THE APPLICATION OF DRY SEPARATION TECHNOLOGY IN THE UNITED STATES

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What is Dry Coal Processing?

FGX SepTech, LLC

A Coal Preparation Process that uses air instead of water to remove unwanted material from coal!

Coal Deshaling Concept

Coal Operation

ROM Coal

Haulage

Dry Coal Cleaner

Processing Plant

High-Density Rock

Applications

- Removing excess ash from ROM coal.
- Pit cleaning/rib coal recovery.
- Gob pile processing.
- Deshaling of metallurgical coal.
- Pyrite removal from high sulfur coal.
- On site processing of High Wall Miner coal.
- Coal prep in regions with water scarcity.
- Processing of low-rank coal, e.g. lignite.
- Destoning of coal in utilities and cement plants.

Who is FGX SepTech LLC?

- Lexington, KY based subsidiary of TSM MFG
- The United States sales and service arm of the world's leader in dry coal processing with over 2,000 units sold.

Results of Expanded FGX-1 Cleaning Performance Evaluation: Performed by Southern Illinois University in conjunction with Illinois Clean Coal Institute.

Coal									
Ash %				Total Sulfur %				Yield %	
Feed	Product	Middlings	Tailings	Feed	Product	Middlings	Tailings	Product	Middlings
29.05	16.91	56.03	88.39	3.89	3.77	3.79	4.72	79.53	7.70
42.88	17.65	46.08	89.26	4.52	3.91	4.04	6.12	50.99	22.85
40.06	15.24	51.88	88.16	4.28	4.23	2.78	6.47	52.28	27.50
42.36	16.33	30.55	80.83	5.13	4.08	4.66	6.66	38.70	26.87
30.84	14.39	45.60	82.53	4.33	4.07	3.76	6.21	65.15	19.77
28.23	15.49	47.61	89.90	4.66	4.16	5.41	7.09	74.02	15.59
34.45	13.48	39.57	85.09	4.68	3.87	4.62	6.87	58.07	19.90
36.79	27.12	84.00	84.58	4.64	4.58	4.83	6.377	83.00	16.12
33.16	21.56	81.14	92.07	4.00	4.00	4.01	4.138	80.93	16.89

Coal									
Ash %				Total Sulfur %				Yield %	
Feed	Product	Middlings	Tailings	Feed	Product	Middlings	Tailings	Product	Middlings
25.94	19.37	27.91	63.61	4.30	3.52	4.43	9.00	68.75	20.33
36.48	12.95	16.15	54.55	5.09	3.42	4.56	5.75	10.16	36.05

Conclusions and Recommendations of SIU Study

A preliminary economic analysis based on the technical data generated during this study and the installation and operating experience of a newly installed full-scale FGX Dry Separator in the US estimates total capital, installation, and operating costs for cleaning Illinois coal using the FGX Dry Separator to be $0.91/ton of raw coal and $1.56/ton of clean coal.

The operating cost alone is estimated to be $0.69/ton of raw coal and $1.19/ton of clean coal.

CASE STUDY

EAGLE RIVER COAL

HARRISBURG, ILLINOIS, UNITED STATES

FGX SepTech, LLC

CASE STUDY:
EAGLE RIVER COAL COMPANY

HARRISBUG, IL

“The FGX plant has worked great for us for the past 4 years. The plant does an excellent job removing ash and sulfur from our raw feed. We see 15% - 18% ash reduced to 8% - 9% ash on our clean product, with sulfur reduction around 1.5%. We are extremely pleased with the performance of our FGX 24A plant and the support we get from the FGX crew. ”

-Joey Pilcher, Eagle River Coal Co.

CASE STUDY

EAGLE RIVER COAL

HARRISBURG, ILLINOIS, UNITED STATES

1. **Type of Coal:** Bituminous
2. **Application:** Thermal & Industrial
3. **Tons Per Annum Processed:** 900,000
4. **FGX Plant:** FGX-24A, 240 Tons Per Hour
5. **Date Commissioned: August 2011**

CASE STUDY (CONT'D)

EAGLE RIVER COAL

HARRISBURG, ILLINOIS, UNITED STATES

Typical Analysis Run of Mine	Post Processed Analysis (Average)	
Ash 16%	Ash 8%	**50% Reduction**
Sulfur 6%	Sulfur 4%	**33% Reduction**
BTU 11,300	BTU 12,500	**10%+ INCREASE**

CASE STUDY (CONT'D)

EAGLE RIVER COAL

HARRISBURG, ILLINOIS, UNITED STATES

Economic Benefit Per Ton

*Ash: $0.10 per every 1% of reduction = $0.80 p/ton

*Sulfur: $0.10 per every .1% of reduction = $2.00 p/ton

*BTU's: $0.25 per every 100 BTU increase = $3.00 p/ton

Sales Price Beneficiation:

900,000 Tons per Annum

x 5.80 per Ton

~~$5,220,000~~ per Annum

*premium/penalty based on average US Thermal coal contract

CASE STUDY (CONT'D)

EAGLE RIVER COAL

HARRISBURG, ILLINOIS, UNITED STATES

Net Economic Benefit

Additional Revenue from Beneficiation per Annum	$5,220,000
Operating and Maintenance Cost per Annum	- $900,000
NET GAIN	$4,320,000

CASE STUDY

SUN ENERGY GROUP

HOLLAND, INDIANA, UNITED STATES

FGX SepTech, LLC

CASE STUDY:
Sun Energy Group
HOLLAND, IN

“This plant has allowed us to sell more coal by the 15th of our first operating month than we have in previous complete months.”
- Bobby Childress, Sun Energy Group

FGX SepTech, LLC

CASE STUDY
SUN ENERGY GROUP
HOLLAND, INDIANA, UNITED STATES

- **Type of Coal:** Bituminous
- **Application:** Thermal
- **Tons Per Annum Procesed:** 300,000
- **FGX Plant:** FGX-12, 120 Tons Per Hour
- **Date Commissioned:** June 2015

CASE STUDY (CONT'D)

SUN ENERGY GROUP

HOLLAND, INDIANA, UNITED STATES

Typical Analysis Run of Mine

Ash 19%

Sulfur 7%

Mercury 3 ppm

BTU 11,100

Post Processed Analysis (Average)

Ash 10%	**50% Reduction**
Sulfur 4%	**33% Reduction**
Mercury <1 ppm	**67% Reduction**
BTU 11,800	**6%+ INCREASE**

CASE STUDY (CONT'D)

SUN ENERGY GROUP
HOLLAND, INDIANA, UNITED STATES

Economic Benefit Per Ton

*Ash: $0.10 per every 1% of reduction = $0.90 p/ton

*Sulfur: $0.10 per every .1% of reduction = $3.00 p/ton

*Mercury: Priceless!

*BTU's: $0.25 per every 100 BTU increase = $1.75 p/ton

Sales Price Beneficiation:

300,000		Tons per Annum
x	5.65	per Ton
$1,695,000		per Annum

*premium/penalty based on average US Thermal coal contract

CASE STUDY (CONT'D)

SUN ENERGY GROUP

HOLLAND, INDIANA, UNITED STATES

Net Economic Benefit

Additional Revenue from Beneficiation per Annum	$1,695,000
Operating and Maintenance Cost per Annum	- $300,000
NET GAIN	$1,395,000

*This coal would be unmarketable at a 19% ash and 3 ppm mercury to most customers in the US thermal coal market!

CASE STUDY

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

FGX SepTech, LLC

CASE STUDY
SHANDUKA COAL
MIDDELKRAAL COLLIERY
MPUMALANGA COALFIELD, SOUTH AFRICA

- "The technology provides a cost-effective solution for upgrading low ranking coal through deshaling. No water is used in the process and subsequently no slurry or polluted water is produced."
  - Johan Cowan, Processing Manager for Genet Mineral Processing, who developed and commissioned the plant at Middelkraal.

"Dry Coal Processing Reaping the Rewards," Mining Mirror Magazine, 1/2/2013

CASE STUDY (CONT'D)

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

- "In May 2012, the air plant achieved a remarkable production target of 400,000 tonnes"
  - Zirk van der Bank, Chief Operating Officer, Shanduka Coal

"Dry Coal Processing Reaping the Rewards," Mining Mirror Magazine, 1/2/2013

CASE STUDY (CONT'D)

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

- **Type of Coal:** Bituminous
- **Application:** Thermal
- **Tons Per Annum Processed:** 4,500,000
- **FGX Plant:** FGX-48A, 480 Tons Per Hour
- **Date Commissioned:** 2010

CASE STUDY (CONT'D)

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

Typical Analysis Run of Mine

Ash 60%+

Post Processed Analysis (Average)

Ash 35%

50% Reduction

or

168,000 Tons per Month of Reject Material

CASE STUDY (CONT'D)

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

Economic Benefit

FGX vs DMS (Conventional)

Tons Processed per Annum:	4,800,000 Tons
FGX Processing Costs (per manager):	x ~~$0.70~~
Total Operating and Maintenance	$3,360,000
Tons Processed per Annum:	4,800,000 Tons
DMS Processing (Assumes $4 per Ton):	x $4
	$19,200,000

CASE STUDY (CONT'D)

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

FGX SepTech vs Dense Media Separation

Net Savings

Dense Media Processing Cost	$19,200,000
FGX Dry Coal Separating Cost -	$3,360,000
NET SAVINGS	**$15,840,000 per annum (est)**

CASE STUDY (CONT'D)

SHANDUKA COAL
MIDDELKRAAL COLLIERY
MPUMALANGA COALFIELD, SOUTH AFRICA

Plant Dependability

Cowan states that the FGX-48A operated on a 7 day per week, 22 hour per day basis with the operator performing an 8 hour preventative maintenance shift every Wednesday. He states that the plant achieved an availability of **97%**!

CASE STUDY (CONT'D)

SHANDUKA COAL

MIDDELKRAAL COLLIERY

MPUMALANGA COALFIELD, SOUTH AFRICA

"Cowan believes that dry processing technology such as air separation will become a viable processing technology for the Waterberg coalfield in the future, because of it's water scarcity."

Description	Air plant	DMS plant
Process Water	None required	Requires water
Thickeners and flocculant dosing	None required	Require thickeners and flocculant dosing
Slurry ponds	None required	Requires slurry disposal
Dewatering of fine product – (Centrifuges)	None required	Requires dewatering of fine products
Maintenance of slurry Pumps, CM pumps, etc.	None required	Requires maintenance
Installed power	Less than DMS plant of similar capacity	Higher than air plant of similar capacity
Capital expenditure	Less than DMS plant of similar capacity	Higher than air plant of similar capacity
Rehabilitation liability	Limited – no slurry ponds	Rehabilitation of slurry disposal system
Operation and maintenance costs	Less than DMS plant of similar capacity	Higher than air plant of similar capacity
Beneficiation of near dense material	Application limited	Suitable for beneficiation of near dense material
Feed material fines moisture >10%	Prefer to screen out fines with moisture >10%	Suitable for beneficiation wet fines

"It is a low-cost dry process with easy operation and low maintenance. It is environmentally friendly and able to remove pyretic sulphur in high-sulphur coal," he concludes.

"Dry Coal Processing Reaping the Rewards," Mining Mirror Magazine, 1/2/2013

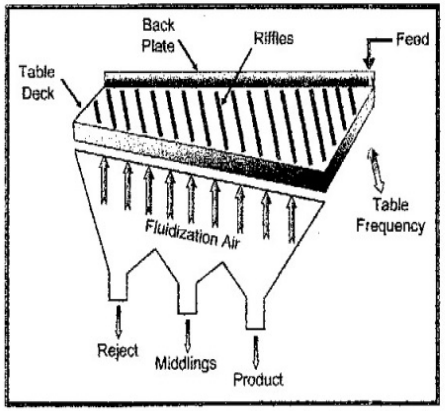
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Table Deck
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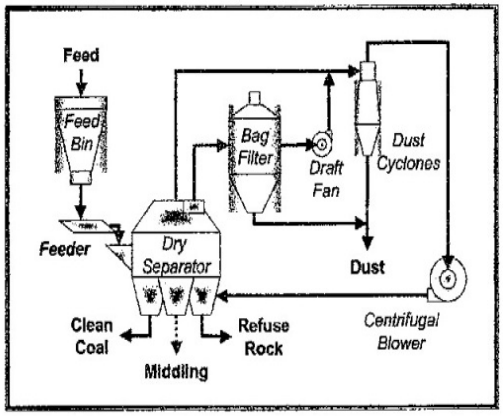
Middlings
Product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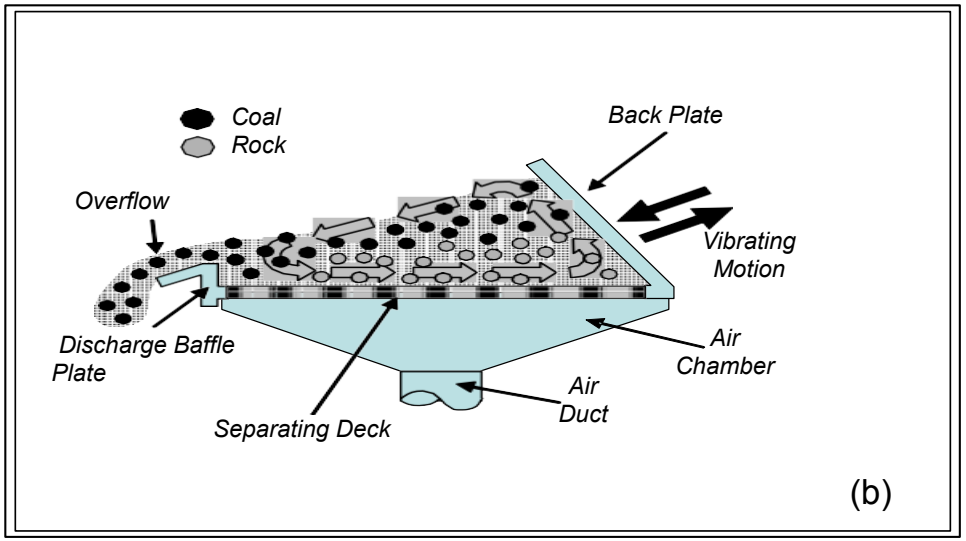
Dry Separator
Dust
Clean Coal
Refuse Rock
Middling
Centrifugal Blower


Coal
Rock
Back Plate
Overflow
Vibrating Motion
Discharge Baffle Plate
Air Chamber
Air Duct
Separating Deck
(b)

DEVELOPMENT OF AN ADVANCED DESHALING TECHNOLOGY TO IMPROVE THE ENERGY EFFICIENCY OF COAL HANDLING, PROCESSING, AND UTILIZATION OPERATIONS

U. S. Department of Energy
Industrial Technologies Program, Mining of the Future ID Number: DE-FC26-05NT42501

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