Discussion on the current situation and development prospect of tight gas exploitation in China

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Abstract: in view of the difficulties in the development of tight gas, this paper first introduces the tight gas briefly, analyzes the distribution of tight gas in China, and deeply analyzes the difficulties in the development of tight gas. According to the actual situation in China, this paper puts forward the relevant countermeasures conducive to the development of tight gas, which lays the foundation for promoting the development of tight gas development industry in China.

Introduction

Due to the high degree of exploration of tight gas in China, relatively clear reserves, relatively mature development technology, large volume and broad development prospects. But for many years, the development progress has been affected because the exploitation cost is higher than that of conventional natural gas. Now the state has made clear the unconventional natural gas status of tight gas, and with the central financial subsidies, the bottleneck problem of development will be solved. Tight gas in China will surely usher in a valuable opportunity for rapid development, and then become one of the main natural gas in China.

1. Significance and current situation of exploration and development of tight gas resources in China

1.1 Concepts of tight gas and significance of exploration and development of tight gas resources in China

At present, there is no strict definition of tight gas at home and abroad. Generally speaking, when the permeability of the local layer is less than 0.1md, the natural gas stored in the sandstone layer can be called tight gas. This kind of resource can only be exploited by fracturing. As an important strategic material for national economic and social development, the supply and demand of energy not only affects the economic development and social stability of a country to a great extent, but also affects the political, economic and security of a region or even the world. Due to the limitation of conventional energy and the impact of a large number of greenhouse gases on the natural environment, more and more countries are trying to find realistic green energy as a substitute. At present, unconventional energy is regarded as a transitional energy in the process of transformation from conventional energy to green energy. Therefore, unconventional oil and gas resources play an increasingly important role in the world energy structure The role.

As an important member of unconventional gas family, tight sandstone gas (tight gas, the same below) is mainly stored in low permeability or ultra-low permeability sandstone reservoirs. At present, the recoverable tight gas reserves in the world are about 21 trillion cubic meters, and the resources are widely distributed, and many countries have started exploration and development of tight gas. Among them, the United States is the country with the earliest development of tight gas and the most mature technology in the world. Relying on the successful development of tight gas and shale gas, the United States has changed from the world's largest energy importing country to a country that can guarantee energy self-sufficiency in less than 10 years. For China, whose energy demand is growing and energy dependence on foreign countries is increasing, it is of great practical

significance for exploration and development of tight gas resources in China to learn from the successful experience of the development of tight gas industry in the United States.

According to the statistics of relevant data in China, the reserves of tight gas in China have reached 9-10 × 1012m3, and the total reserves account for more than 22% of all natural gas reserves, which are relatively widely distributed in the northwest and southwest regions of China. In recent years, the development of tight gas in China has been increasing. It is predicted that by 2030, the output of tight gas in China will reach 4.3 × 1010m3. However, in the process of tight gas development, affected by various factors, it is relatively difficult to develop. If these problems can not be solved, they will directly affect the development of China's tight gas development industry. Therefore, it is necessary to conduct in-depth study on the problems in the process of tight gas development and put forward corresponding measures to promote the development of the industry.

1.2 Analyses on the market situation of tight gas industry in China

According to the prediction results of the Chinese Academy of engineering, tight gas will maintain rapid growth in the future, and its development can take three steps: first, accelerate the production pace of Ordos and Sichuan bases during the 12th Five Year Plan period, strengthen the exploration of tight gas in Tarim, Junggar, Songliao and Bohai Bay basins, develop and improve the exploration and development supporting technologies, and realize the rapid development of tight gas, 2015 The annual output reaches 50 billion cubic meters. Step 2: during the 13th Five Year Plan period, a systematic, efficient and low-cost technical system will be formed. The tight gas in major basins will be developed and utilized on a large scale, with a large-scale increase in production, reaching 80 billion cubic meters in 2020. The third step is to achieve stable development of tight gas after 2020, and the output will reach 120 billion cubic meters by 2030.

Large scale exploration and development of tight gas in China started from Sulige gas field in Ordos Basin. Sulige gas field was discovered in 2000, mainly located in the middle and north of Ordos Basin. The main producing strata are the Permian Shihezi Formation and Shanxi formation. The reservoir thickness is 20-40 meters, and the depth is 2500-3500 meters. Its "low permeability, low pressure, low abundance" and other characteristics lead to the unsatisfactory early test production effect, and it was not until 2006 that the large-scale development began. Since 2008, the reserves and production of Sulige gas field have achieved rapid growth with the promotion and application of vertical well stratified fracturing, horizontal well staged fracturing and other technologies.

Sulige tight gas field started horizontal well development test in 2002, carried out horizontal well fracturing technology breakthrough test in 2008, applied horizontal well scale in 2010-2011, and now has entered large-scale commercial development. In 2015, the tight gas production of Sulige gas field was 23.39 billion cubic meters, accounting for 61% of China's tight gas production. The single well investment of tight gas includes comprehensive drilling + surface construction investment. The total investment of single vertical well is 6-8 million yuan / well, and that of single horizontal well is 12-15 million yuan / well. Take Sulige gas field as an example, the typical production changes of two wells. The initial production of horizontal wells is 30000-50000 m3 / day, while that of vertical wells is 6000-14000 m3 / day, and the high-yield period is generally 3-5 years.

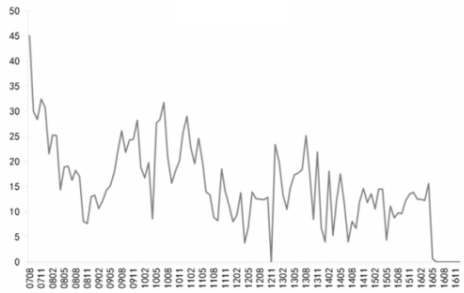

Figure1. actual monthly production of single well a of Sulige tight gas (10000 m3)

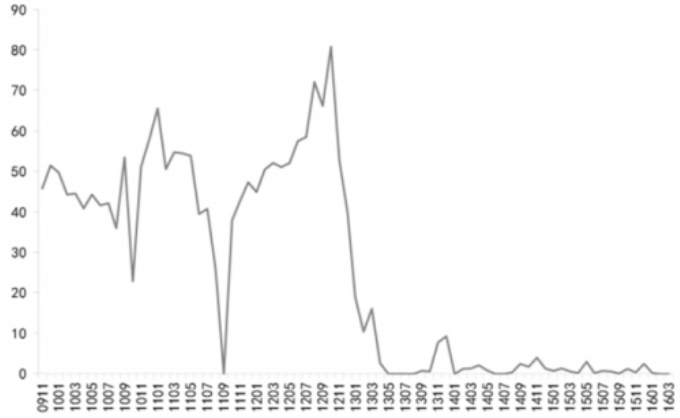

Figure 2. actual monthly production of single well B of Sulige tight gas (10000 m3)

The tight gas needs to be fractured, and the initial production is relatively high, but the decline is fast, and the decline is slow in the middle and late stages, and the time to maintain low production is relatively long. Because there is no stable production period for a single tight gas well, the way of inter well replacement is usually adopted to keep the total production stable and increase.

Take block m of Sulige gas field as an example. From 2006 to 2014, a total of 12.1 billion yuan of exploration and development funds was invested in block m; the total wellhead production capacity was 4.68 billion m3 / year, the annual production gradually increased from 30 million M3 to 2.27 billion m3, and the actual ex factory price increased from 62 yuan / m3 to 1.25 yuan / m3; due to the declining production of old wells, at the end of 2014, the wellhead production capacity was 2.3 billion m3, and the centralized pressurized mining was fully implemented; in 2015, the production was 2.07 billion m3, comprehensive mining was realized The combined decline rate is about 23%.

From the production curve of single well in this block, the average decline rate of single well in the first year is about 30%, in the second year is about 25%, and in the third year is about 20%. The average decline rate of straight well in the first three years is between 22% and 26%. The decline rate slows down from the fourth year, and tends to be stable after the decline rate in the tenth year is about 10%, and the complete life cycle is about 15 years.

According to the gas production characteristics of tight gas, the production method is generally adopted for asset depreciation, and the proportion of annual production of single well / economic recoverable reserves of single well is used for depreciation. The production method can ensure that the total investment is evenly distributed in the dense gas. The average cumulative reserves of a single vertical well are generally about 10-30 million cubic meters, and over 80% of the final recoverable reserves will be recovered in the first ten years.

2. Problems in the development of tight gas

2.1 The difficulty of exploration is relatively large and the technical requirements for development are relatively high

Firstly, for tight gas reservoir, the heterogeneity of the formation is relatively strong, and the relationship between water and gas in the formation is relatively complex, which makes it more difficult to carry out natural gas exploration and cannot accurately predict the content of tight gas in the formation; secondly, due to the relatively poor physical properties of the reservoir in the tight gas reservoir, the gas well production is relatively low in the process of development; finally, in the process of In the process of gas reservoir development, it needs the participation of supporting facilities. However, the construction of supporting facilities in the field of tight gas development in China is still not perfect, and the relevant technologies still need to be improved.

2.2 Relatively high development cost and relatively poor economic benefit

For tight gas reservoirs in China, due to the relatively low formation abundance, the production of single gas well is relatively low. In the process of development, the rate of gas well production reduction is relatively accelerated. Generally, large-scale drilling operations are required to ensure the production of the block. Therefore, the construction investment cost in the process of gas reservoir exploitation is increasing, and the daily cost and routine cost are increasing The ratio of natural gas to natural gas is relatively large [2]. On the other hand, the price of natural gas in China is relatively low, and it may be kept at a low price for a long time, which makes the economy of tight gas development relatively poor.

2.3 No obvious policy support

Due to the influence of various factors such as the difficulty of exploration, development and economy, tight gas in China is still unable to carry out economic exploitation. At present, only sporadic development can be carried out, which makes tight gas in China unable to form industrialization. Relatively speaking, China has only introduced corresponding supporting policies for shale gas and other types of natural gas, and the shale gas development government will give 0.4 yuan / m3 subsidy, which is an effective condition for shale gas to be successfully developed and industrialized. However, for the development of tight gas, the state has not issued corresponding supporting policies. Therefore, although some gas fields have already been equipped with supporting policies Due to the influence of economic factors, tight gas has lost money year after year in the development process, so it has to give up favorable development conditions.

3. Development strategy of tight gas

3.1 Establish and improve relevant standards of tight gas

In the United States, any natural gas reservoir with a formation permeability lower than 0.1md can be called a tight gas reservoir; in Germany, any natural gas reservoir with a formation permeability lower than 0.6md can be called a tight gas reservoir; in the United Kingdom, any natural gas reservoir with a formation permeability lower than 1md can be called a tight gas reservoir. However, there is no definition of tight gas reservoir in China, which has caused some problems for the development of tight gas. In order to promote the development of tight gas development industry, relevant units should first establish and improve the relevant standards of tight gas according to the reservoir characteristics, and in some aspects, tight gas can be classified as unconventional natural gas for management.

3.2 Establish and improve natural gas price mechanism

The establishment and improvement of the price mechanism of natural gas can be started from two aspects. First, since the production of natural gas in the tight gas producing areas is decreasing, the price of tight gas is priced according to the stock gas. Therefore, the relevant departments of the state should accelerate the reform of the price of natural gas, so that the price of stock natural gas and incremental natural gas can reach the same track The relevant departments should also study the new pricing mechanism of natural gas, and increase the economic benefits of tight gas development from the side [3]; secondly, according to the similarities and differences of sandstone properties in tight gas reservoir, establish the classification, stratification and phased development standards of tight gas, and improve its economic benefits from the perspective of development.

3.3 Launch tight gas development support policies

There are two main ways to launch the supporting policies for tight gas development: first, the relevant national departments should formulate the corresponding tight gas development plan, establish the short, medium and long-term plan for tight gas development with the support of the relevant government departments, and establish the corresponding safeguard measures to promote the development of tight gas industry; second, formulate the supporting measures for tight gas

development according to the shale gas supporting standards Hold policies, including VAT free, tariff free, accelerated depreciation of relevant assets, etc., to promote the development of tight gas development industry from the perspective of policies.

4. Discussion on the development prospect of tight gas in China

4.1 Tight gas is the leader of unconventional natural gas in China

Tight gas, also known as tight sandstone gas, refers to the natural gas in sandstone formation with permeability less than 0.1 millidarcy, which is recognized as the three unconventional natural gas in the world together with shale gas and coalbed gas. China first discovered tight gas resources in Sichuan Province in 1971. The tight gas reserves of Sichuan Basin and Ordos Basin account for about 90% of the whole country. At present, in the development process of unconventional natural gas in China, the development of tight gas is far ahead.

4.1.1 Comparison of proved reserves

In 2017, the total proved reserves of natural gas in China were 14.22 trillion cubic meters, including 3.8 trillion cubic meters of tight gas, accounting for 26.72%; 1 trillion cubic meters of shale gas, accounting for 7.03%; and 0.69 trillion cubic meters of coalbed gas, accounting for 4.85%.

4.1.2 Comparison of production

In 2016, China's total natural gas output was 137.1 billion cubic meters, of which tight gas output exceeded 40 billion cubic meters, accounting for about 29.18%; shale gas output was 7.882 billion cubic meters, accounting for 5.75%; and coalbed methane output was 4.495 billion cubic meters, accounting for 3.28%. In 2017, China's total natural gas output was 148.7 billion cubic meters, of which tight gas output accounted for about 30%; shale gas output was 8.995 billion cubic meters, accounting for only 6.05%; coalbed methane output was 4.704 billion cubic meters, accounting for only 3.16%.

4.1.3 Comparison of predicted output in 2020

According to the 13th five year plan for energy development, China's natural gas production will reach 220 billion cubic meters in 2020, among which, according to the prediction of the Chinese Academy of engineering, the tight gas production will reach 80 billion cubic meters, accounting for 36.36%. According to the 13th five year plan for the development of shale gas and coal bed methane, the output indicators in 2020 are 30 billion cubic meters and 10 billion cubic meters respectively, accounting for only 13.64% and 4.55% respectively.

To sum up, it is no exaggeration to say that tight gas is the leader of unconventional natural gas in China.

4.2 The addition of tight gas increases the volume of unconventional natural gas and its proportion in the total natural gas volume

4.2.1 Increase in proved reserves

Due to the addition of tight gas, the proved reserves of unconventional natural gas increased sharply from 169 million cubic meters to 549 million cubic meters, and the proportion in the total proved reserves of natural gas also increased sharply from 11.88% to 38.6%.

4.2.2 Increase in production

Due to the addition of tight gas, the production of unconventional natural gas increased sharply from 12.377 billion cubic meters to 52.377 billion cubic meters in 2016, and the proportion of total natural gas production in that year increased sharply from 9.03% to 38.21%. In 2017, the production of unconventional natural gas increased sharply from 13.699 billion cubic meters to

about 58.3 billion cubic meters, and the proportion in the total production of natural gas in that year also increased sharply from 9.21% to 39.21%.

4.2.3 Increase in predicted output in 2020

Due to the entry of tight gas, the predicted output of unconventional natural gas in 2020 will soar from 40 billion cubic meters to 120 billion cubic meters; the proportion of the total predicted output of natural gas in 2020 will also soar from 18.18% to 54.55%. In other words, the production of unconventional natural gas will exceed that of conventional natural gas, achieving a historic transformation.

Conclusions

To sum up, China's tight gas reserves are relatively large and widely distributed. In the future, China's efforts to develop tight gas will continue to increase. However, China still faces many problems in the process of tight gas development, which are divided into two aspects: technology and policy. Therefore, China's relevant units should establish and improve the relevant standards of tight gas, establish and improve natural gas Starting from the gas price mechanism and the introduction of tight gas development supporting policies, we have taken a number of effective measures to promote the development of China's tight gas industry. Based on the study of the exploration and exploitation process of China's tight gas resources, this paper finds that many achievements have been made in the development of China's tight gas over the years, but there are still major problems, including: the lack of strong and effective fiscal and tax support policies; the highly monopolized system to reduce the enthusiasm of enterprises in the development of dense gas; the unreasonable price formation mechanism of natural gas; the lack of comprehensive utilization of tight gas geological reserves Capacity; technical bottleneck needs to be broken; the contradiction between tight gas resource development and environmental protection is prominent; the total number of talents in tight gas industry is short, the reserve is insufficient and the loss is serious.

In view of these problems, and drawing on the experience of the successful development of tight gas in the United States, this paper puts forward policy suggestions for the exploration and development of tight gas in China: first, from the national level, we should give strong policy support to the exploration and development of tight gas; second, from the industrial level, we should speed up the pace of research and break through the technical bottleneck in the process of exploration and development of tight gas; third, from the enterprise level And attach importance to the linkage of national capital to provide a good market atmosphere for the development of tight gas.

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