Development Status of Coal Mining in China

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Abstract As a controllable active resource in China, coal mining is facing the transition from output to quality. Based on the total mining production and average capacity, the current situation and level of coal mining at three scales of mine, city and province is analyzed, data support for the layout of sustainable mining development and the optimization of output is provided. The results show that China's coal is mainly mined by underground mining, accounting for 87%, with an average production capacity of 0.93 million tons. Open-pit mining accounts for 13%, with an average production capacity of 5.73 million tons. So the average production capacity of open pit and underground workers is 1.045 million tons, with 1,181 coal mines capacity lower than 0.3 million tons, accounting for 35% of the total coal mines, contributing only 4% to their output. They are distributed in about 48 cities in 6 provinces, seriously restricting the green coal mining. The coal industry should speed up the reduction of small coal mines in key provinces and cities, eliminate outdated production capacity in the central region, increase the speed and proportion of coal resources moving westward, and promote high-quality development of coal mining.

Keywords: coal mine; production; capacity; price indices

By the end of December 2018, China had 3,373 fully-licensed coal mines with a total output of 3.53 billion tons/year, with an average production capacity of 1.045 million tons/mine, including 0.93 million tons/mine for underground mining and 5.73 million tons/mine for open-pit mining^[1]. China's coal produc-

tion is dominated by underground mines, which accounts for 87% and open-pit mining for 13%. China has about 25 provinces engaged in coal mining, mainly concentrated in 165 urban areas, and the mining level is shown in Fig. 1.

Fig.1 Coal mining level distribution in China (National Energy Administration Notice No. 2 of 2019)

At present, the regional distribution and mining technology level of coal mines in China vary greatly, and advanced and backward exist side by side. There are 41 working faces of 10 million tons in China, including 25 underground mines and 16 open-pit mines. However, there are 1,181 mines with an annual output of less than 0.3 million tons (1,176 Wells and 5 open pits), accounting for 35% of the total number of coal mines and only 4% of the total output, showing a serious imbalance between quantity and output. In order to advance the national three-year action plan for the special rectification of work safety, in the next three years, small coal mines with an annual output of less than 0.3 million tons will be disposed of by category and more efforts will be made to eliminate and close them. By 2022, the proportion of large coal mines in China will reach more than 70%. At the same time, by further improving the level of mechanization, information, automation and intelligence of coal mines, the number of intelligent working faces for coal mining and mining has reached 1,000 from 280 at present, and the production capacity of this part of coal mines

will account for 1 billion to 1.5 billion tons. At the same time, the proportion of national coal mine safety production standardization at the first and second levels will also reach over 70% [2].

In order to discuss the status and level of coal mining in China in detail, this paper analyzes coal mining from three dimensions: mine, city and province, which provides data support for the proactive strategic layout of coal resources in China.

1 Types of coal mining in China

1.1 Mining type

China is the largest coal mining country and is turning to high-quality development. Due to national conditions and geographical differences, coal mining is dominated by underground mines, accounting for 87% and 13 per cent of open-pit mining. China has 3,292 underground mines with a total production of 3,063 million tons and an average capacity of 0.93 million tons per mine. There are 81 open-pit mines, with a total production of 463 million tons and an average capacity of 5.73 million tons/mine. The produc-

tion capacity of underground mines and open-pit mines is shown in Fig. 2.

Fig.2 Proportion of coal mining types

1.2 Underground mining

In order to analyze the mining level of underground mines in detail, the classified statistical distribution is shown in Fig. 3. The interval coordinates are below 0.3 million tons, 0.3-1 million tons, 1-10 million tons and above 10 million tons.

Fig.3 Overview of underground mine capacity

There are significant differences in the number and production capacity of underground mines in China, and there are too many low-yielding coal mines. The production capacity of coal mines is mainly concentrated in those with an annual output of 1 million tons or less, and the output percentage is negative, which seriously drags down the coal mining level. In the Fig.3, the production capacity with the highest proportion is in the range of 0.3 to 1 million tons, and there are about 1,288 of them, accounting for 39% of the total coal mine, while the output contribution is only 24%. Secondly, there are 1,176 coal mines with a production capacity of less than 0.3 tons,

accounting for 36% of the total coal mines, and the output contribution is only 4.5%. The mainstay of China's coal output is the coal mines with an annual output of over 1 million tons, among which 803 have an annual output of 1 to 10 million tons, accounting for 24% of the total, and the output contribution is as high as 60%. There are 25 mines with an annual output of 10 million tons, accounting for less than 1% of the total, while the output contribution is 11%. In terms of the average contribution ratio of production capacity, 10 million tons of mines is 88 times that of mines below 0.3 million tons. It can be seen that the current focus of production capacity reform is to close coal mines of less than 0.3 million tons, reduce the number of coal mines of 0.3 to 1 million tons, increase the number of mines with production capacity of more than 1 million tons.

1.3 Open-pit mining

Compared with underground mines, open-pit mines are concentrated in nine provinces, among which Inner Mongolia, Xinjiang and Shanxi account for 95% of the total output of open-pit mines. Coal production of open-pit mines varies widely, with Inner Mongolia producing 290 million tons, while Guangxi produces only 200, 000 tons. In open-pit mines, the number of medium-capacity mines is large, but the number of high-capacity and low-capacity mines is small. On the whole, the output contribution rate of the open-pit mine with a capacity of over 10 million tons is positive, as shown in Fig. 4.

Fig.4 Overview of open pit coal mine capacity

The production capacity of open-pit mines is mainly between 1 million and 10 million tons. There are 36 such open-pit mines, accounting for 44% of the

total and only 30% of the output contribution, which is lower than the average level. Secondly, there are 24 open-pit mines with a production capacity of 0.3 million to 1 million tons, accounting for 30% of the total, while the output contribution is only 2.8%, which is seriously lower than the average level. There are 5 open-pit mines with a capacity of less than 0.3 million tons, accounting for 6% of the total, while their output contribution is less than 0.1%. There are 16 open-pit mines with positive output contribution, all of which have a production capacity of more than 10 million tons, accounting for 20% of the total coal mine, while

the output contribution is as high as 67%. Based on the comprehensive comparison, it can be seen that the production capacity level of open-pit mines is seriously polarized. The negative contribution rate of open-pit mines with a production capacity of less than 10 million tons affects the average mining level. The lower the production capacity, the more obvious it is. Therefore, it is necessary to speed up the reduction and closure of open-pit mines with a production capacity of less than 1 million tons.

2 City rank of China's coal mining

with a coal production capacity of 15 to 50 million tons, with a total output of 893 million tons, which can be regarded as the reserve force of modern coal mining cities. Yinchuan has the highest annual coal output, while Dazhou has the lowest, with 34% of the cities in this echelon below the national average.

The level of city coal mining depends not only on the output of coal, but also on the number of coal mines. Ordos, the city with the largest coal output, has a large number of coal mines (237). However, after calculating the average value, its production capacity is lower than that of Fuyang. The reason is that Fuyang has only three coal mines (the annual output is 11.4, 9.6 and 5 million tons respectively), and its production capacity is higher after calculating the average value. Secondly, Xilingol, Hulun Buir, Huainan and Baoji have higher average coal production capacity. Xilingol has 16 coal mines, including four open-pit mines with an annual coal output of 10 million tons and three open-pit mines with an annual coal output of more than 5 million tons, raising the average coal production capacity in the region. Hulunbuir has 19 coal mines, and its average coal production capacity is high because it has two open-pit mines of more than 20 million tons. The average coal production capacity of 16 coal mines in Huainan was increased after the elimination of 2 low-yielding coal mines. Baoji has only two coal mines (the annual output is 5 and 4 million tons respectively) due to the small number of coal mines, and its average coal production capacity is relatively high.

Dazhou (Sichuan), Southwest Guizhou Autonomous Prefecture (Guizhou), Zunyi (Guizhou), Qujing (Yunnan), Jixi (Heilongjiang) and Qitaihe (Heilongjiang) are cities with annual coal output of 10 million tons, but the average coal production capacity is less than 0.3 million tons. Their common characteristics are low total coal output, large number of coal mines and low average coal production capacity, which are the key points of optimization and reform of coal mines. In general, there are 44 coal mines with an average coal production capacity of more than 1.045 million tons, accounting for about 70% of the major

coal mining cities. It can be seen that there is still much room for improvement in both the number and average coal production capacity of coal mines.

3 Interprovincial coal production level

3.1 Provincial coal output and capacity

China has 25 provinces and municipalities directly under the Central Government engaged in coal mining, and their output and levels vary greatly due to their wide geographical distribution. The production status and average coal capacity level are listed below, as shown in Fig. 6.

Fig.6 Coal production capacity of provinces

Eight of China's major coal-producing provinces produce more than 100 million tons of coal, followed by Shanxi, Inner Mongolia, Shaanxi, Xinjiang, Guizhou, Shandong, Henan and Anhui, which can be seen as the first echelon of coal production. Among them, Guizhou and Henan are lower than the national average production capacity.

There are 11 provinces in the second echelon of coal production, with coal output between 10 million and 100 million tons, mainly in Heilongjiang, Ningxia, Hebei, Sichuan, Gansu, Yunnan, Liaoning, Jilin, Chongqing, Jiangsu and Hunan, among which Hunan, Sichuan, Heilongjiang, Yunnan, Chongqing and Jilin are significantly lower than the national average. The coal output of the third echelon is relatively low, mainly in six provinces, namely Jiangxi, Guangxi, Qinghai, Fujian, Beijing and Hubei. Except for Beijing, the coal output of the echelon is all lower than the national average. From the perspective of coal output and average coal production capacity, the six

provinces in urgent need of coal mining reform are Jiangxi, Hubei, Hunan, Sichuan, Fujian and Heilongjiang, respectively. The number of coal mines accounts for 27%, but the coal output contribution rate is only 5% and the average coal production capacity is less than 0.3 million tons.

Similarly, taking the average coal production capacity of 1.045 million tons as the baseline, the provinces at the higher level are Shanxi, Inner Mongolia, Shaanxi, Xinjiang, Shandong, Anhui, Ningxia, Hebei, Gansu, Liaoning, Jiangsu, Qinghai and Beijing. The main reason why these provinces have high average coal production capacity is that they have geographical advantages, good coal storage conditions and large reserves, which are the main areas where the coal mining strategy is transferred. Another reason is that outdated production capacity is constantly eliminated and the mining level is improved, such as Shandong, Beijing, Jiangsu and other regions.

The provinces with low average coal production capacity are mainly located in the southern China, with complex geographical conditions, low total production and many coal mines, which should be paid close attention to in the future coal production capacity reform. In order to implement the country about In order to implement the country put forward about the requirement of classification management work of coal mine with an annual output of less than 0.3 million tons, Jiangxi Development and Reform commission Commission, Jiangxi Emergency Management Office, Jiangxi Provincial Department of Finance, Jiangxi Provincial Natural Resources Department, Jiangxi Provincial Department of Ecology and Environment, Jiangxi Provincial Administration of Resource, Jiangxi Provincial Administration of Coal Mine Safety has made Implementation plan for classified disposal of coal mines less than 0.3 million tones/year in Jiangxi Province. The implementation plan clarifies the overall requirements, main tasks and safeguard measures, and calls for further strengthening the closure of coal mines with an annual coal output of 0.9 million tons or less in Pingxiang city, and resolutely eliminating coal mines of with an annual coal output of 0.9 million tons or less that do not meet

the standards of industrial policy, safety, environmental protection, resources and quality^[3].

It is worth noting that Guizhou and Henan are great provinces of coal producing, and their mining level is lower than the national level, so outdated coal mines should be eliminated as quickly as possible. In April, 2020, Guizhou province released 254 legally produced coal mine production capacity, totaling 135 million tons, as of March 31, 2020 ^[4]. In 2020, Henan province will eliminate coal overcapacity, close and withdraw six coal mines, and promote high-quality development of coal mining ^[5].

3.2 Output and production capacity of open-pit coal mine

China's open-pit coal mining is concentrated in the three provinces of Inner Mongolia, Xinjiang and Shanxi, with Inner Mongolia producing the most, accounting for 64% of the country's output. The production capacity of open-pit coal mines in China varies greatly, as shown in Fig. 7.

Fig.7 Distribution of Open-pit Coal Mines

Both Ha'erwusu open-pit coal mine and Shenhua Baorixile Energy Co., Ltd. open-pit coal mine have a coal production capacity of 35 million tons, while that of No. 9 well of No. 5 panel of Gulianhe open-pit coal mine of Greater Khingan Range and No. 3 well of the Gulianhe open-pit coal mine in the Greater Khingan Range is only 50,000 tons and 40,000 tons, showing a serious polarization. takes 5.73 million tons as the standard line of the average production capacity of open-pit coal mines in China, and only Inner Mongolia and Shanxi are above the standard line, which

shows the uneven distribution of output and production capacity of open-pit coal mines in China. In order to improve the level of open-pit coal mining in China, urgent attention should be paid to the reform of open-pit coal mining in Guangxi, Heilongjiang and Qinghai provinces.

4 China Coal Price Index (CTCI)

The price of coal in China is closely related to coal production capacity, which indirectly reflects the balance between supply and demand. The National Development and Reform Commission made it clear in Memorandum on curbing abnormal price fluctuations in the coal market that from 2016 to 2020, in order to prevent abnormal price fluctuations in coal, the state has established an early warning mechanism for abnormal price fluctuations, dividing thermal coal prices into green, blue and red. Green area (normal price), the green area is 500~570 yuan/ton; The blue area is 570 ~600 yuan/ton or 470~500 yuan/ton; The red area is above 600 yuan/ton or below 470 yuan/ton. CTCI of each province can reflect the competitiveness of coal mining to a certain extent. The distribution of CTCI of provinces with large coal production capacity in the past six years is shown in Fig. 8.

Fig.8 Coal production capacity of provinces^[6]

It can be seen that in the past six years, only in 2017 and 2018, the national average thermal coal price was within a reasonable range, while in the other four years, the price was relatively low, mainly due to the oversupply of coal production. Due to geographical and regional economic development differences, Shandong, Henan and Anhui have long been at high

coal prices, while Xinjiang, Inner Mongolia, Shanxi and Shaanxi have long been at low coal prices, and the price advantage represents the potential of coal mining in the future. On April 30, 2020, China National Coal Group, China Huaneng Group and State Power Investment Group formally signed the 2020 coal medium and long term contract, with the benchmark coal price of 535 yuan/ton. Coal power enterprises will successively complete the contract signing work before May 10, 2020. Large coal enterprises should give full play to their leading role in stabilizing the market and take effective measures to keep the price within the green range and prevent the price of coal from going up and down dramatically ^[7-8].

5 Conclusions

1) China is geographically diverse and has a variety of coal mining conditions, with 1,181 coal mines with an annual coal output of less than 0.3 million tons, accounting for 35% of the total. The contribution rate of output is only 4%, which seriously restricts the sustainable mining level of coal mines. Jiangxi, Hubei, Hunan, Sichuan, Fujian and Heilongjiang provinces were the main areas to reduce underground mine, while Guangxi, Heilongjiang and Qinghai provinces were the main areas to reform and optimize open-pit mines.

2) China's average coal production capacity is 1.045 million tons per mine, and the average coal production capacity of underground mine is 0.93 million tons/mine, accounting for 75% of the total number of coal mines lower than the average level. The average coal production capacity of open-pit coal mines is 5.73 million tons/mine, and the number of coal mines lower than the average level accounts for 68%. The average coal production capacity level of underground mines and open-pit mines has great room for optimization.

3) China will transition from a major country to a powerful country in coal mining, and from output to quality. China should accelerate the strategic shift of coal in the west region, optimize the central region,

and promote coal to become a sustainable resource that can be adjusted proactively.

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Figures

Figure 1

Coal mining level distribution in China (National Energy Administration Notice No. 2 of 2019) Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

Figure 2

Proportion of coal mining types

Figure 3

Overview of underground mine capacity

Figure 4

Overview of open pit coal mine capacity

Figure 6

Coal production capacity of provinces

Figure 7

Distribution of Open-pit Coal Mines

Figure 8

Coal production capacity of provinces[6]