EFFECT OF DRY PRE-DESHALING OF HIGH ASH METALLURGICAL COAL ON DOWNSTREAM WET PROCESS PLANT

Dry Coal Separation Technology Seminar

Australia

November, 2023

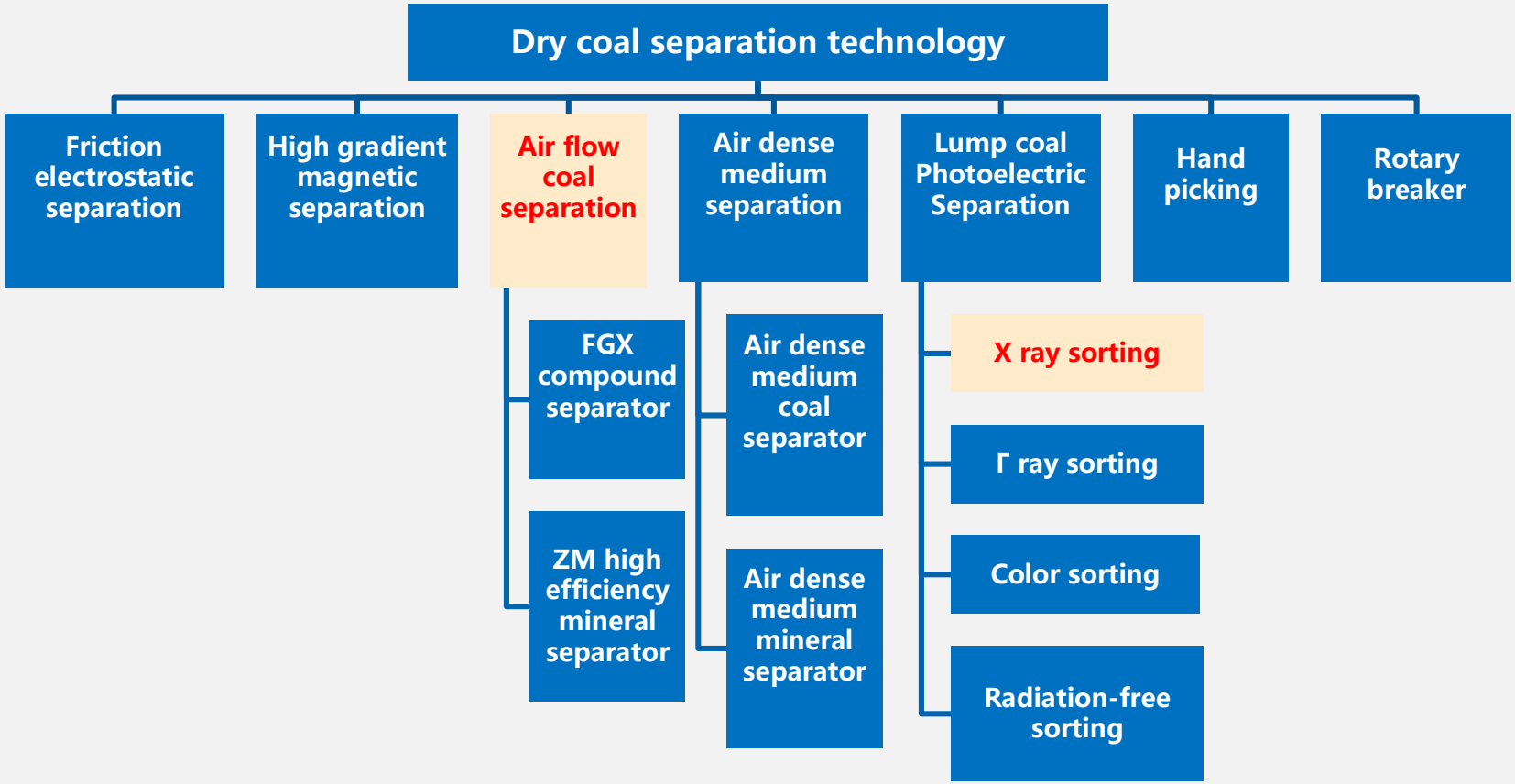
TANGSHAN SHENZHOU MACHINERY GROUP CO., LTD, CHINA

ENGINEERING RESEARCH CENTER OF DRY COAL PROCESSING EQUIPMENT， HEBEI, CHINA

CONTENTS

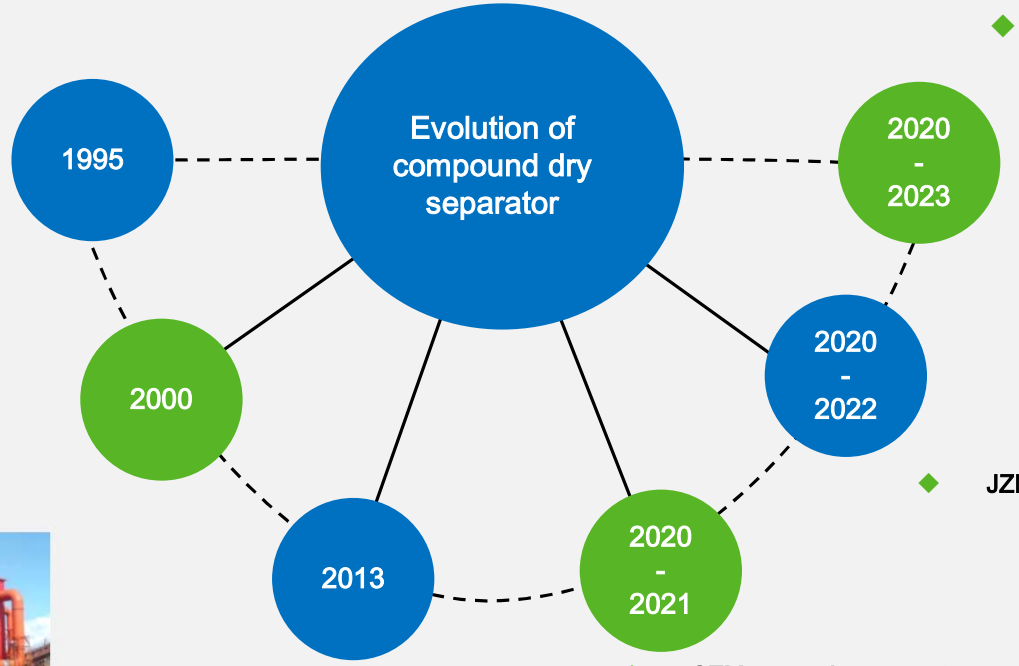
1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

1) Large-scale and serization of dry separation equipment



1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

1) Large-scale and serization of dry separation equipment



- FGX Compound Dry Separator

80-0mm mixed coal separation

- FGXH Environment-friendly dry separator

80-0mm mixed coal separation

- ZM High efficiency mineral separator

80-0mm mixed coal separation
80-30mm lump coal separation
30-1mm fine coal separation

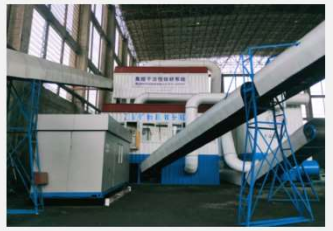
- CZM super dry separator

100-0mm mixed coal separation

- Large scale mobile full size separation system for open pit mine

300-0mm coal separation

- JZM Step type fine coal separator



50-0mm fine coal separation

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

1) Large-scale and serization of dry separation equipment

Typical compound dry separator (air flow separation equipment)

Type	Forces of sorting	Model	Maximum unit capacity, t/h	Typical Feed size，mm	Ecart probable moyen, Ep	Producer
mixed coal compound separator	air blowing + vibration motor	ZM600	600	-100+0	0.13-0.23	TSM
		CZM500	500	-100+0	0.13-0.19	TSM
fine coal compound separator	air blowing + vibration motor	MZM500	300	-25+0	0.18	TSM

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

1) Large-scale and serization of air flow separation equipment

Capacity of representative IDS type photoelectric coal sorters

Model	Description	Separation mechanism	Feed size mm	Maximum capacity t/h	Producer
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

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

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

- Separation of lignite----9 Mt/a plant of No. 1 Coal mine of Shanghai Miao Mining Co., LTD of Shandong Energy Group to process -30mm fine coal;
- Lump coal separation----3 Mt/a plant of Kailuan donghuantuo coal mine to process 80-30mm coal;
- Pre-deshaling of metallurgical coal ----1.2 Mt/a plant of Suntuan coal mine of Huaibei Mining Group to process -50mm coal;
- <13mm fine coal processing----2.2 Mt/a plant of No. 5 coal mine of Shanxi Yangquan Mining Group;
- 300-0mm Dirty coal processing in open pit coal mine ----2.0 Mt/a plant at Huolinhe South open-pit mine of China Power Investment Corporation
- 300-50mm coal X ray sorting ----1.0 Mt/a plant at Dongbaowei coal mine;
- ……

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

A. 30-0mm lignite coal processing

- 9 Mt/a plant of No. 1 Coal Mine of Shanghai Miao Mining Co., LTD of Shandong Energy Group

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

A. 30-0mm lignite coal processing

- 9 Mt/a plant of No. 1 Coal Mine of Shanghai Miao Mining Co., LTD of Shandong Energy Group

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

B. 300-50mm lump coal x ray sorting

- 1.0 Mt/a plant at Dongbaowei coal mine

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

C. 300-0mm size range dry separation (X ray sorting + air flow separation)

- 2.0 Mt/a plant at Huolinhe South open-pit mine of China Power Investment Corporation

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

3) Improved dry separation accuracy

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
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, SG_{50}, g/cm³	>1.7	>1.7	Separation density, SG_{50}, g/cm³	1.3-2.5
Separation accuracy, Ep, g/cm³	0.13-0.19	0.18-0.28	Separation accuracy, Ep, g/cm³	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, kWhr/t	<1.6	<2	Unit power consumption, kWhr/t	<1.6

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

4) Diversified separation processes

- **Mixed coal separation**

  <80mm coal processed by FGX, ZM , CZM compound dry separator

- **Fine coal separation**

  <30mm coal processed by MZM coal separator;

- **Lump coal separation**

  300-50mm coal processed by X ray separator;

- **300-0mm full size range dry separation**

  300-50mm X ray sorting+ 50-0mm compound dry separation(air flow separation) for both power coal and coking deshaling;

- **Wet+Dry process combination**

  +13mm coal by Heavy medium separation, 13-0mm dry separation

  or Pre-deshaling by dry separation + wet process re-cleaning;

  ……

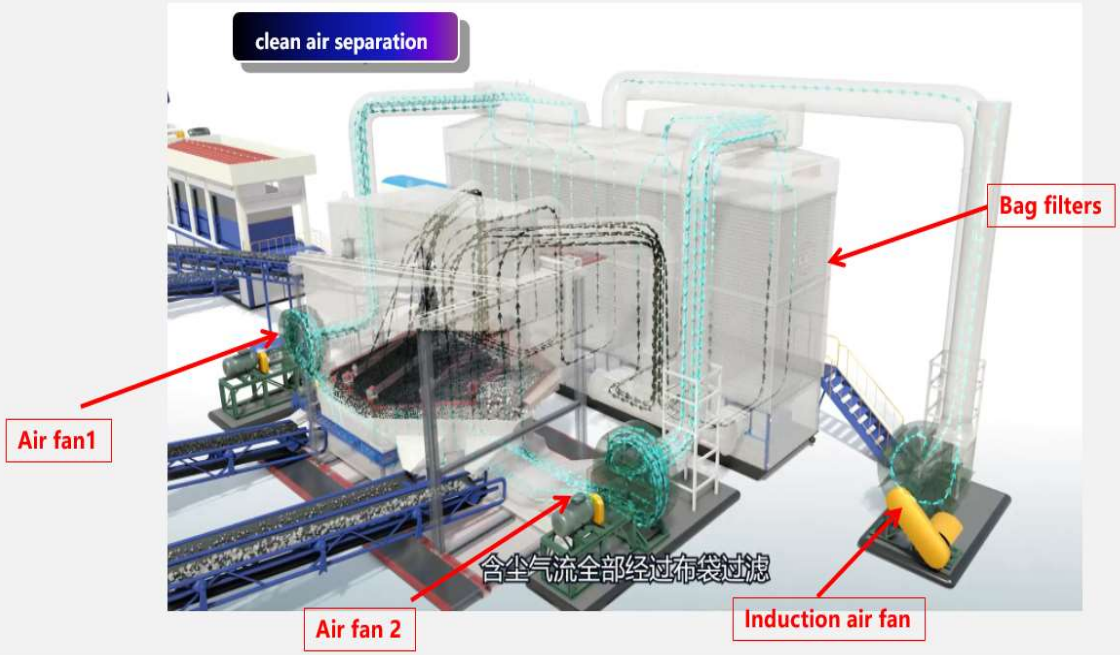
1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

5) Significant energy and water saving

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+10mm: ZM separator, -10mm bypassed	1200	2.52
Ru Jigou anthracite Company Ningxia Coal Group National energy Group	2.0	-300+80 mm : Intelligent sorting, -80+0mm: ZM separator, clean coal: fines removal @ 3 mm	>2000	2.49
Average				2.80

1. DRY COAL SEPARATION TECHNOLOGY IN CHINA

6) Environmental protection performance Improvement



- **All bag filters**
  Closed, negative pressure operation, all dusty air is filtered;
- **Clean air coal separation**
  Filtered air, less erosions, less congestion;
- **Convenient Maintenance**
- **Less dust emission**
  Dust emission concentration:<20mg/NM^3;
- **Modular design**

2 BENEFITS OF PRE-DESHALING OF HIGH ASH METALLURGICAL COAL

Worsening quality of metallurgical raw coal

- Increasing rock content, increasing ash;
- Decreasing of lump coal quantity;
- Very low good coal ratio in >50mm particles;
- High ratio of coal powder;
- Existing of some easy to degrade clay rock;
- Bad froth flotation selectivity;
- …

2 BENEFITS OF PRE-DESHALING OF HIGH ASH METALLURGICAL COAL

Negative effect of clay particles in wet process separation

- Increased viscosity of heavy meidum and thus lower separation effficiency of HMC and HMV;
- Worsening froth flotation performance;
- High consumption of collectors anf frothers;
- Difficult to settle in thickener;
- High moisture of coal slime cake;
- High power consumption;

2 BENEFITS OF PRE-DESHALING OF HIGH ASH METALLURGICAL COAL

Negative effect of clay particles on froth flotation:

- Pollution of clean coal
- Low selectivity
- High froth flotation clean coal ash and low tailing ash
- Inceased chemical consumptions
- High clean coal moisture;
- Low overal clean coal yield;
- Complicated flowsheet;
- High capital and operation cost

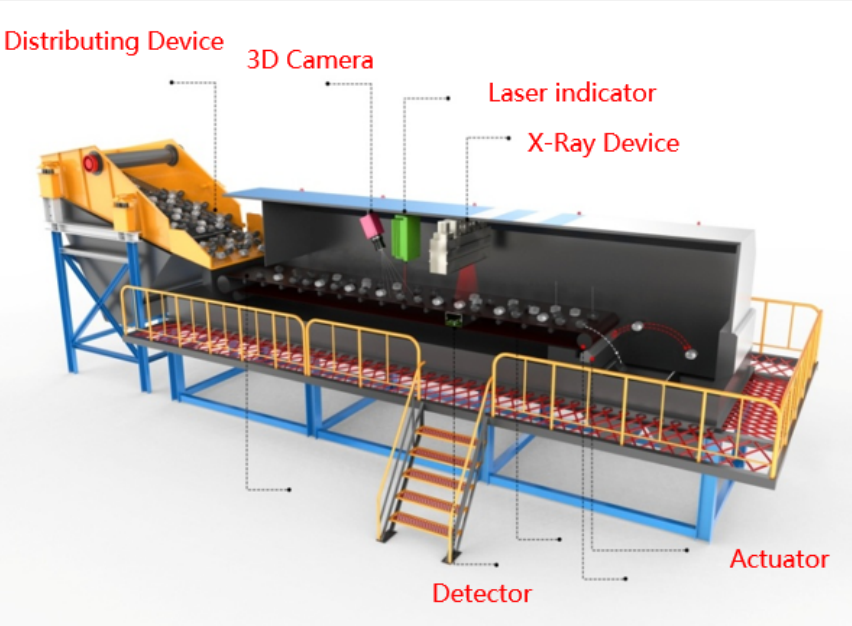
2 BENEFITS OF PRE-DESHALING OF HIGH ASH METALLURGICAL COAL

Advantages of dry coal deshaling of high ash raw coal

1. Lower ash of raw coal feeding to heavy medium cyclone plant,;
2. Reduce wear and tear of equipment and pipes,prevent plugging of equipment;
3. Increased unit capacity of equipment;
4. Increased separation efficiency if heavy medium cyclone;
5. Better quality feed to flotation, signifcantly reduce clay particles entering froth flotation machines and improve its performance；
6. Increased overal clean coal yield；
7. Less quantity of high moisture of coal slime cake；
8. Save water, power, magnetite and chemicals;

3. PERFORMANCE OF DRY SEPARATORS

A. 300-50mm coal X ray sorting



- Single belt channel maximum capacity: 200-280 TPH
- Reasonable separation bottom size limit: 50mm
- High density cutting (>1.8), separation efficiency: E_P=0.06-0.1 g/cm³;
- Low density cutting (<1.4), separation efficiency: E_P =0.05 g/cm³;
- Deshaling rate >98%, coal loss in reject<1%

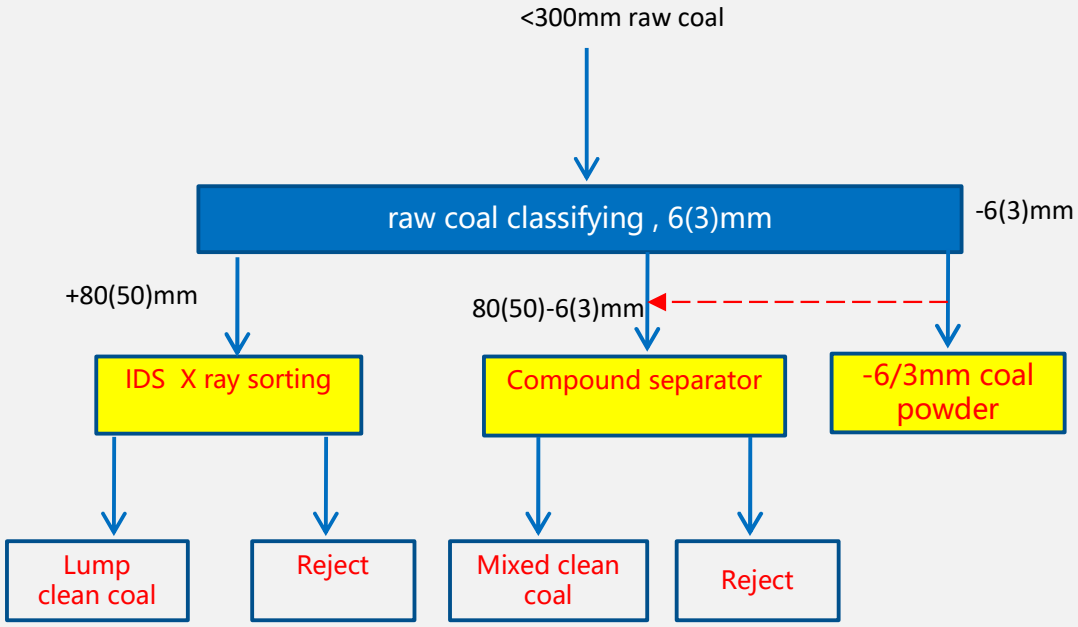
IDS Lump Coal Intelligent Sorter

3. PERFORMANCE OF DRY SEPARATORS

B. CZM Compound dry separator

Type	Super dry separator CZM500
Unit power consumption	1.64
Nominal capacity	500
Feed size,mm	100-0
Separation efficiency	0.13-0.19
Installed system power kW	964
Overall dimensions (L * W * H) m	25×17×10

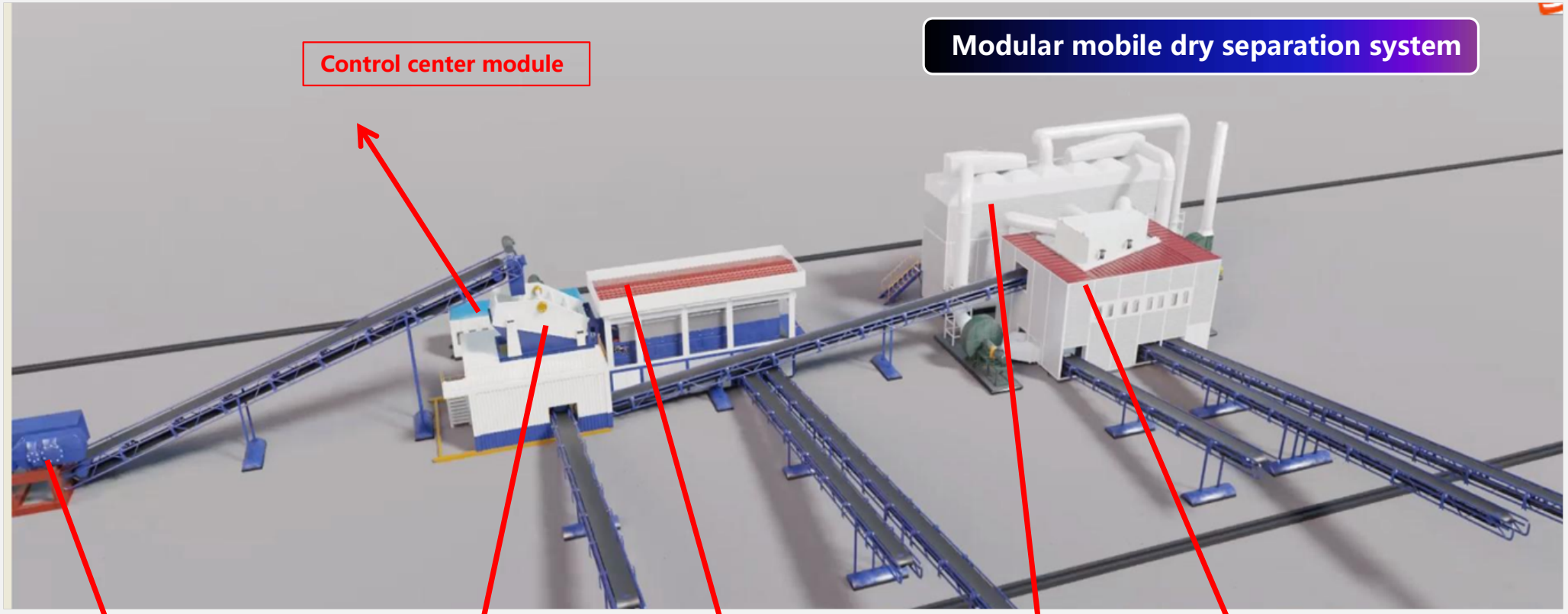
4. 300-0mm FULL SIZE SEPARATION PROCESS FLOWSHEET



IDS+ZM System Power consumption: <3 kWh/t

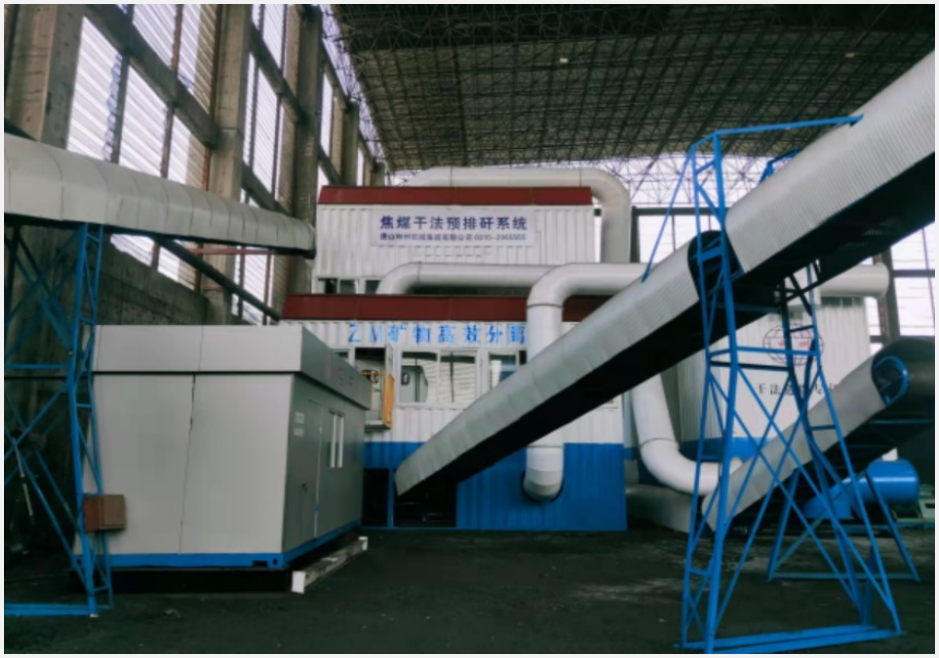
- It is suitable for sorting of raw coal containing high ratio of lump coal and coal containing high hardness rock;
- Reduce the cost of wet washing;
- Helping to release coal mining production capacity;
- No high moisture coal slime product;
- Flexible processes;
- Modular design;
- Energy saving ;
- Can be used in large power coal and metallurgical coal plants

4. 300-0mm FULL SIZE SEPARATION PROCESS FLOWSHEET



5. INDUSTRIAL TESTING AND APPLICATION CASES

1) Shuguan Coal Mine of Shanxi Metallurgical Coal Group



Clean coal yield: ↑1.3%;

Feed to flotation: ↓15%;

Flotation feed ash: ↓5.67%;

Coal slime tailing quantity: ↓32%

Economical benefits: ↑23-30 RMB/t

Unit power consumption: ↓17.5%

Product balance of dry separation (Shuguan Coal Mine)

Product	Yield Wt%	Ash Ad%
Clean coal	65.11	37.85
Reject	34.89	81.30
Raw coal	100.00	53.01

Power consumption before and after raw coal pre-deshaling

Separation processes	Direct wet processing	Dry separation+Wet washing
Ratio of raw coal washed	100%	65.11%
Power consumptionkWh/t	15.3	12.62

5. INDUSTRIAL TESTING AND APPLICATION CASES

1) Shuguan Coal Mine of Shanxi Metallurgical Coal Group

Table 1 Raw coal size analysis（2022. 4. 16）

Size,mm	Wt%	Ad%	Cumulative	
			Wt%	Ad%
>13	33.43	73.12	33.43	73.12
13-6	17.87	59.09	51.31	68.24
6-3	12.59	46.43	63.89	63.94
3-0.5	28.55	34.00	92.44	54.69
0.5-0	7.56	32.48	100.00	53.01
合计	100.00	53.01		

5. INDUSTRIAL TESTING AND APPLICATION CASES

1) Shuguan Coal Mine of Shanxi Metallurgical Coal Group

Table 2 Raw coal float-sink testing analysis（2022. 4. 16）

Size	>13mm		13-6mm		6-3mm	
S.G	Wt%	Ad%	Wt%	Ad%	Wt%	Ad%
<1.4	5.66	8.07	22.28	7.67	36.79	6.98
1.4-1.6	1.88	24.73	5.71	24.46	7.71	24.53
1.6-1.8	2.67	42.77	4.56	42.07	4.82	42.61
>1.8	89.79	79.14	67.45	80.16	50.69	78.75
合计	100.00	73.12	100.00	59.09	100.00	46.43

5. INDUSTRIAL TESTING AND APPLICATION CASES

2) Linxi Coal Mine of Kailuan Coal Group

JZM70

5. INDUSTRIAL TESTING AND APPLICATION CASES

2) Linxi Coal Mine of Kailuan Coal Group

Dry Separation of >6mm Coal

Size （mm）	Density g/cm^3	Yield （%）	Ad%	Qnet,ar, Kcal/kg
CLEAN COAL	<1.8	15.46	14.57	6963
	>1.8	9.35	83.59	608
	合计	24.81	40.57	4569
REJECT	<1.8	0.36	15.79	6852
	>1.8	74.83	82.20	737
	合计	75.19	81.89	766
RAW COAL	<1.8	15.82	14.60	6960
	>1.8	84.18	82.36	723
	合计	100.00	71.63	1710
DESHALING RATE			88.9%	
COAL LOSS IN REJECT			0.48%	

5. INDUSTRIAL TESTING AND APPLICATION CASES

2) Linxi Coal Mine of Kailuan Coal Group

Dry Separation of >3mm Coal

Size (mm)	Density g/cm^3	Yield (%)	Ad%	LHV Kcal/kg
CLEAN COAL	<1.8	24.07	14.28	6976
	>1.8	18.03	83.06	657
	合计	42.10	43.73	4271
REJECT	<1.8	0.63	16.28	6789
	>1.8	57.27	82.26	732
	合计	57.90	81.54	798
RAW COAL	<1.8	24.71	14.33	6971
	>1.8	75.29	82.45	714
	合计	100.00	65.62	2260
DESHALING RATE			76.1%	
COAL LOSS IN REJECT			1.09%	

5. INDUSTRIAL TESTING AND APPLICATION CASES

2) Linxi Coal Mine of Kailuan Coal Group

Froth flotation product balance (without dry pre-deshaling)

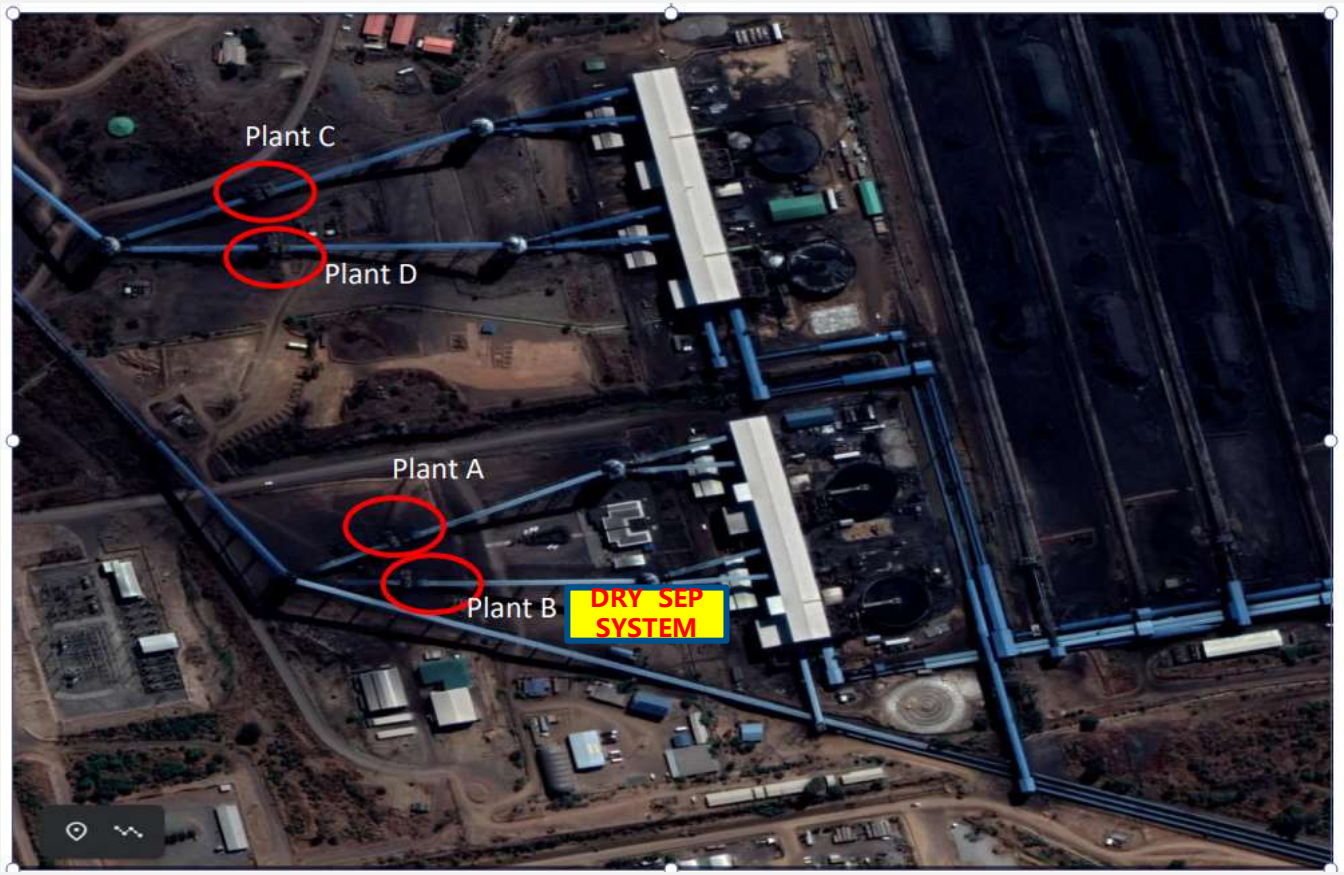
Product	Wt%	Ad%
Clean coal	**65.63**	13.96
Reject	24.37	**50.39**
Raw coal	100.00	26.48

Froth flotation product balance (after dry pre-deshaling)

Product	Wt%	Ad%
Clean coal	**77.89**	13.53
Reject	22.11	**62.34**
Raw coal	100.00	24.32

5. INDUSTRIAL TESTING AND APPLICATION CASES

3) VULCAN RESOURCES, Mozambique



- Feed capacity： 8000TPH ；
- Raw coal ash: >45%;
- Low clean coal yield;
- Unsatisfactory flotation;
- High operational ost;

5. INDUSTRIAL TESTING AND APPLICATION CASES

3) VULCAN RESOURCES, Mozambique

Size wise Ash distribution of PLY UCS6

Size		Fractional (%ad)		Ash (%ad)
Fraction (mm)		Mass %	Mass (g)	Calculated
	+ 50.0	4.0	1923.8	65.5
50.0	+ 4.0	56.9	27305.5	55.1
- 4.0	+ 1.0	17.4	8355.1	38.3
- 1.0	+ 0.25	10.9	5219.2	28.2
-0.25		10.8	5196.4	32.5
Total		100.0		47.2

5. INDUSTRIAL TESTING AND APPLICATION CASES

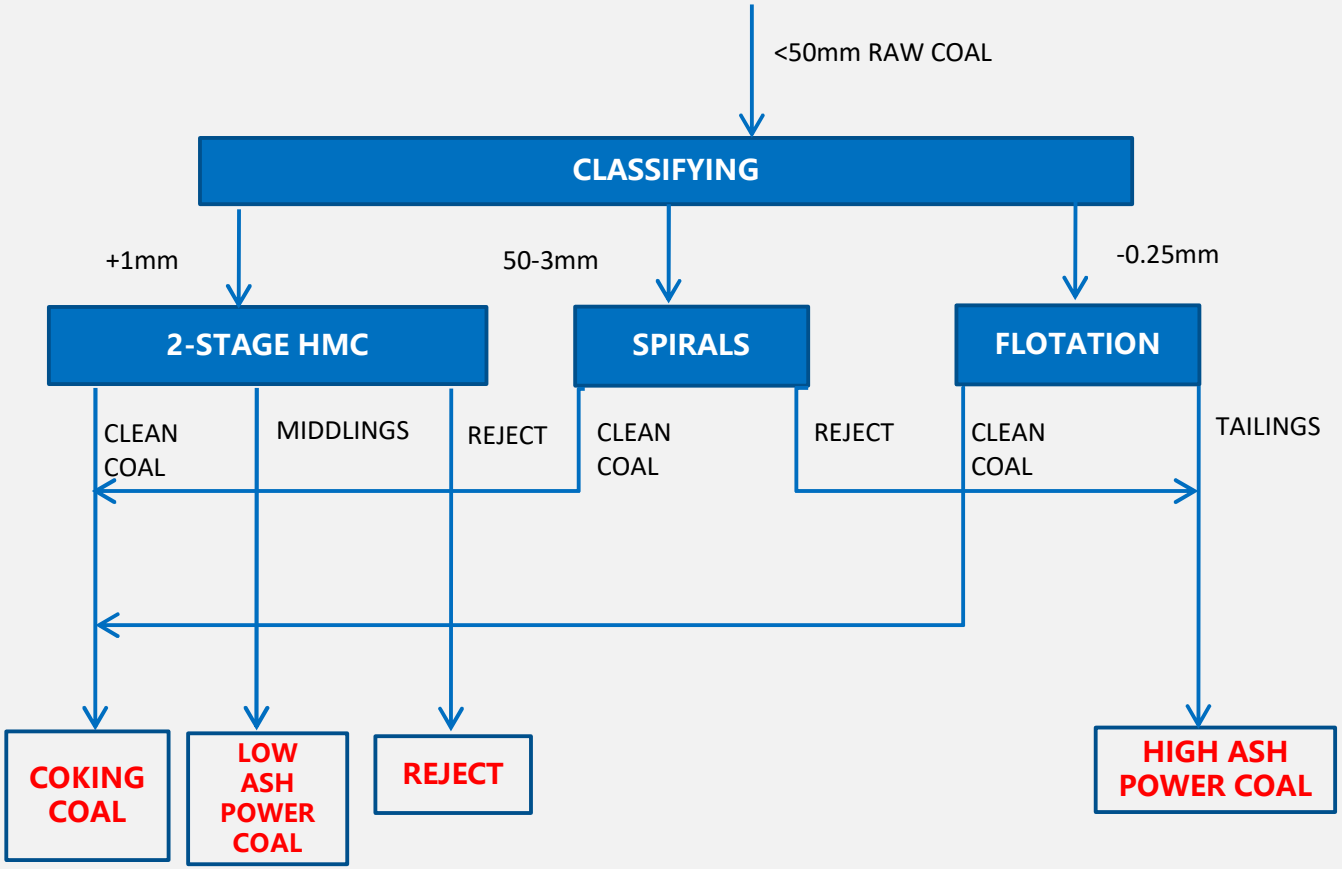
3) VULCAN RESOURCES, Mozambique

Size wise Ash distribution of PLY UCS6

SG		Wt%	Aad%	Cum Wt	Cum Aad%
<1.25		0.00	0.00	0.00	0.00
1.25	1.30	0.30	8.40	0.30	8.40
1.40	1.35	0.50	11.10	0.80	10.08
1.35	1.40	1.45	14.00	2.25	12.61
1.40	1.45	2.88	18.80	5.13	16.08
1.45	1.50	4.31	23.20	9.44	19.33
1.50	1.55	7.17	26.00	16.61	22.21
1.55	1.60	4.65	30.20	21.26	23.96
1.60	1.70	9.40	38.60	30.66	28.45
1.70	1.80	9.29	45.70	39.95	32.46
1.80	2.00	13.52	57.70	53.46	38.84
>2.00		46.54	73.70	100.00	55.06
Total		100.00	55.06		

5. INDUSTRIAL TESTING AND APPLICATION CASES

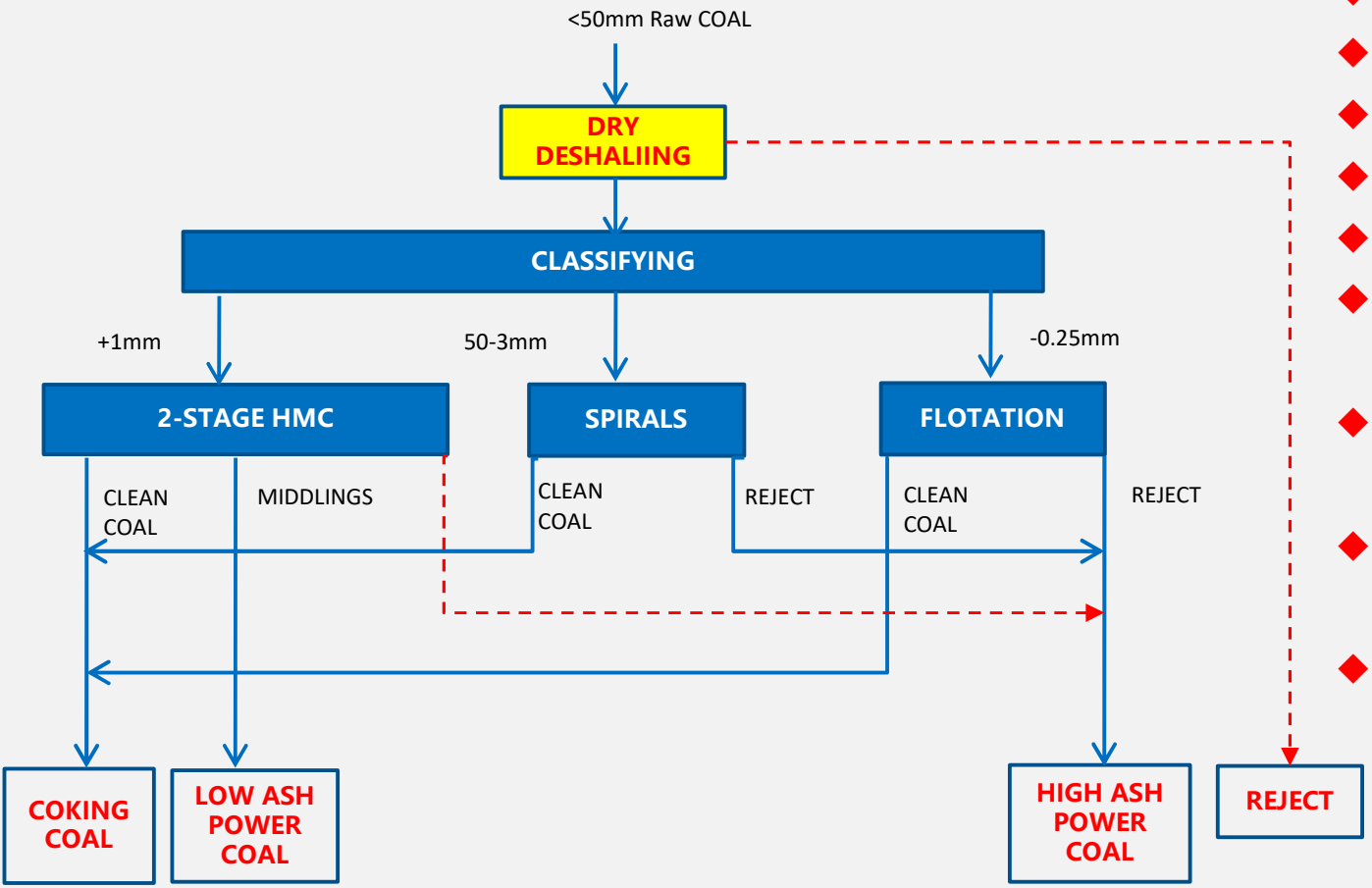
3) VULCAN RESOURCES, Mozambique



- High ash raw coal;
- Serious wear and tear in euipment and pipes;
- Low cutting density in HMC,
- Rereject ash is low;
- High flotation clean coal ash;
- Large quantity of coal slime;
- High operation cost;

5. INDUSTRIAL TESTING AND APPLICATION CASES

3) VULCAN RESOURCES, Mozambique



- Lower raw coal ash at least 10 pc points;
- Less wear and tear;
- High as reject, less coal loss in reject;
- All products fro wet process are saleble;
- Increase 18 pc points of power coal ;
- Flotation feed drop by 13.7%, ash lowered by 5.8 pc points;
- Flotation clean coal ash is lowered by 0.5-1 pc points;
- Overal clean coal yield in creased by 2 pc points;
- Reduce coal slime tailings by 41%;

5. INDUSTRIAL TESTING AND APPLICATION CASES

3) VULCAN RESOURCES, Mozambique

Product balance of dry separation pilot testing

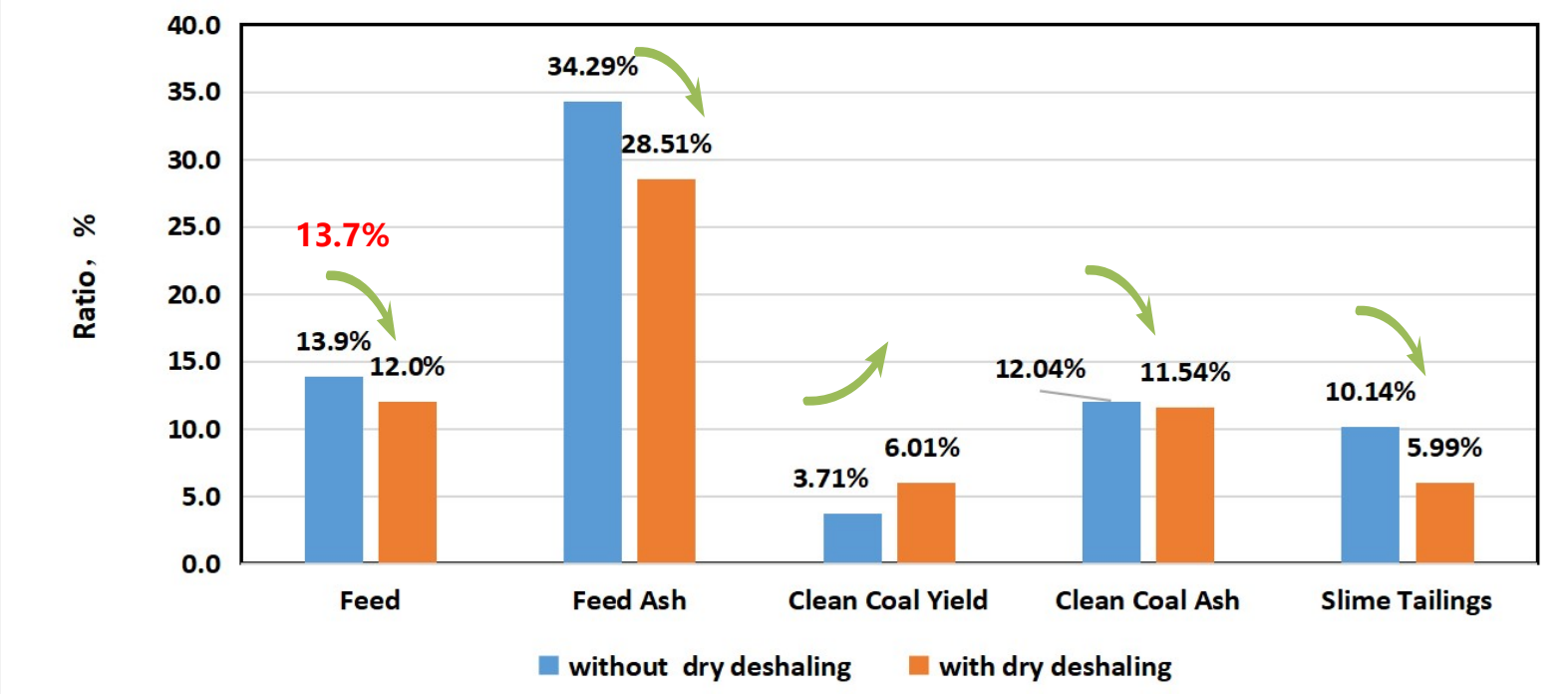
Product	Yield %	Ash, Aad%
Clean coal	68.91%	38.11
Reject	31.09%	71.6
Raw Coal	100.00%	48.52

- **Reject yield: >30%;**
- **Reject ash: >70%;**
- **Raw coal ash lowered : > 10%;**

5. INDUSTRIAL TESTING AND APPLICATION CASES

3) VULCAN RESOURCES, Mozambique

ESTIMATED EFFECT ON FROTH FLOTATION BY DRY PRE-DESHALING



06

PART

Conclusions

- Improvement in serialization, capacity, efficiency and environmental protection of dry separators;
- 300-0mm full size range dry separation can enhance flotation performance;
- Dry separation can be used for both power coal and metallurgical coal plant;
- Dry separation will help to increase clean coal yield and quality, cut capital cost and operation cost, save power consumption and water, and bring more environmental protection benefits....

Thanks

Tangshan Shenzhou Manufacturing Group Co., Ltd

Address: No. 6, Saojiaodi, Tangbai Rd. Tangshan, Hebei, China
Tel: 0086-15132633118
www.tsshenzhou.com
email: xyk@tsshenzhou.com