Process Flowsheet Design to Maximize Pyrite Rejection and Enhance Coal Heating Value Using Dry Beneficiation Technology

Tangshan Shenzhou Manufacturing Group (TSM)

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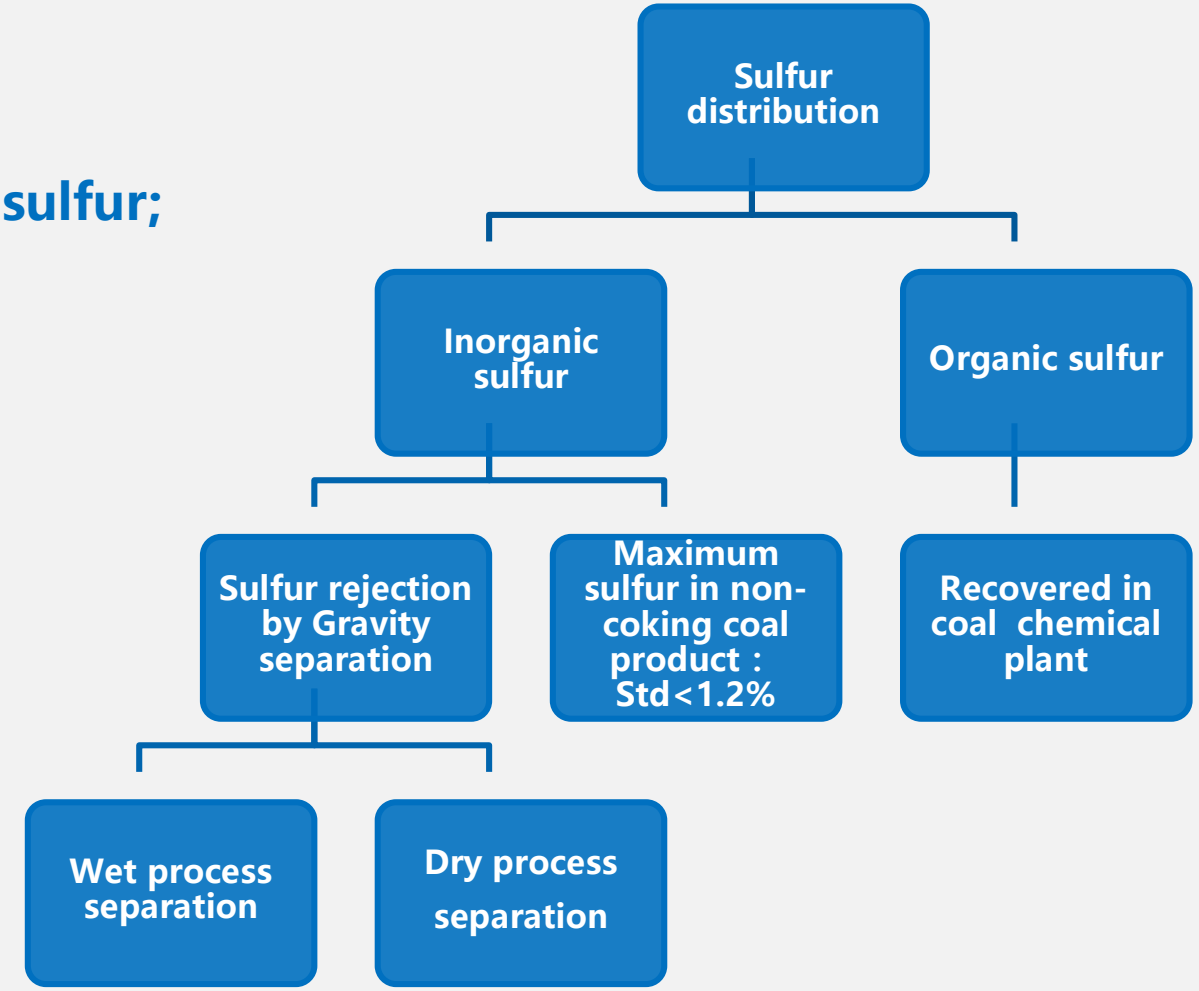
PART

Main Problems with Wet Process Separation

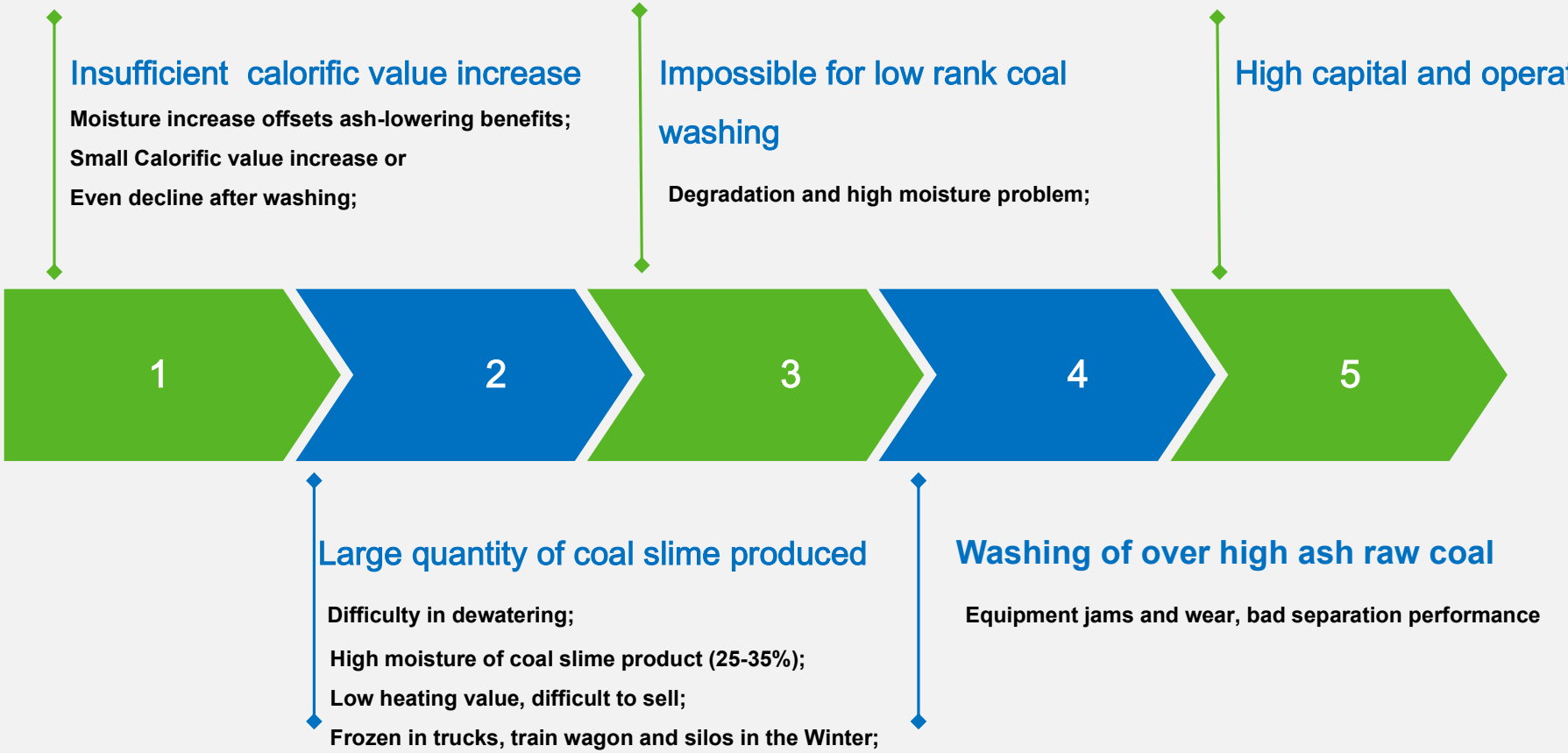
- Moisture Problem of Clean Coal
- Coal Slime Problem
- Difficulty in Processing Low Rank Coal

Main Problems with Wet Process Washing

Dry separation
cheapest way to reduce sulfur;



Main Problems with Wet Process Washing



Main Problems with Wet Process Washing

Coal Slime Problem

Main Problems with Wet Process Washing

Difficulty in washing lignite coal

- High ash, high moisture, low calorific value;
- Easy weathering fracture;
- Soft clay rock, easy degradation;
- Not suitable for wet process separation;
- Inclined to spontaneous combustion;

02

PART

Dry Coal Separation Technology of TSM

- Equipment Classification
- FGX and ZM Dry Separator

Dry Coal Separation Technology of TSM

ZM High Efficiency Mineral Separator

Deshaling of high ash 100-0mm coal ;
Pre-deshaling of coking coal ;
Low rank coal separation

IDS X-Ray Sorter

For separation of >80 (50) mm coal

GZQ Air Dense Medium Separation

Low density separation of +6mm coal;
Production of low ash coking coal and coal used in pulverized coal injection

Drying-Dry Separation System

For sticky wet coal separation

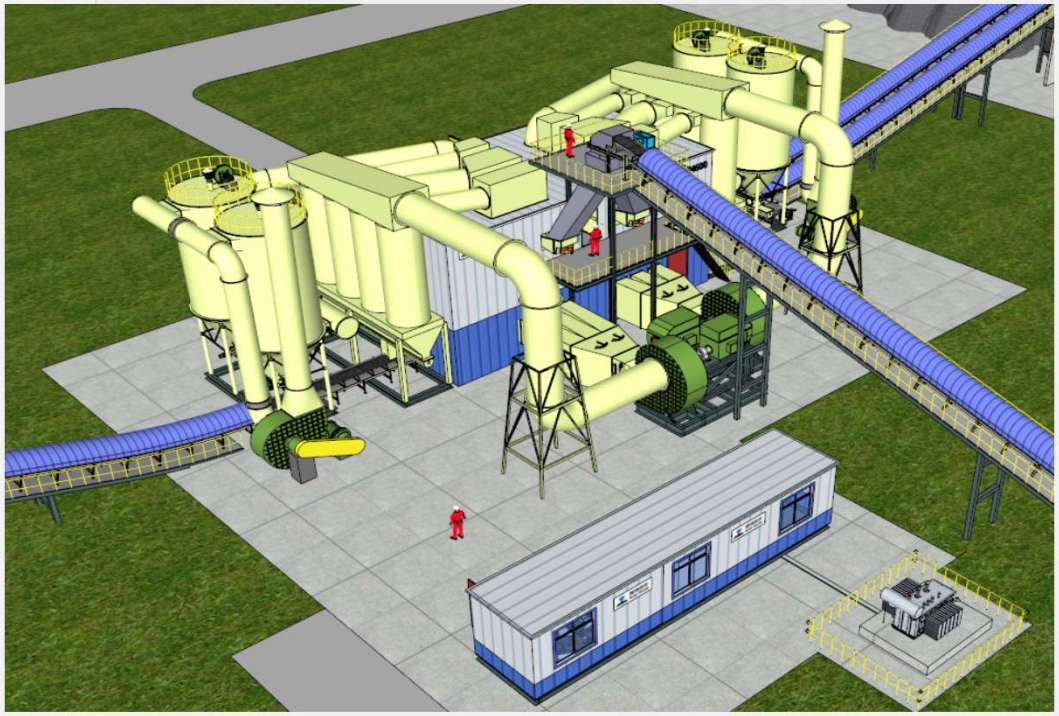
Dry Coal Separation Technology of TSM

Conventional FGX Type Dry Coal Separator

New Generation ZM Type Dry Coal Separator

Item	ZM High Efficiency Mineral Separator
Separation Sharpness	Efficient separation size range: mixed coal separated: 80-3mm; Fine coal: 25-1mm; Ep=0.13-0.23 g/cm^3
Dust Control	Enclosed system, negative pressure operation, Dust emission: <40mg/M^3
Noise Control	The independent noise reduction processing
Automation Level	Intelligent control, convenient operation and management, concise design and low accident probability
Modular Design	Modular assembly, convenient to move

ZM Mineral Separator



Model	Capacity (TPH)	Feed Size (mm)	Installed Power (kw)	Footprint of main system (m^2)
ZM35	30-35	50-0	130	50
ZM70	60-70	60-0	245	90
ZM100	90-100	60-0	356	130
ZM150	125-150	80-0	425	150
ZM200	175-200	100-0	690	300
ZM300	250-300	100-0	825	300
ZM400	350-400	100-0	1200	500
ZM600	550-600	100-0	1400	1000
ZM1200	1100-1200	100-0	2800	1500

Dry Coal Separation Technology of TSM

Main Application of Dry Coal Separation in China

01 Deshaling of High Ash Mixed Non-coking Coal

02 Deshaling of High Ash Lump Non-coking Coal

03 Deshaling of High Ash Fine Non-coking Coal

04 Pre-deshaling of High Ash Coking Coal

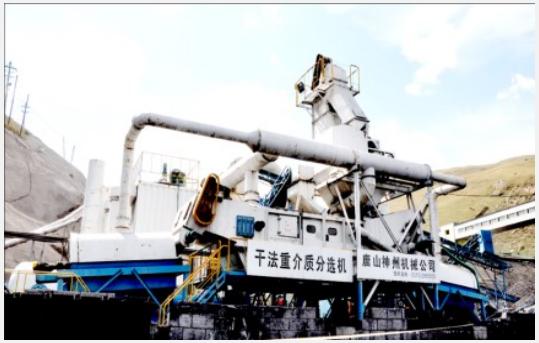
05 Separation of Low Rank Coal (Lignite)

Application of Dry Coal Separation Technology in China

80-0mm Mixed Coal Separation
(6.0 Mtpa,Yushujin Coal Mine)

300-0mm Lignite Separation
(2.0 Mtpa, South Open Pit Mine)

-30mm Coal Separation
(9.0 Mtpa,Shanghaimiao Coal Mine)



80-6mm Air Dense Medium Separation
(0.5Mtpa, Kuangou Coal Mine)

60-0mm Wet Coal Separation
(1.0 Mtpa,Yushan Coal Mine)

Pre-deshaling of 80-30mm Coking Coal
(3.0 Mtpa, Donghuantuo Coal Mine)

Application of Dry Coal Separation Technology in China

Deshaling of High Ash Non-caking Long Flame Coal

-30mm Mixed Coal Separation
(9.0 Mtpa Shanghaimiao No 1 Coal Mine)

Largest dry separation plant ever built， 9 MPTA!

Application of Dry Coal Separation Technology in China

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03

PART

Typical Sulfur Rejection Flowsheet In Dry Separation

- Mixed Coal Desulfurization Process
- Fine Coal Desulfurization Process
- Rough and Re-cleaning Separation Process

Typical Sulfur Rejection Flowsheet in Dry Separation

1. Mixed Coal Desulfurization Process

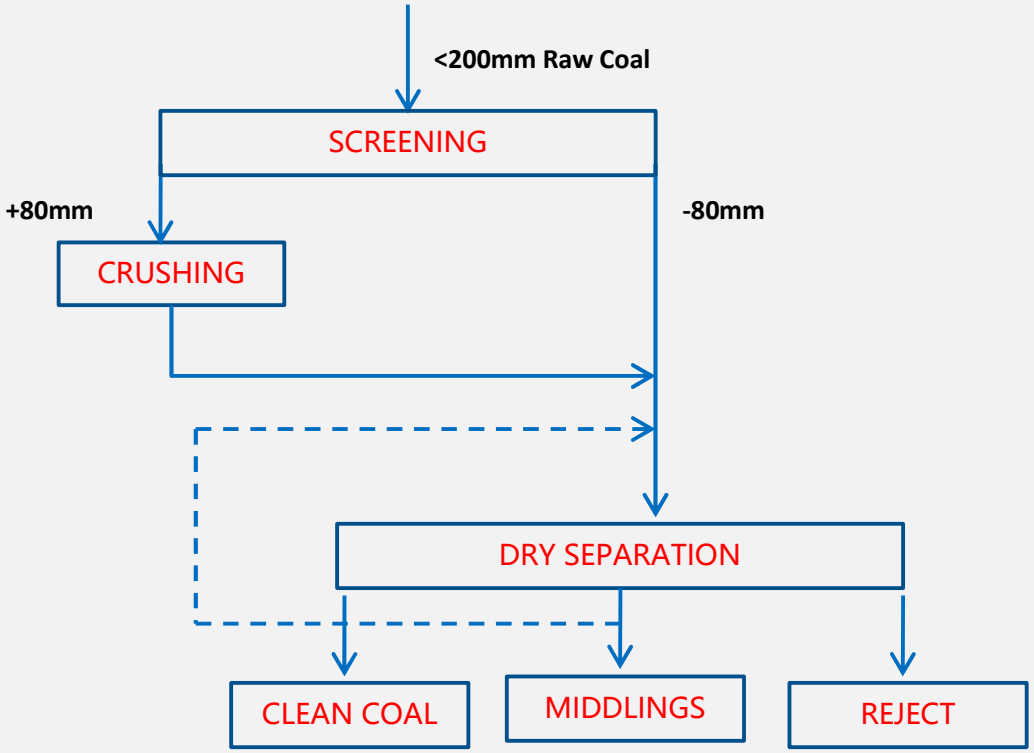


Figure 1 Simple rough separation process flowsheet

- Suitable for separation of easy-to-wash coal;
- No coal slime cake produced;
- High clean coal yield;
- Good sulfur rejection in 80 ~ 3mm coal;
- Low capital and operation cost

Typical Sulfur Rejection Flowsheet in Dry Separation

1. Mixed Coal Desulfurization Process

Case 1. Fengshenkui Coal Mine

Size Distribution Analysis of No. 5 Raw Coal

Size mm	Wt%	M_t , %	A_d , %	$S_{t.d}$, %	Qnet.ar/ ($MJ \cdot kg^{-1}$)
> 25	28.39	22.3	32.13	1.68	14.77
25 ~ 13	17.2	21.8	29.37	2.76	15.75
13 ~ 6	19.41	23.3	23.78	2.57	16.90
6 ~ 3	11.44	24.4	20.4	1.29	17.38
3 ~ 1	13.14	24.6	20.43	0.92	17.43
< 1	10.42	24	27.36	0.57	15.54
Total	100	100	23.1	1.78	16.08

Typical Sulfur Rejection Flowsheet in Dry Separation

1. Mixed Coal Desulfurization Process

Case 1. Fengshenkui Coal Mine

Float-sink testing analysis of 25 ~ 13mm raw coal

Density (g/cm³)	Wt, %	$S_{t.d}$,%
< 1.6	84.14	0.60
1.6 ~ 1.8	1.84	8.43
> 1.8	14.02	17.05
Total	100.00	3.05

Typical Sulfur Rejection Flowsheet in Dry Separation

1. Mixed Coal Desulfurization Process

Case 1. Fengshenkui Coal Mine

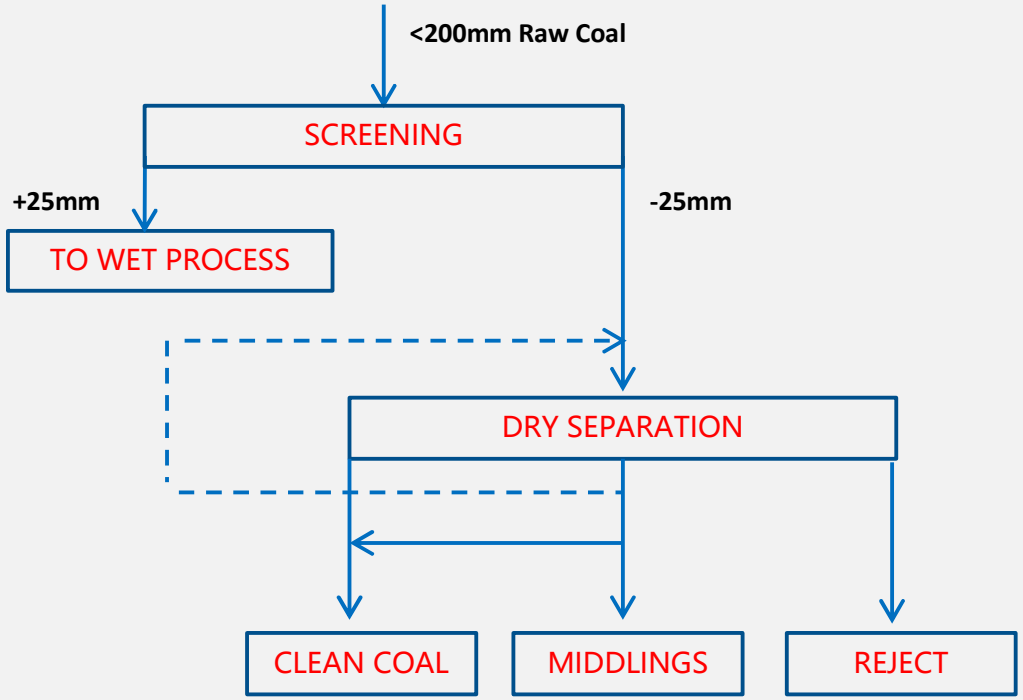
Dry separation performance of <80mm No.5 raw coal

Product	Wt,%	Ad, %	$S_{t.d,}$ %
Clean Coal	79.35	8.21	0.52
Middlings	7.72	11.81	1.46
Reject	12.93	35.34	7.16
Total	100	12.00	1.45

The sulfur rejection rate: 63.8% .

Typical Sulfur Rejection Flowsheet in Dry Separation

2. Fine Coal Desulfurization Process



- Stabilize and enhance fine coal quality
- No coal slime cake produced;
- Increase ratio of raw coal separated;
- Good sulfur rejection in 25 ~ 1mm coal;
- Low capital and operation cost;
- Good for rebuilding of brown plant

Figure 2 Fine coal desulfurization process flowsheet

Typical Sulfur Rejection Flowsheet in Dry Separation

2. Fine Coal Desulfurization Process

Case 1. Selian No. 1 Coal Mine

Product balance of dry separation of <25mm raw coal

Product	Wt,%	Index				
		Mt%	Mad%	Ad%	St.d%	Qnet,ar MJ/kg
Clean Coal	79.97	25.99	8.85	21.24	0.48	16.41
Middlings	12.72	23.61	7.99	30.99	0.63	14.57
Reject	7.31	10.90	2.55	76.39	5.56	3.76
Total	100.00	24.59	8.28	26.51	0.87	15.25

Overall sulfur rejection rate: 65.73%;
Heating Value increased by 1.16MJ/Kg(277kcal/kg)

Typical Sulfur Rejection Flowsheet in Dry Separation

2. Fine Coal Desulfurization Process

-13mm Fine Coal Separation
(0.9 Mtpa Gaoshang Plant, Henan Energy and Chemical Group Company)

Typical Sulfur Rejection Flowsheet in Dry Separation

2. Fine Coal Desulfurization Process

Case 2. Gaoshan Coal Mine

Dry separation product balance (2019.06.16)

Name	Wt%	Mt%	Ad%	Std%	Qnet,ar, Kcal/kg
Raw coal	100.00	6.4	31.65	3.01	5009
clean coal	77.85	6.8	21.95	1.84	5902
clean coal dust	3.00	8.6	15.80	1.83	6300
Reject	19.15	2.8	73.47	9.00	1178

Heating value increase: >900kcal/kg, Sulfur rejection rate: 57.3%

Typical Sulfur Rejection Flowsheet in Dry Separation

3. Rough and re-cleaning separation process

- Suitable for separation of difficult-to-wash coal
- No coal slime cake produced;
- High clean coal yield;
- Two stage cleaning of -13mm fine coal
- Low capital and operation cost

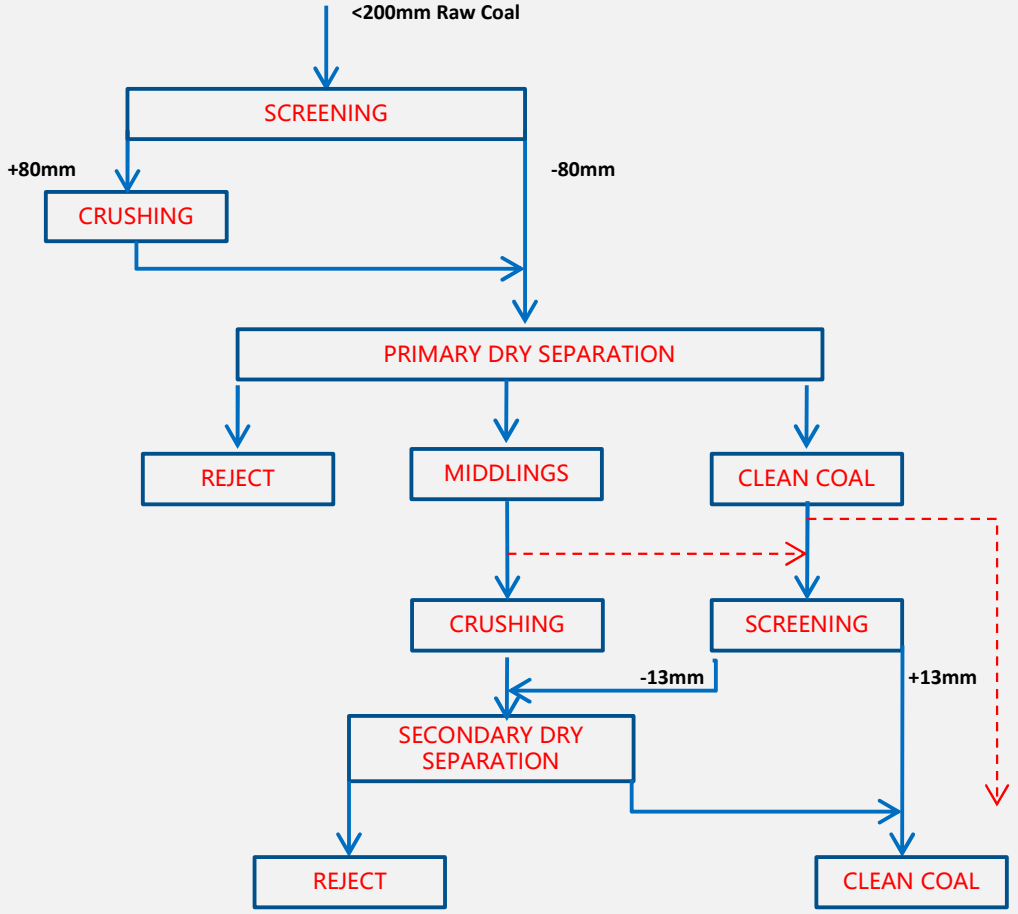


Figure 3 Rough and re-cleaning separation process

Typical Sulfur Rejection Flowsheet in Dry Separation

3. Rough and re-cleaning separation process

Case 1. Yushujing Coal Mine

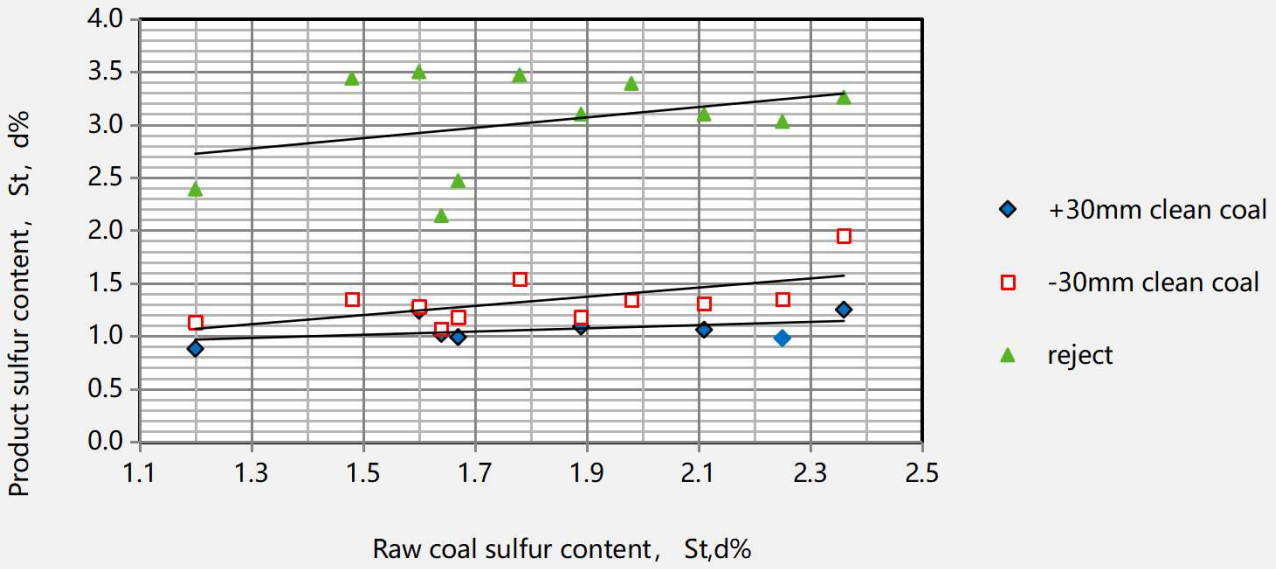
Product balance of dry separation （Date: 2018.04.06）

Product	Wt，%	Mt,%	Ad,%	St.d,%	Qnet,ar, MJ/kg
Raw coal	100.00	20.17	43.32	1.87	10.97
+30mm clean coal	10.52	26.5	15.84	1.09	16.79
-30mm clean coal	52.96	24.9	24.97	1.18	15.19
reject	36.52	11.5	77.86	3.10	3.19

The overall desulfurization rate: 60.54%
The heating value increased by 4.22MJ/Kg (>1000Kcal/kg)

Typical Sulfur Rejection Flowsheet in Dry Separation

3. Rough and re-cleaning separation process



Sulfur content changes with raw coal quality

Typical Sulfur Rejection Flowsheet in Dry Separation

3. Rough and re-cleaning separation process

Table 8 Size distribution of -30mm clean coal from rough separation

Size,mm	Wt%	Mt%	Ad%	St.d%	Qnet,ar, MJ/kg
+25	8.82	22.9	20.21	0.75	16.15
25-13	16.35	22.5	20.17	1.02	16.14
13-6	20.16	22.2	19.81	1.29	16.10
6-3	18.94	22.1	22.30	1.68	15.40
3-0	35.73	22.3	36.02	1.46	12.79
Total	100	22.3	26.17	1.33	14.80

Typical Sulfur Rejection Flowsheet in Dry Separation

3. Rough and re-cleaning separation process

Re-cleaning of -13mm fine clean coal from rough separation

Product	Wt,%	Mt%	Ad%	St.d%	$Q_{net,ar,}$ MJ/kg
Clean coal	87.88	24.81	25.93	1.14	14.57
Middlings	4.45	22.90	33.14	1.98	13.27
Reject	7.67	13.20	68.18	6.87	5.19
Total	100	23.83	29.49	1.62	13.79

04

PART

Advantages of Dry Coal Separation

Advantages of Dry Coal Separation

- Simple process, low investment, low operation cost;
- Save reject transportation cost;
- Higher clean coal yield and higher calorific value
- Save water resource;
- No water pollution risk, no slurry impoundment;
- Environmental friendly, Easy to prepare EIA (Environmental Impact Assessment) report and obtain environmental approval/clearance;
- Short construction period;
- Less barriers and more drivers in settling up of dry coal washries.
- Dry separation can meet non-coking coal quality requirement in processing

Advantages of Dry Coal Separation

Index of Dry Separation

Process	Technology level	Process Complexity	Coal slurry system	Worker efficiency（t/man.d）	Power consumption（kwh/T）	Water consumption（M^3/T）	Magnetite consumption（Kg/T）	Capital cost USD/T	Operation cost USD/T
Dry Separation	Well developed	Simple	None	400-600	2.5-3.5	0	0	1-1.5	0.4-0.7

05

PART

CONCLUSIONS

- Dry Separation Technology is Well Developed in China after Years of Efforts;
- Great Improvement in Capacity, Separation Efficiency and Environmental Protection Performance;
- The Choose of Desulphurization Process Will Depend on Raw Coal Washability and Product Sulfur Content Requirement;
- Three Typical Pyritic Sulfur Removal Flowsheets are Introduced;
- Dry Separation Technology and Equipment Has a Broad Application Prospect in India

THANKS

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