Development and engineering application of coal dry separation technology and equipment in China

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ABSTRACT

Under the situations of the Chinese government's policy of carbon dioxide emission reduction and accelerating the clean and efficient use of coal, China's coal dry separation and dry separation technology has been rapidly developed and applied. This paper briefly reviews the development history of dry beneficiation and summarises the current development status of dry beneficiation technology in China.

Great progress has been made in the application range, separation accuracy, dust removal effect, separation process design and other aspects. China has successfully developed large scale composite dry separators, lump coal dry sorting equipment, reject removal systems in large open pit coal mines, underground coal separation technology and a new generation of air heavy medium dry coal separation technology. It also has successfully developed the world's first set of modular dry coal separation system with wide feed size range and high separation efficiency. The development trend of dry separation technology will be to accelerate development of the intelligent core coal preparation equipment, to develop -6 mm fine coal separation equipment aiming to reduce the bottom limit of separation size, to remove reject at coal mine underground in-situ, to apply dry separation technology to non-coal minerals, and to promote the overseas coal washing market.

Key Words: Intelligent sorting machine, air dense medium separator, fine coal separation, underground coal mine reject removal.

PREFACE

On September 22, 2020, China advised at the 75th session of the United Nations General Assembly that it would strive to reach the peak of its carbon emissions by 2030 and become carbon neutral by 2060. In 2021, China's raw coal output was 4.3 billion tonnes, of which 76% was processed through coal preparation plants. At present, 100% of coking coal is separated, but the processing ratio of thermal coal is relatively low. About 1.1 billion tonnes of raw coal is directly burned and used without any processing and the processing ratio is still much lower than that of developed countries.

In 2021, the raw coal output of Shanxi, Shaanxi, Mongolia and Xinjiang provinces is 3.30 billion tonnes, accounting for 76.7% of the national total raw coal produced. The thermal coal in northern Shaanxi is dominated by long flame coal and non-stick coal, but the water resources in this area are severely lacking, the raw coal processing ratio is low, and the unprocessed raw coal contains large content of rock, which requires additional transportation costs. The thermal coal in eastern Inner Mongolia and Xinjiang area is mainly lignite and long-flame coal, which is easy to degrade in the washing process and clean coal yield is low, so this raw coal is not suitable for wet processing. Therefore, it is necessary to accelerate the R&D and application of advanced energy saving and emission reduction processes and technologies for coal beneficiation, and to eliminate unsuitable washing processes and maintain production capacity while increasing the coal processing ratio. The target is to realise the 100% processing ratio of thermal coal in China and the pre-deshaling of high-ash coking coal as soon as possible, to reduce pollutant emissions in coal utilisation, and to make contributions to the realisation of carbon emission control goals.

Table 1: The quantity and processing ratio of raw coal in China in recent years

Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Raw coal processed, billion tonnes	20.4	21.7	24.2	24.7	25.1	24.7	26.4	28.2	28.9	32.7
Processing ratio,%	56.0	59.0	62.5	65.9	66.2	70.2	71.8	73.2	74.1	76.0

Dry separation technology does not use water, and it effectively avoids problems such as coal degradation and high moisture product freezing in winters. The investment in dry coal preparation plant is generally 1/3-1/4 of that of wet process plants, and the operating cost is ½ of that of wet processing plants. The advanced dry separation technology that has low dust emission and saves water and electricity will be the preferred technology to improve the processing ratio of thermal coal (Li, 2014).

DEVELOPMENT STATUS OF DRY SEPARATION TECHNOLOGY

Large-scale and seriation of air flow separation equipment

Dry separation technology includes air flow coal separation, photoelectric coal separation and air dense medium fluidized bed coal separation (Liu et al, 2019; Jia et al, 2020; Xia et al, 2019; Wei, 2010). Tangshan Shenzhou Manufacturing Group Company (TSM) makes three type air flow separation equipment, they are FGX compound separator, ZM high-efficiency mineral separator and CZM super dry separator. FGX compound separator can separate mixed coal (-100 mm) and lump coal (-100 +13 mm). The maximum processing capacity of -80 +0 mm coal in double 24 m^2 decks of ZM high-efficiency mineral separator reaches 600 t/h (Liu, et al, 2019). CZM super dry separator uses a single 26 m^2 deck to process -70 +25 mm lump coal and its maximum processing capacity is 500

t/h. In addition to the separation of mixed coal and lump coal, the ZM compound dry separator can also independently deal with <30 mm fine coal or finer coal through the adjustment of operating parameters (Zhang, 2019). For example, when the ZM600 separator is used to process -30 +3 mm coal in Shanghaimiao mining company, the processing capacity of a 24 m^2 single deck can reach more than 250 t/h (Jia et al, 2020).

Table 2: Typical air flow separation equipment

Type	Forces of sorting	Model	Maximum unit capacity, t/h	Typical Feed size, mm	Ecart probable moyen, Ep	Maker
mixed coal compound separator	air blowing + vibration motor	FGX-48A	480	-80+0	0.2-0.30	TSM
		ZM600	600	-100+0	0.13-0.23	TSM
fine coal compound separator	air blowing + vibration motor	CZM500	500	-100+0	0.12-0.19	TSM
		ZM600	500	-25+0	0.18	TSM

At present, the photoelectric intelligent sorting machine widely adopts X-ray + image assisted recognition and sorting system. Taking IDS series separators as an example, when treating -300 +50 mm, -100 +25 mm and -50 +25 mm lump coal, the maximum single-channel treatment capacity can reach 240, 140 and 60 t/h, respectively. Under the premise of coal loss rate less than 1%, the deshaling rate can reach 98%, 95% and more than 92%, respectively.

Table 3: Capacity of representative IDS type photoelectric coal intelligent sorters

Model	Description	Separation mechanism	Feed size, mm	Maximum capacity, t/h	Maker
IDS-240A	Lump coal separation	X-ray recognition	-300 +50	240	TSM
IDS-140A	Medium size coal separation	X-ray recognition	-100 +25	140	TSM

In February 2022, the world's first 200 t/h air dense medium dry coal preparation system was successfully developed by China University of Mining and Technology and TSM, and it has now entered the stage of equipment commissioning and trial operation.

Construction and operation of a number of large demonstrative dry separation projects

With the increasing production capacity of coal mines, the newly developed dry separation equipment has significantly increased the processing capacity of singular equipment items and improved the separation performance. A number of demonstrative large-scale dry coal preparation projects have now been built. Recently, the installed processing capacity of the mixed coal dry separation system at No. 1 Coal mine of Shanghai Miao Mining Co., LTD of Shandong Energy Group reached 9.0 Mt/a, and the processing capacity of -300 +50 mm IDS single channel in Tiebei Mine of Zhalainur Coal Industry Co., LTD reached 240 t/h. The annual processing capacity of -13 mm final coal in coal preparation plant of No. 5 coal mine of Shanxi Yangquan Mining Group reached 2.2 Mtpa (Wang, 2019), and the processing capacity of the IDS and ZM dry separation system for dirty coal processing in Huolinhe South open-pit mine of China Power Investment Corporation reached 2.0 Mt/a (Dong et al, 2019). The completion of these large-scale dry separation plants indicates that the processing capacity of dry separation systems can meet the requirements of large-scale coal mining operation.

Figure 1: 9 Mt/a dry separation plant at Shanghaimiao Mining Co., Ltd

PERFORMANCE OF DRY SEPARATION TECHNOLOGY

Improved dry separation accuracy

When the ZM mineral separator separates -80+0 mm mixed coal, the lower limit of effective separation size is 3 mm, and when the high density is 1.7-2.3 RD, the separation Ep value is in the range of 0.13-0.23. The audits completed by China Coal Processing and Utilization Association show that when the separation density of -80 +3 mm grain is 1.9 RD, the Ep of the ZM600 dry separator in Yushujing Coal mine is 0.145, which can approach the separation accuracy of the jigs. When the separation density of -50 +6 mm in Meihuajing Coal Mine of Ningmei Group is 2.0 RD, the Ep of ZM10 separator is 0.14-0.165. When the separation density of -50 +3 mm particles is 2.1 RD, the Ep of ZM10 separator is 0.17. When the IDS X-ray sorter discharges reject at high separation density, the coal loss in reject is less than 3% and the dry separation deshaling rate is more than 95% (Wang, 2020). The separation accuracy of -300 +50 mm lumps of IDS is close to that of heavy medium vessels and lumps jigs. The separation accuracy of air dense medium dry separator is close to the separation accuracy of wet process heavy medium vessel when the coal size is +6 mm, and the Ep value is about 0.04.

Improved dust removal effect

Traditional FGX compound dry coal preparation equipment uses a single stage dust removal, and the dust emission concentration is generally around 80 mg/m^3. The dust flow in the circulating fan causes impeller wear of the main fan. The new generation of compound dry separator such as CZM super dry separator uses the whole bag dust removal system. The air containing dust is filtered by the bag filter and recycled into the air distribution chamber under the sorting deck of the separator, which prolongs the service life of the impeller. The dust removal efficiency was improved, and the dust emission concentration was lower than 20 mg/m^3.

Diversified separation process

Combined with the emergence of new dry separation equipment recently, many new dry separation processes were developed to meet the needs of different customers. For example, in the old thermal coal preparation plants without dry separation systems (Zhang, 2019), the calorific value of final thermal coal products is greatly increased after the dry-wet combination processes were adopted. Dry pre-concentration of high-ash coking coal improves the coal quality of raw coal feeding wet process plant, reduces equipment and pipeline wear, reduces the content of high-ash fine coal slimes in flotation system, reduces the content of coal slimes in heavy media suspension, improves the separation efficiency and improves the clean coal recovery rate. ZM fine coal separation is used for pre-concentration of -50 +0 mm final coal for Linxi coal mine of Kailuan Mining Group. After dry separation of +13 mm, +6 mm and +3 mm raw coal, the rock rejection rates of +1.8 RD density material reach 99.2%, 88.9% and 76.1%, respectively, and the coal loss in +3 mm reject is less than 1%. The wet and dry separation systems are independent of each other, and the dry separation system does not increase the load of wet process tailings treatment system. The combination of traditional wet coal separation and dry coal separation processes can increase the proportion of raw coal separated in thermal coal plant, improve the flexibility of the final product, and meet the market specifications for particle size, calorific value and other aspects.

A process combination of and IDS X-ray lump coal separator and a ZM dry separator can be used to separate -300 +80 mm and -80 +0 mm particle size respectively. Combined with fine coal removal, it can achieve -300 +6 or -300 +3 mm wide size range of separation in a process with reduced comminution costs. This process has been successfully applied in Huolinhe Henan Lutian Mine (Dong et al, 2019), Datang Power Plant, Baiyinhua No. 3 Mine and other coal enterprises.

Significant energy and water saving

The unit power consumption of thermal coal washing reaches 5-10 kWh/t. For a -300 +0 mm size range dry separation process, the power consumption can be controlled within 3 kWh/t, and the power consumption per tonne of coal for an X-ray module can be reduced to less than 1.5 kWh/t (Wang and Xia, 2022). For example, before the transformation of Yushujing coal preparation plant, the power consumption of heavy medium separation was 6 kWh/t. After dry separation replaced wet processing, the water consumption was reduced from 0.1 m^3/t to 0, and the power consumption was reduced to the current 2.65 kWh/t, saving 55.8% of electricity. Clean coal yield was increased by 16%, coal tailings were not discharged, labour efficiency increased by 2-3 times, and the processing cost of one tonne of coal decreased by 4.26 Chinese yuan (Liu, 2021).

CORE DRY SEPARATION EQUIPMENT INTRODUCTION

The compound dry separator is composed of a separation deck, vibrators, air chambers, a frame, a hanging device and a feeding chute, etc. The separation deck with a vibrating motor is suspended from the frame by four wire ropes or an electric suspension via a dampening spring. The separation deck is composed of a right angle trapezoidal deck surface covered with air holes, a back plate, a grid, a discharge baffle and a reject gate. A number of air distribution chambers with control air valves are arranged at the lower part of the deck surface (Figure 2).

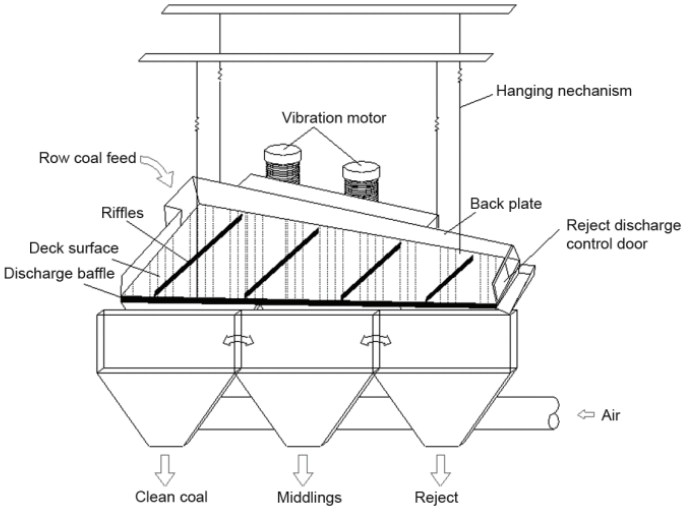

Figure 2: Structure of compound dry separator

The core component of the separator is the separation deck, the feeding end is wide and reject discharge end is narrow. The trapezoidal hypotenuse is the discharge end, and the right side is provided with a back plate, which is at a certain angle with the bed. The vibration motor on the backplane exerts periodic forces perpendicularly and horizontally. Under the combined action of air flow power and deck surface vibration forces, the raw coal entering from one corner of the bed surface is quickly dispersed, forming a bed. The clean coal particles move to the discharge end of the deck under the action of gravity. The rock with a high density sinks on the deck surface, moves close to the deck toward the back plate under the action of friction and then shifts to rock discharge chute end after back plate obstructs the movement.

In 2013, TSM successfully developed ZM series high-efficiency mineral separator based on the FGX. In 2021, the CZM series super dry separator with unit area processing capacity far exceeding the ZM type equipment, MZM fine coal separation equipment processing -30 mm fine coal, and JZM step coking coal deshaling dry separator were developed on the basis of ZM separator. The separation principle of these new dry separators is basically the same as that of FGX compound dry separators, except for the adjustment and optimization of the bed surface aperture, vibration parameters, air distribution system and dust removal system.

Figure 3: CZM200 Super dry separator

Figure 4: MZM150 fine coal separator

The separation density of the compound dry separator is more than 1.7 RD, the clean coal recovery rate is higher than the heavy medium separation, and it has the advantages of energy saving and emission reduction. Dry separation does not consume water, does not produce tailings and power consumption of main separator is <2.5 kWh/t. However, the compound dry separator cannot separate +100 mm lump coal, while IDS is suitable for +50 mm lump coal separation.

Since 2016, X-ray intelligent lump coal separators have been widely used in coal preparation plants, mainly replacing hand-picking operation and partial lump-coal washing equipment (Zhao, 2019; Jens-Michael Bergmann, 2019; Liu, 2020; Wang, 2020). Based on advanced X-ray imaging technology and artificial intelligence recognition algorithms, the X-ray automatic intelligent sorting machine carries out real-time identification and precise rejection of minerals to achieve efficient sorting. It has been widely used in coal sorting, pre-cleaning of gangue from raw ore in metal mines, waste ore scavenging and other processes.

Taking IDS X-ray intelligent dry separator as an example, the dry separator is mainly composed of a feeding system, a feed distribution belt conveyor, identification device, solenoid valve actuator, air supply system, dust removal device, power distribution system, control system, etc. (Figure 5).

The materials are uniformly arranged on the belt conveyor through the classifying screen. When coal and rock pass through the X-ray identification device, the intelligent identification method is adopted to establish the analysis model suitable for different coal characteristics, and the digital identification of coal and rock is carried out. When the material passes through the sorting room, the actuator analyses and identifies the result, opens the corresponding high-frequency solenoid valve and rejects the rock particles by spraying high pressure air. Under the action of high pressure air, the movement trajectory changes and the rock particles finally enter the reject chute. The system collects the dust produced by high pressure air in the sorting room by means of cloth bag pressure and dust removal.

The upper feeding size limit of the X-ray dry separator can reach 400 mm; the separation density is higher than 1.8 RD, the clean coal recovery rate is higher than the heavy medium vessel, and the power consumption is lower than 1.6 kWh/t. This technology can replace hand-picking operation and some heavy medium vessel equipment; however, it requires the feed material is evenly distributed in a single layer. When the feed size is less than 50 mm, the sorting accuracy and single-channel processing capacity decreases.

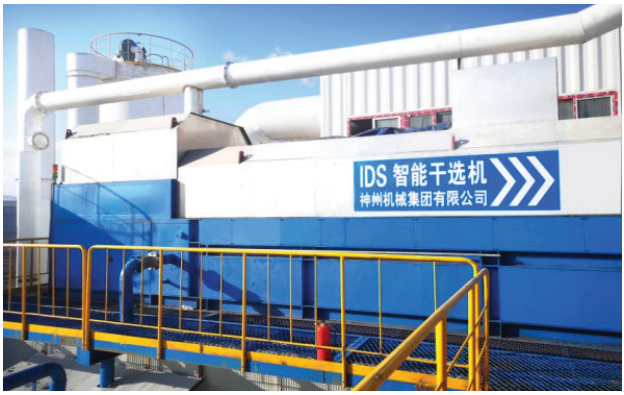

Figure 5: IDS X-ray sorter

The technical parameters of typical composite dry separators and X-ray dry separators are shown in Table 4.

Table 4: Technical parameters of typical dry separator

Compound dry separator			X-ray intelligent separator	
Item	CZM500 Super separator	MZM500 Fine coal separator	Item	IDS-2000A
Nominal capacity (t/h)	500	300	Nominal capacity, t/h	200
Deck area (m^2)	26	24	Belt width, m	2.0
Unit capacity ($t/m^2/h$)	>18	>12	Belt speed, m/s	2.5-3
Feed size(mm)	<100	<30	Feed size, mm	<400
Bottom size limit of efficient separation (mm)	3	1	Optimal sorting granularity range, mm	300-50
Separation density RD_{50} (g/cm^3)	>1.7	>1.7	Separation density, SG_{50}, g/cm^3	1.3-2.5
Separation accuracy, Ep	0.13-0.19	0.18-0.28	Separation accuracy, Ep, g/cm^3	0.06-0.1 Rock rejection rate:>95%, coal loss in reject:<1%
Installed power (kW)	964	675	Installed power, kW	260
Unit power consumption (kWh/t)	<1.6	<2	Unit power consumption, kWh/t	<1.6
Dust emission concentration (mg/m^3)	<20		Flow rate of air compressor, m^3/min	>50
Overall dimensions L × W × H (m)	25×17×10	21×7.6×11.2	Overall dimensions L × W × H (m)	12 x 2.86 x 3

-300 +0 MM FULL SIZE RANGE DRY SEPARATION FLOWSHEET

From the perspective of investment, operating cost, processing capacity and sorting accuracy, IDS X-ray intelligent sorting is suitable for sorting +50 mm lump coal, CZM super dry separator can separate -80 +0 mm mixed coal, MZM fine coal dry separator processing is suitable for -30 +0 mm fine coal. The combination of photoelectric and air flow separation equipment can realize the wide size range separation of <300 mm coal.

Full size range intelligent super dry coal preparation processes can be used for separation of dirty coal, engineering coal and inter-band coal in both open pit mine and underground mines (Figure. 6), and it can also be used for pre-concentration of high-ash coking coal (Figure. 7).

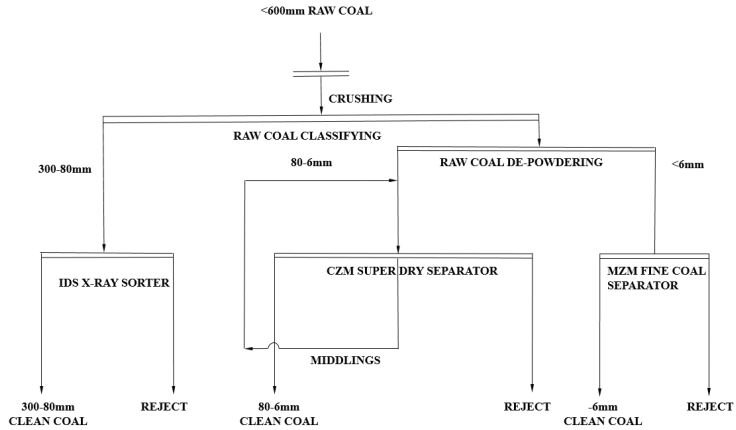

Figure 6: Thermal coal wide size range dry separation process flowsheet

When the coal is crushed to less than 300 mm, it is transported to the raw coal classifying screen by the belt conveyor. The double deck raw coal screen uses 6 mm and 80 mm apertures to classify the raw coal into three-size products. -300 +80 mm lump coal is fed into the mobile intelligent lump coal dry separator for sorting. The -6 mm fine coal is fed into a MZM fine coal separator, and -80 +6 mm mixed coal is transported to a CZM super dry separator by belt conveyor.

Advantages of the process:

1 **Modular design**
Each sub-system of the mobile separation station is of highly modular design, and each module is fully self-contained. The whole processing station adopts mobile design, and the equipment can be put into operation in a short period after equipment delivery and module connection.

2 **Energy conservation and emission reduction**
The super dry separator has energy saving benefits compared with traditional coal preparation. The processing capacity per unit area of separation deck increases by 40%, and the main separation system reduced energy consumption by 30%.

3 **Clean air coal preparation**
The mobile super dry separator adopts the whole bag dust removal system to realise clean air beneficiation. While the main fan circulates air to keep the feed loose, the induced draft fan maintains the negative pressure operation of the separator. All the dust-containing air is filtered through the cloth bag, and the emission concentration is low.

4 Intelligent control

Dry separation technology is more suitable for the separation of dirty and mixed coal in open pit mines, and it conforms to the China's policy of resource conservation and comprehensive utilization as well as energy conservation and emission reduction in open pit mines, which is conducive to the ecological construction of open pit coal mines.

The power consumption of wide-size range dry separation in some open-pit mines is shown in Table 5.

Table 5: Cases of wide-size range dry separation of dirty mixed coal in open pit mines

Name	Capacity, Mtpa	Separation process description	Calorific value increase (kcal/kg)	Designed unit power consumption (kWh/t)
Xilinhot Power Generation Co., LTD. (Shengli Dong No. 2 Open Pit Coal Mine)	3.0	-300 +80 mm: IDS sorter, -80 +6 mm: ZM separator, -6 mm bypassed	500-700	2.81
South Opencast Coal Mine of State Power Investment Huolinhe Opencast Coal Industry Co. LTD	2.0	-300 +80 mm: IDS sorter, -80 +0 mm: ZM separator, clean coal: fines removal @ 6 mm	700-900	3.03
Tiebei Coal Mine Jalainur Coal Industry Co China Huaneng Group	3.6	-300 +80 mm: IDS sorter -80 +0 mm: ZM separator	400	3.16
Liujia Coal Mine State energy group	0.8	Raw coal classified at 40 mm and 10 mm, +40 mm: Intelligent sorting, -40 +10 mm: ZM separator, -10 mm bypassed	1200	2.52
Ru Jigou anthracite Company Ningxia Coal Group National energy Group	2.0	-300 +80 mm: Intelligent sorting, -80 +0 mm: ZM separator, clean coal: fines removal @ 3 mm	>2000	2.49
Average				2.80

A full size range deep deshaling process (Figure 7) can be used to handle coking coal with high raw coal rock content. The -300 mm raw coal is classified at 50 mm, final coal -50 mm is screened at 3 mm, -50 +3 mm is separated by JZM step dry separator, and -3 mm fine coal is bypassed. Clean coal is mixed with -3 mm fine coal and sent to a wet process plant for further treatment.

Characteristics of this processing flowsheet:

1) +50 mm X-ray separation reduces the crushing cost of reject.
2) The JZM dry separator delivers effective de-stoning of -50 +3 mm coal, and the quality of final coal entering the wet processing system is fundamentally guaranteed irrespective of fluctuations of raw coal quality.
3) Flexible process
   When the raw coal quality is good, the fines bypass size can be changed to 4 mm or 6 mm. When the coal quality is poor, all -50 +0 mm coal is separated without fines bypass.
4) Dry separation system does not consume water, does not increase the load of the existing tailings treatment system, and does not produce high moisture slime products
5) Dry clean coal can be screened to produce some low ash lump clean coal when raw coal has easy washability.

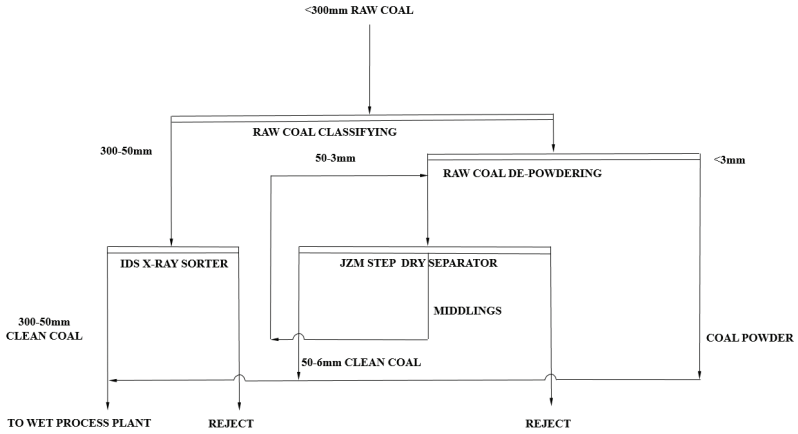

Figure 7: Coking coal deep pre-deshaling dry separation process flowsheet

The advantages of the separation process include:

1) **Improves the accuracy of the heavy medium separation and reduces the medium consumption**
   The lower the ash content of raw coal, the less high ash fine coal slimes enter into the heavy medium suspension and lower medium viscosity, and it not only improves the precision of heavy medium separation and clean coal yield, but also conducive to the medium D&R of heavy medium cyclone products and improved the separation efficiency of magnetic separators.
2) **Reduces energy consumption**
   Reducing the feed to the wet processing plant reduces the quantity of slimes and consequently the flotation energy consumption.

3) **Improve the flotation performance**
Dry separation technology can remove most dilution material in +3 mm raw coal, and correspondingly reduce the amount of secondary high ash coal slimes produced by dilution abrasion and coal degradation. This will improve the effect of flotation system, reduce the ash content of flotation feed and increase the yield of flotation product.

4) **Local deshaling of raw coal can save reject transportation costs**
The raw coal of Shuguang Coal Mine of Shanxi Coking Coal Group is a very high ash (53%,ad) coking coal with low moisture content and the -3 mm coal content is 36.%. The dilution content of +13 mm, +6 mm and +3 mm raw coal is 79% (ar), 68% (ar) and 51% (ar), respectively. After dry separation, the reject rates of +1.8 RD material in +13 mm, +6 mm and +3 mm raw coal are 92.7% (ar), 76.9% (ar) and 65.20 (ar), respectively. Repeated tests in two weeks show that the yield of clean coal ranges from 65.1% to 74.9% (ar), with an average yield of 69.6% (ar). The average rates of deshaling of +13 mm, +6 mm and +3 mm are 91.0% (ar), 75.3% (ar) and 64.3% (ar) respectively and the average coal loss in reject is 0.50% (ar).

Table 6: Dry separation product balance

Product	Wt (%,ar)	Ash (%, ad)
Clean coal	65.1	37.8
Reject	34.9	81.3
Raw coal	100.0	53.0

DEVELOPMENT TREND OF DRY SEPARATION TECHNOLOGY

Intelligent development of dry separator

Intelligent coal mine construction is inseparable from the intelligence of coal preparation systems. The intelligence of dry preparation plants should be based on automatic control technology and rely on modern information and network technology to build intelligent control systems for coal preparation plants (Song, 2019; Fen et al, 2013; Gup et al, 2019; Yang et al, 2019). The core of the intelligent dry separation system is the intelligence of the compound dry separator. The intelligent dry separation system can be divided into data collection, data aggregation analysis, intelligent learning, equipment execution feedback and other links. Through the data collection and aggregation analysis, the dry coal preparation expert system is established to intelligently regulate the dry separation process. The system can obtain the feed condition of raw coal, the angles of the deck surface, the air flow distribution, the electric flip plate, the vibration of the excitation motors and other characteristic data in real time to optimize the operation of the coal preparation process, so that the equipment can automatically run in the best status according to the change of coal quality.

Research and development of fine coal dry separation equipment

With the development of mining mechanisation, the content of -6 mm fines in raw coal is increasing. The minimum effective separation particle size of ZM mineral high efficient separator is 3 mm, and the minimum separation particle size is 1mm when the feed size distribution is -13 mm. As the separation effect of -6 +3 mm particle size is poor, one of the main directions of the development of dry separation technology will be to reduce the lower limit of the separation size, and it is necessary to develop a special separator for processing minus 6 mm fine coal.

Underground coal mine deshaling by dry separation

The integration of technology for deshaling and backfilling emplacement in underground coal mines is one of the objectives of engineering practices for safe and green coal mining and clean and efficient utilization of coal (Xin et al, 2011; Wang, 2016; Sun et al, 2017; Yang, 2022). At present, the X-ray sorters that have been installed underground can only separate +50 mm lump coal and the single-channel processing capacity is low. Compound dry separators particle feed size range can reach 100 -3 mm as the separating size limit is lower than that of X-ray sorter. The research on the combination of compound separation and X-ray separation equipment, combined with raw coal fines bypass, can achieve -300 +6 mm wide size range for deshaling, which will be a major direction for the development of efficient mining, coal separation and rock backfilling integration technology.

CONCLUSIONS

China's coal preparation dry separation technology has been widely used in thermal coal deshaling and coking coal pre-concentration both at home and abroad. The X-ray intelligent sorting machine for lump coal and the air flow separation technology for fine coal were successfully developed, and the large-scale transformation of coal preparation plants to handle easy-to-degrade coal was successfully achieved. The progress of dry separation technology makes it possible that higher quantities of thermal coal could be separated in this way in future. Lump-coal separation technology such as IDS will eliminate the hand-picking operation, and the fine coal compound separator can be effectively applied for the pre-concentration of high ash coking coal with east-to-degrade properties. The pre-concentration of raw coal improves the quality and hence achievable separation performance in the subsequent wet processing plant. Dry separation has a broad application prospect in the field of underground dilution rejection. The development of dry separation technology, however, in the areas of dry separation plant design standardization and construction, improvement of reliability of equipment, environmental performance and intelligent level and other aspects are still insufficient.

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