demand and the realistic background has become increasingly prominent. It has gradually evolved into a bottleneck restricting the sustainable development of the shale gas industry, affecting the implementation of the national oil and gas development strategy. It is urgent to analyze the problems existing in the current development model of "pollution first, treatment later". The following three aspects can reflect the current issue.

2.1. The Leading Ideas Contradict the Concept of Green Development

The Fifth Plenary Session of the 19th Central Committee of the Communist Party of China held in 2020 emphasized the in-depth implementation of the spirit of the 19th National Congress of the Communist Party of China and further put forward precise requirements for the construction of ecological civilization in terms of phased goals and implementation paths. During the "14th Five-Year Plan" period, "the construction of ecological civilization will achieve new progress, the green transformation of production and lifestyle will achieve remarkable results, the allocation of energy resources will be more reasonable, the utilization efficiency will be greatly improved, the total emission of major pollutants will continue to decrease, the ecological environment will continue to improve, the ecological environment will continue to improve, the security barrier will be more solid, and the urban and rural living environment will be significantly improved" [5]. To achieve this goal, we should implement the concept of green development effectively. The idea of green development summarises the experience of the Chinese people's economic and eco-friendly development through decades of labor practice under the party's leadership. This idea is based on China's specific national conditions and further inherits Marx's thought on the harmonious development of man and nature [6]. In addition, the concept of green development also has two connotations: first, man and nature are a community of life, and human beings should respect nature, conform to nature, and protect nature. Second, lucid waters and lush mountains are invaluable assets [7].

However, the current development model of the shale gas industry does not focus on the moral interaction between man and nature. On the contrary, it is dominated by anthropocentrism and blindly pursues maximising human self-interest. Anthropocentrism believes that people occupy a dominant position in the world. That is, people are both the center of activity and thinking. According to this idea, human beings are the masters of nature, and natural things exist to serve human beings. Only human beings have intrinsic value, other beings in nature only have use value as tools. The current predicament in the development of the shale gas industry fully confirms the limitations of the behavior of following the anthropocentrism and ruling nature with a protagonist attitude. Such limitations cause: first, the harmonious relationship between man and nature will be broken. Due to the lack of necessary ecological awareness, actors often ignore the influence of the external diseconomy of their behavior when they pursue their own interests and blindly pursue The target of rock gas production results in a large number of resource consumption and waste accompanying phenomena every year. Second, the contradiction between people will become more and more prominent, because traditional anthropocentrism believes that people exist in isolation, and the behavior of individuals is based on their interests as the starting point and foothold, which in turn leads to an imbalance in the relationship between people. Third, the relationship between people and society is tense. When weighing the interests of individuals and the overall interests of the community, they tend to favor the former and do not hesitate to evade social responsibilities and cause harm to the general interests of society[8].

Undeniably, anthropocentrism's emphasis on the dominant position of human beings is not absolutely wrong. However, under the dominance of this kind of thinking, man and nature are divided into opposite subject-object relationships, and satisfying personal desires and pursuing maximizing personal interests is regarded as the subject's code of conduct. According to this code, the human will is supreme. In this way, to seek self-interest, human beings will inevitably go astray with the end of conquering nature. Holmes Ralston of the United States once proposed in the book *Environmental Ethics* that nature has intrinsic value, and human beings should respect the inherent value of nature. In the development process of the shale gas industry, human beings should correct the subject-object relationship between themselves and nature, implement the concept of green development, and reasonably carry out material exchange activities. Only by respecting the equal status of nature can we adjust the contradictory relationship between man and nature in a true sense and promote the healthy and long-term development of the industry.

2.2. The Development Model Contradicts the Idea of Sustainable Development

As Marx said, consciousness originates from practice and actively reacts to practice. Awareness guides and controls practice. In the development process of the shale gas industry, if human beings take selfish interests as the starting point, they will inevitably adopt a simple and rude way to carry out the exploration and exploitation of shale gas. The extensive development model has clearly reflected that. On the one hand, the lack of effective communication and understanding among the various players in the shale gas industry, who are committed to pursuing their interests, has resulted in a poor management mechanism within the industry. It can be demonstrated by the fact that the approval process is complicated, the advantages between the central bodies are difficult to complement each other, and the incompatibility of hazardous waste disposal planning sites and shale gas development mobility, etc. On the other hand, due to the blind pursuit of output and efficiency, a large amount of waste liquid and residue are generated during shale gas development, resulting in substantial environmental pressure and safety hazards. Whether the imperfect management mechanism or the potential environmental risks are the apparent signs of the unsustainable development model of the shale gas industry.

Sustainable industrial development refers to the idea of sustainable development running through the overall evolution process of the industry to achieve the steady growth of enterprise scale and efficiency and the continuous improvement of competitiveness. The ultimate goal is to promote a stable and harmonious relationship between economic, social, and ecological benefits. It can be seen that obtaining economic benefits is only an essential direction of sustainable development, and its ultimate goal is to achieve a dynamic balance of economy, society and ecology. For the shale gas industry, sustainable development not only requires extending the industry's life cycle as much as possible but also minimizing the negative impact on the environment, exerting the value of resources, and improving the overall benefits of society during the development process[9].

From the perspective of time, unsustainable development only focuses on immediate interests and cannot achieve the organic combination of short-term and long-term interests. From the perspective of space, all subjects in unsustainable development pay more attention to their interests and cannot achieve the harmonious unity of local and overall interests. From the perspective of culture, unsustainable development lacks an effective benchmark for value evaluation and fails to reflect the harmonious unity of value and rational standards. In the overall development of the shale gas industry, it is necessary to implement the concept of sustainable development and lay the foundation for its vigorous development.

2.3. The Waste Treatment Capacity Contradicts the Actual Demand

The exploration of shale gas resources in China started late, and the technical level still limits the exploitation process. Pollution prevention and control problems accompany the entire life cycle of the shale gas industry chain, including exploration, exploitation, storage, transportation, distribution, and utilization. It can be found that there are environmental pollution problems in all aspects of its development, involving water resource occupation, methane gas overflow, fracturing fluid flowback, and improper treatment and disposal of drilling cuttings. Among them, a large amount of fracturing flow-back fluid and solid waste accompany the two stages of drilling engineering and fracturing engineering[10]. Taking the Sichuan Basin as an example, most of the shale gas wells in southern Sichuan adopt the method of "four openings and four completions" for drilling operations, and the flowback volume of a single well can reach 1000-1500 tons. Among them, the vertical well section is drilled with water-based drilling fluid, and the output of water-based cuttings is 900-1000 tons per well. The deflection and horizontal sections are drilled with oil-based drilling fluid, and the output of oil-based cuttings is 600-700 tons per well[11]. According to the plan of the National Energy Administration, China will achieve shale gas production of 80-100 billion cubic meters in 2030, of which shale gas production in Sichuan Basin will reach 50-80 billion cubic meters per year under the condition that the policy support is in place and market development is smooth. To achieve the above goals, the oil-bearing cuttings produced by shale gas exploitation in Sichuan Basin will exceed 1 million tons annually. If these drilling cuttings are not properly stored and disposed of, environmental impact and risk issues will not be optimistic.

According to a survey, companies in the shale gas development area in southern Sichuan with both related licenses and the oil-bearing cuttings processing capacity are far from enough to accept the oil-based cuttings produced in Changning, Weiyuan, Luzhou and other areas. At the same time, some qualified and capable enterprises are far away from shale gas production areas and need to transport cuttings over long distances. This situation brings high disposal costs and does not meet the corresponding waste disposal management methods. Due to this situation, many oil-bearing cuttings generated by shale gas development need to be stored in a temporary storage area. There is a considerable risk of environmental pollution. The existing oil-based cuttings treatment scale is challenging to meet the increasing processing demand, and the contradiction between the two is becoming more and more prominent. The treatment of drilling

waste fluid and waste cuttings is not timely, and the excessive accumulation of waste on site has caused a high risk of environmental pollution. Some drilling companies have to suspend platform work. This current situation seriously affects the progress of mining and causes a lot of economic losses to the country while causing idle personnel and equipment.

3. ANALYSIS OF ECOLOGICAL GOVERNANCE COUNTERMEASURES

With the rapid production of shale gas in China, it is inevitable to promote the green and sustainable development of the industry. Xi Jinping pointed out that "coordinated development and green development are both concepts and measures, and policies must be in place and implemented"[12]. To realize the shale gas industry's green development and sustainable development, the government, enterprises and the public must change their thinking, optimize the industrial development model, and improve the technical level of enterprises.

3.1. Reverse the Dominant Thinking and Implement the Concept of Green Development

The concept of green development is based on the primary national conditions that China's economic and social development is trapped in the bottleneck of the ecological environment. It is proposed to meet the inevitable requirements of today's industrial transformation, green transformation and people's growing needs for a better life. Only when the concept of green development is deeply rooted in people's hearts and used to guide practical activities can the industrial development model be further optimized. It is necessary for the government, enterprises and the public to change their thinking, optimize the industrial development model and improve the technology level of enterprises to realize the green and sustainable development of the shale gas industry. In this way, the initiative of each subject to carry out green activities and the rationality of industrial development will be enhanced.

3.1.1 Build an institutional system for green development

Explicit legal norms and a sound regulatory system have direct and efficient guidance and restraint on the activities of enterprises and citizens. The institutional system of green development can restrain and correct the behavior of various entities in the industry before and after activities. According to the requirements of the report of the 19th National Congress of the Communist Party of China, "it is necessary to accelerate the establishment of legal systems and policy orientations for green production and consumption and to establish and improve an economic system for green, low-carbon and circular development"[13]. Building a practical and effective institutional system is the basis for promoting green production. Specifically, it includes the following three aspects.

First, improve the green policy system. Xi Jinping pointed out: "Only implementing the strictest system and the strictest rule of law can provide a reliable guarantee for constructing ecological civilization".[14] As China's green policy system is imperfect, especially for the shale gas industry, policy support and control efforts are limited. On the one hand, tax policy's regulatory role should be considered. A green tax system with rewards and punishments should be constructed with collecting environmental protection tax as the primary method. On the other hand, the relevant laws and regulations should be refined, and the implementation of policies should be strengthened. Currently, the appropriate systems of China's green development lack pertinence, mainly based on suggestions. It is difficult to exert the enforceability of laws to reflect their due normative role. Therefore, it is necessary to formulate explicit legal norms for each link included in the green development of the shale gas industry, strengthen the operability and enforcement of the law, and clarify the direction for the green development of the industry.

Second, formulate industry technical standards. Since China has not yet issued the corresponding inspection standards for drilling cuttings, relevant institutions still need to refer

to various indicators of urban sludge for inspection in the actual operation process, whose applicability is subject to examination. In this regard, China should conduct a scientific assessment of the environmental risks of the hazardous wastes associated with the shale gas exploitation process on time, formulate standards for the identification and resource utilization of dangerous wastes in the shale gas industry which are consistent with our national conditions, and form a full-process environmental protection technology system.

Third, reform the environmental supervision system. Under the norms of legal systems and industry standards, enterprises in all links of the shale gas industry chain have been greatly constrained by their behavior. However, only the comparison scale is not enough to ensure the legality of corporate activities and the fairness of the industry. Green development is inseparable from a solid environmental supervision system. Reforming the existing environmental supervision system requires the government to earnestly assume environmental responsibilities, perform supervisory functions, and play a supervisory role. From a horizontal perspective, supervision channels should be broadened, the role of the masses should be brought into full play, environmental protection files should be established for shale gas extraction enterprises, and environmental protection inspections and risk assessments should be carried out regularly. From a vertical perspective, we can implement a vertical management mechanism, adhere to the territorial responsibility for environmental quality, promote local governments to perform their duties, and assign environmental responsibility to individuals. On the one hand, we should improve the ecological performance appraisal system and make environmental benefits an essential indicator for assessing the work performance of leading cadres under the guidance of a correct implementation program. On the other hand, we should improve the ecological responsibility system, extend the time limit for accountability, implement the lifelong system of environmental responsibility according to local conditions, effectively improve the supervision effectiveness of supervisors and units, and avoid the phenomenon of "big thunder and little rain"[15].

3.1.2 Create an educational environment for green development

To promote the green development of the shale gas industry, we should infiltrate the concept of green development in its development process and popularize the idea to all central bodies in the industry. Considering the key stakeholders in the shale gas industry, government policymakers, internal managers of enterprises, and residents of resource locations are all targets of green education. The concept of green development should be integrated into the education system of the government, enterprises and communities to promote the green way of thinking runs through all aspects of the shale gas industry.

A combination of online and offline methods can be adopted for publicity and education. We can promote the concept of green development and carry out systematic education on environmental protection knowledge for different groups through modern communication tools, such as TV, mobile phones and other media. For the type of activities to be carried out, for example, we can choose special lectures in which the makers of green development policies can interpret policies systematically for shale gas extraction companies; experience exchange meetings in which representatives of outstanding enterprises implementing green production and green transformation in the industry can conduct experience sharing and exchange activities. When various actors in the shale gas industry gradually realize that environmental protection and development are not contradictory, the government's green supervision, enterprises' green production and residents' green supervision initiative will be significantly improved.

3.1.3 Create the public opinion atmosphere of green development

By judging the behavior of the subject being evaluated, public opinion feeds back the results to the subject and the public, thereby prompting the subject to continuously adjust their

behavior toward the standards and requirements of green development. By giving positive or negative evaluations to the subject being evaluated, public opinion will stimulate or inhibit their behavior accordingly, thus guiding the subject's follow-up activities to approach the direction of green development gradually. For policymakers, after listening to the voices of the masses, adjusting relevant policy standards promptly can meet the interests of enterprises and residents of resource areas to the greatest extent on the basis of satisfying green development. For shale gas extraction companies, actively collecting or passively accepting public opinions of the project site and promptly correcting wrongdoings is conducive to building an excellent corporate image.

To properly play the role of public opinion, it is first necessary to establish and improve a management mechanism for environmental public opinion issues and provide an effective platform to respond to and handle the feedback efficiently. Secondly, give full play to the advantages of media communication to expand the influence of public opinion, commend and encourage advanced deeds that implement the concept of green development, and criticize self-interested behaviors that violate this concept. Compared with the enforcement power of the law, public opinion plays a role with flexible management. It subtly transforms the will of the organization into people's conscious actions, thereby preventing the occurrence and deterioration of pollution problems from the source.

3.2. Optimize the Development Model and Insist on Sustainable Development

The idea of sustainable development of shale gas energy means that the development should not only meet the needs of the current generation but also not damage the due interests of future generations[16]. It should also reflect green, sustainability and development in the development process. Currently, China's shale gas development must not only change the extensive production mode that relies too much on the consumption of material resources but also improve the current status of the management mechanism. Promote upgrading the industrial structure through reform and innovation, optimize the development model, and promote the industry's sustainable development.

First, the premise for enterprises to carry out shale gas hazardous waste treatment business is to have The Hazardous Waste Business License. The specific application process is cumbersome and time-consuming, and it needs to go through environmental assessment approval, environmental protection independent acceptance and filing, technical evaluation and administrative approval. Only after a series of formalities can you apply for a business license from the Provincial Department of Ecology and Environmental Protection. At the same time, there is a certain degree of overlap in the approval operations of EIA and technical assessment in the above process. Because of the current situation of the cumbersome application process and complicated approval procedures for shale gas hazardous waste treatment enterprises, there are two suggestions. We can establish a particular working group for shale gas drilling cuttings and implement rapid approval of qualifications for enterprises engaged in drilling cuttings treatment. Next, optimize the service process and moderately relax the business scope of The Hazardous Waste Business License for enterprises that hold skid-mounted devices and engage in hazardous waste treatment on the premise of completing the environmental impact assessment of the operation site.

Second, the processing of shale gas drilling cuttings, especially oil-based cuttings, has high requirements on factors such as site, technology, capital, market, and talent. The qualification requirement is a single legal person, and it is difficult for a single entity to have all the elements simultaneously. Due to the minimal number of companies that fully meet the requirements, the supply and demand in the oil-based cuttings treatment market are unbalanced, resulting in unreasonable treatment prices. In response to the problem that the advantages of different hazardous waste treatment enterprises are not complementary, these enterprises can carry out

joint venture cooperation in terms of sites, capital, technical personnel and markets around the issue of oil-based rock chip treatment and apply for The Hazardous Waste Business License together.

Third, we can take the current situation of shale gas development in Sichuan as an example. The Sichuan Provincial Department of Ecology and Environmental Protection promulgated Sichuan Province Centralized Hazardous Waste Disposal Facilities Construction Plan (2017-2022), which has carried out regional deployment for hazardous waste treatment in the province. However, according to the investigation, the distribution in the main shale gas production area is challenging to meet the needs of shale gas oil-based cuttings treatment and contradicts the fluidity of shale gas development. Given the contradiction between the distribution of hazardous waste disposal planning and the fluidity of shale gas development, it is recommended to optimize the layout of hazardous waste treatment facilities, dynamically adjust the hazardous waste treatment facilities, and encourage enterprises with facilities and sites to carry out equipment renovation and technological innovation according to their service radius and the actual needs of the development of shale gas industrialization.

3.3. Improve the Technical Level and Carry Out Green Technology Innovation

Science and technology are both the primary productive force and a double-edged sword. On the one hand, the progress of science and technology has realized the development and utilization of clean energy, such as shale gas, which has promoted the optimization of the energy structure and the promotion of energy conservation and emission reduction to a certain extent. On the other hand, the traditional development method is limited by the technical level and mainly adopts the one-way linear model of endpoint governance to violently plunder natural resources. Current development methods have inevitably caused environmental pollution and ecological damage, which are contrary to the original intention of human beings to develop clean energy. To this end, we should follow the guidance of green culture, infiltrate the concept of green development into the technology development process, and promote green development with the help of green technology innovation.

Green technology innovation introduces ecological ideas into the technological innovation process. It not only ensures the innovation and practicality of the technology but also pursues clean, environmentally friendly, green and efficient technical means. Its goal is to achieve economic value and ecological value at the same time[17]. The main contents of green technology innovation in the shale gas industry include waste reduction technology at source, recycling technology, clean processing technology, etc., to achieve pollution-free development or less pollution development. The green technology innovation of the shale gas industry adheres to the principles of development in protection and protection in development. It promotes the transformation of its development model from extensive to intensive. Specifically, there are the following two suggestions.

First, build a technological innovation consortium. Led by government departments, it comprehensively integrates the resources of talents, information, technology, and capital of domestic and foreign universities, research institutes and enterprises. It might be a technology research center that can carry out scientific research, talent training and achievement transformation. The research center can also realize the integration of production, education, research and application and solve the processing and disposal problems such as the reduction, harmlessness and resource utilization of drilling cuttings.

Second, carry out key technology research. Set up special technical funds, conduct scientific research project bidding at home and abroad, and carry out scientific problems and key technology research for the treatment technology of drilling rock chips, especially oil-based rock chips. And form them as soon as possible. In this way, oil-based rock chip treatment technology will be developed as soon as possible.

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