Coal Preparation

"*A Discussion on Conventional and Advanced Technology*"

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Coal Preparation

- PRESENTATION OUTLINE
  - What is “Coal Preparation”?
  - Introduction and Background
  - Why use “Coal Preparation”?
  - How is “Coal Preparation” Engineered?
  - Conventional Technologies
  - Advanced Technologies
  - Applications
  - Closing Comments

What Is Coal Preparation?

- Coal preparation is the removal of undesirable material from the Run-of-Mine (ROM) coal by employing separation processes which are able to differentiate between the physical and surface properties of the coal and the impurities. Through coal preparation, a uniform product is achieved.

Washability Study

- The selection of the logical separation process is based upon a laboratory study of the ROM called a washability study.
  - Size Distribution
  - Yield Curve
  - Cumulative Float Curve
  - Cumulative Sink Curve
  - Partition (Tromp curve)

Why Coal Preparation?

- Remove extraneous, non-combustible material
  - Ash reduction
    - lower particulates
    - reduced ash handling at power station
  - Sulfur reduction (lower SO_X emissions)
  - Carbon and NO_X Emissions Reduction
- Reduced transportation costs per unit of heat
- Guarantee consistent heat value
  - Improved plant efficiency

Customer Requirements (Commercial Motivation)

- The purpose of these developments and others has been to economically improve the quality of coal to make it suitable for a specific purpose.
  - About 80% of the US production is used in electricity generation
  - The properties and the quantities of the impurities in coal are of major importance in the design and operation of steam generating equipment.
  - The steam coal users, mostly utilities, require optimum calorific value, consistent grindability, minimal moisture and ash variability.

Energy and Coal

- BTU/lb (kilo-calories/kg) in coal

  (1 BTU/lb = 0.556 Kcal/kg)

  – Lignite 4500 (2500) – 7000 (3890)
    - High moisture (25%) with ash
  – Low Grade Bituminous 5000 (2780) – 9000 (5000)
    - High ash (+20%) with moisture (10%)
  – Thermal Bituminous 8000 (4450) – 12000 (6675)
    - Medium ash (10-12%) with moisture (9%)
  – High Grade Bituminous +12000 (+7000)
    - Low ash (<7%) with low moisture (<8%)

Effects of Ash on Heat Value

Empirical Formula for Indian Coals

Gross Calorific Value in Kcal/kg = 85.6 x (100-1.1A – M) – 60M

A = Ash content, wt%   M = equilibrated moisture content, wt%

- 40% ash, 10% M GCV = 3338 kcal/kg (6000 Btu)
- 30% ash, 10% M GCV = 4280 kcal.kg (7700 Btu)

1 ton 40% = 0.78 tons 30%

Coal to Electricity
"Heat Rate"

- The average heat rate is approximately 10,000 Btu (2,520 kcal) per kilowatt-hour generated. This number will vary depending upon the type of boiler, heat exchangers, auxiliary power consumption etc. but the efficiency of most plants in operation today is between 30 – 35%.
- By providing a higher concentration of heat in the fuel (lower ash and moisture content), the associated costs of transportation, handling, crushing, pulverizing and residual waste (flyash) disposal in the electricity generation are reduced because fewer weight units per kilo-watt hour generation will be required.

Does Coal Washing Help GHG Emissions Reduction?

(presented March 10, 2000 by S. Padmanaban, USAID/India at CPI 2000 New Delhi)

- Typical Emissions using raw coal (42%) in a standard Indian coal fired power plant.
  - Carbon Dioxide – 1.11 kilograms carbon dioxide per kilo watt hour of commercial power
- Typical Emissions using washed coal (30%) in a standard Indian coal-fired power plant
  - Carbon Dioxide – 1.045 kilograms carbon dioxide per kilo watt hour commercial power
- Other Co-benefits: Reduction in auxiliary power consumption, reduction in fly-ash management costs at power plants, lowered ESP loading, reduced emissions

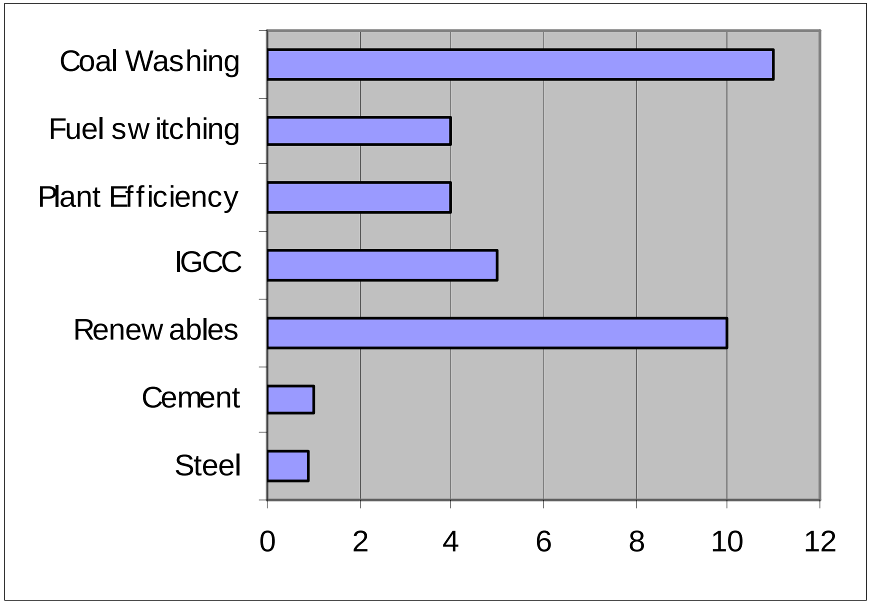
How Does Coal Washing Compare with other GHG Emissions Reduction Opportunities?

(presented March 10, 2000 by S. Padmanaban, USAID/India at CPI 2000 New Delhi)

Some good opportunities for GHG reduction in India are found in:

- Electric power generation, transmission $ distribution
- Industrial energy Utilization
- Transportation

Annual GHG Mitigation Potential in India



Technical and Economic Limitations of Coal Preparation

- Technical
  - ROM coal characteristics
  - Available technology
- Economic
  - Capital costs
  - Operating costs
  - Yield/energy recovery

Levels of Coal Cleaning

- Level 1
  - Rough Scalping and Crushing
- Level 2
  - Coarse Coal (+1/2 inch) Cleaning only
- Level 3
  - Coarse and Fine Coal Cleaning
- Level 4
  - Coarse, Fine, and Ultra Fine Coal Cleaning
- Level 5
  - Level 4 Cleaning plus middlings crushing and rewash

Equipment-Cleaning

- Conventional
  - Heavy media separators (vessels and cyclones)
  - Pulse water separators (jigs)
  - Constant velocity separators (water only cyclones)
  - Froth Flotation (Aeration) Cells

MOST COMMON COAL CLEANING EQUIPMENT WITH THEIR COMMON APPLICATION RANGES AND APPROXIMATE Ep VALUES

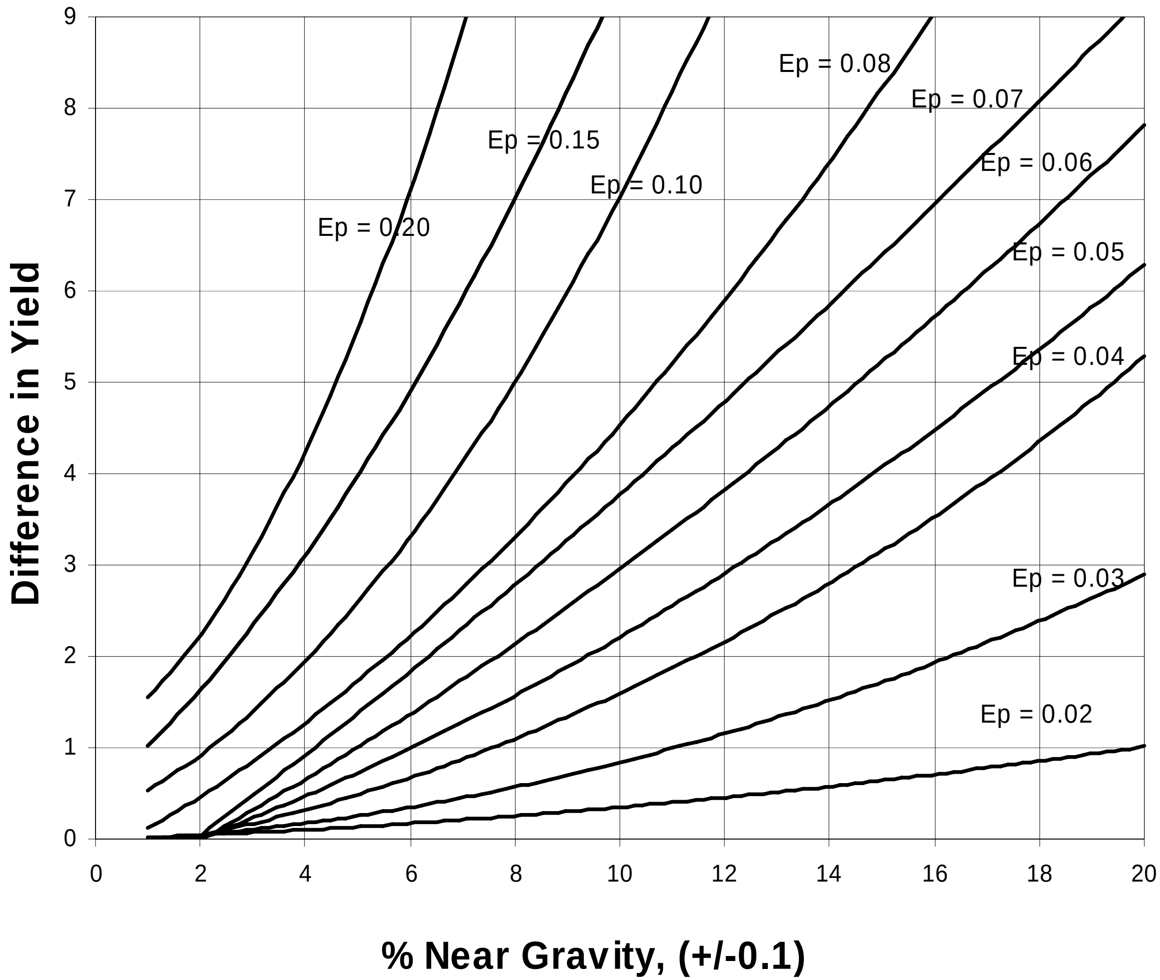
HMV - Heavy Media Vessel
HMC - Heavy Hedia Cyclone
WOC - Water-only-cyclone
DT - Deister Table
FC - Flotation Cell
RB - Rotary Breaker
BMJ - Baum Jig
BCJ - Batac Jig
SPI - Spiral

Particle Size	Equipment	1.35	1.40	1.50	1.55	1.60	1.70	1.80		1.90	2.00
35mmx100mm	RB					------	------	------	------		
35mmx100mm	HMV	0.011	0.013	0.016	0.018	0.020	0.024				
35mmx100mm	HMC	0.010	0.012	0.014	0.015	0.016	0.018	0.020	0.022		
35mmx100mm	BMJ			0.060	0.066	0.072	0.084	0.096		0.108	0.120
35mmx100mm	BCJ			0.045	0.050	0.054	0.063	0.072			
18mmx35mm	HMV	0.013	0.015	0.019	0.022	0.024	0.028				
18mmx35mm	HMC	0.017	0.018	0.019	0.020	0.022	0.024	0.026	0.028		
18mmx35mm	WOC					0.110	0.135	0.160		0.185	0.210
18mmx35mm	BMJ			0.070	0.077	0.084	0.098	0.112		0.126	0.140
18mmx35mm	BCJ			0.050	0.055	0.060	0.070	0.080	0.090		
5mmx18mm	HMV	0.024	0.028	0.037	0.041	0.045	0.054				
5mmx18mm	HMC	0.021	0.022	0.023	0.024	0.025	0.027	0.029	0.031		
5mmx18mm	WOC					0.130	0.155	0.180		0.205	0.230
5mmx18mm	BMJ			0.080	0.088	0.096	0.112	0.128		0.144	0.160
5mmx18mm	BCJ				0.061	0.066	0.077	0.088		0.099	0.110
5mmx18mm	DT				0.061	0.066	0.077	0.088	0.099		
0.5mmx5mm	HMC	0.032	0.034	0.037	0.038	0.040	0.043	0.046		0.050	0.060
0.5mmx5mm	WOC					0.155	0.175	0.200		0.225	0.250
0.5mmx5mm	BMJ						0.140	0.160		0.180	0.200
0.5mmx5mm	BCJ					0.090	0.105	0.120		0.135	0.150
0.5mmx5mm	DT					0.090	0.105	0.120		0.135	0.150
0.5mmx5mm	SPI							0.160	(Up to 2mm)	0.170	0.180
0.1mmx0.5mm	HMC					0.160	0.170	0.180		0.190	0.050
0.1mmx0.5mm	WOC					0.180	0.200	0.213		0.246	0.260
0.1mmx0.5mm	BCJ						0.180	0.193		0.206	0.220
0.1mmx0.5mm	DT						0.180	0.193		0.206	0.220
0.1mmx0.5mm	SPI							0.180		0.190	0.220
0.1mmx0.5mm	FC					------	------	------			
-0.1mm	FC					------	------	------			

Particle Size

Separation Gravity

IMPORTANCE OF EFFICIENCY
DIFFERENCE BETWEEN THEORETCIAL AND PRACTICAL YIELD AS A FUNCTION OF PERCENTAGE OF NEAR GAVITY MATERIAL (Ep = Probable Error)



NEAR GRAVITY MATERIAL: AMOUNT OF MATERIAL WITHIN +-0.1 SPECIFIC GRAVITY OF THE SEPARATING GRAVITY

Ep Values Using Heavy Media Cyclone Separation for Dipka's Coals

Guranteed Coefficient = 1.15

Size Fraction	Separation Sp.Gr.	Ep Predicted	Guranteed
100mmx13mm	1.50	0.014	0.016
	1.55	0.015	0.017
	1.60	0.016	0.018
	1.65	0.017	0.020
	1.70	0.018	0.021
	1.75	0.019	0.022
	1.80	0.020	0.023
13mmx1mm	1.50	0.032	0.037
	1.55	0.033	0.038
	1.60	0.034	0.039
	1.65	0.035	0.040
	1.70	0.036	0.041
	1.75	0.037	0.043
	1.80	0.038	0.044
1mmx0	1.60	0.165	0.190
	1.65	0.168	0.193
	1.70	0.171	0.197
	1.75	0.174	0.200
	1.80	0.177	0.204

Heavy Media Vessel

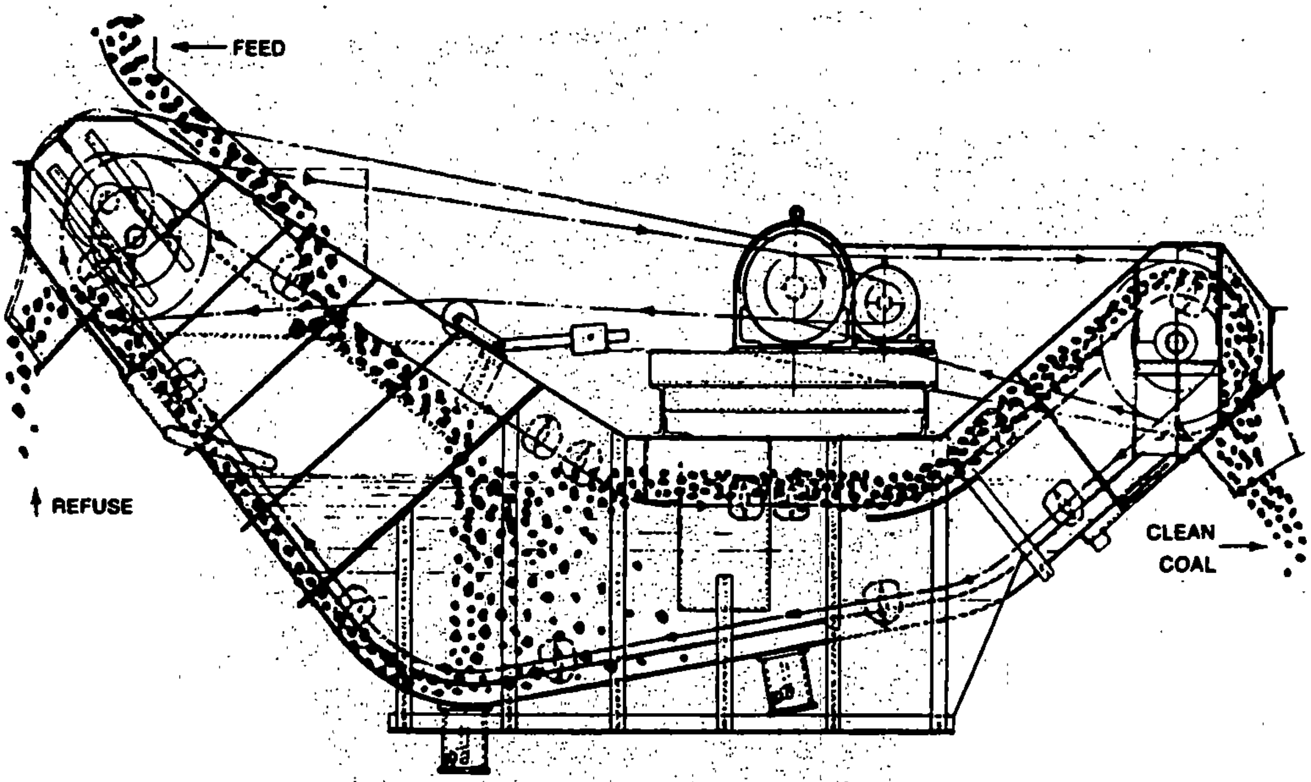


Fig. 7-10. DSM vessel. *Source:* Roberts & Schaefer Co.

Heavy Media Cyclone

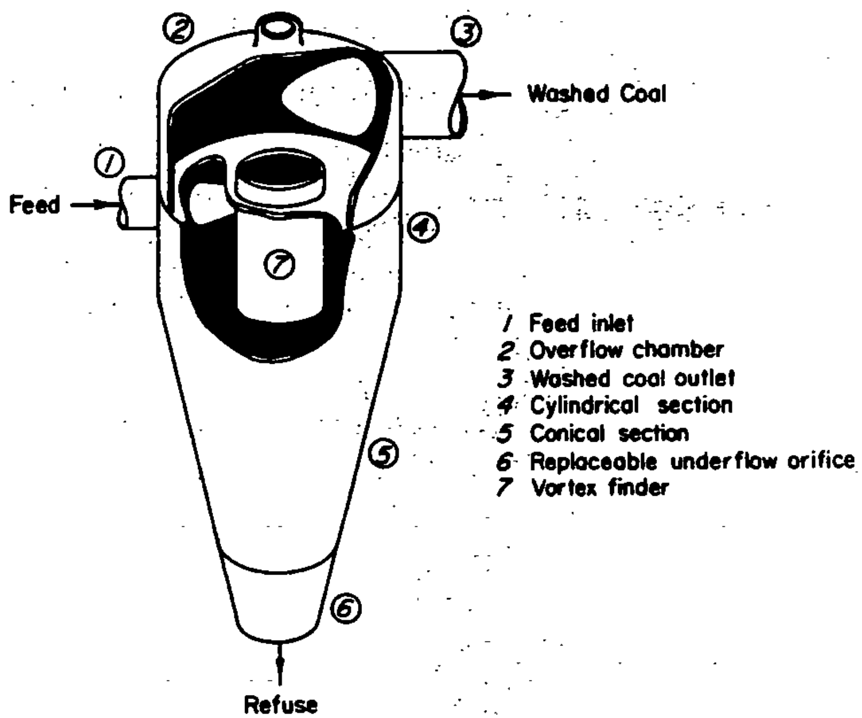


Fig. 7-51. Dense-medium cyclone.

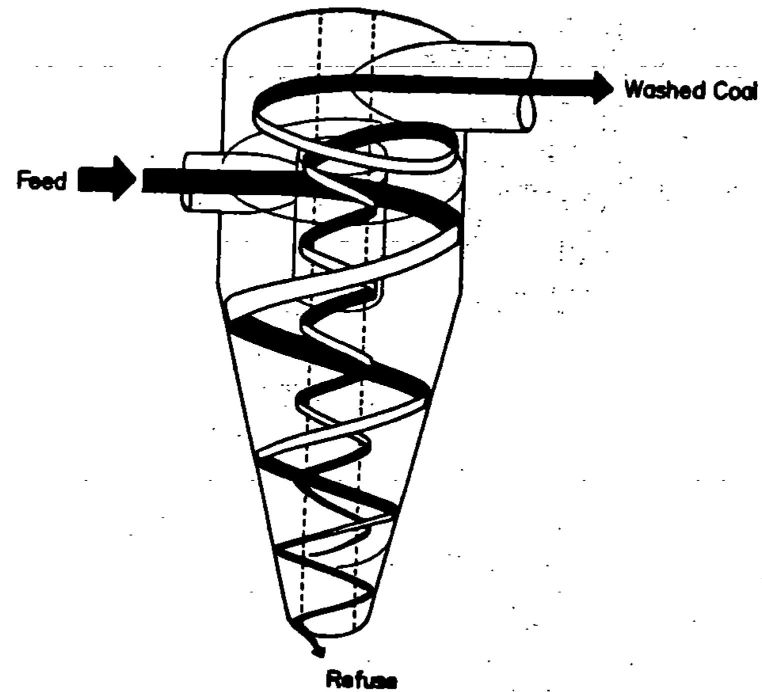
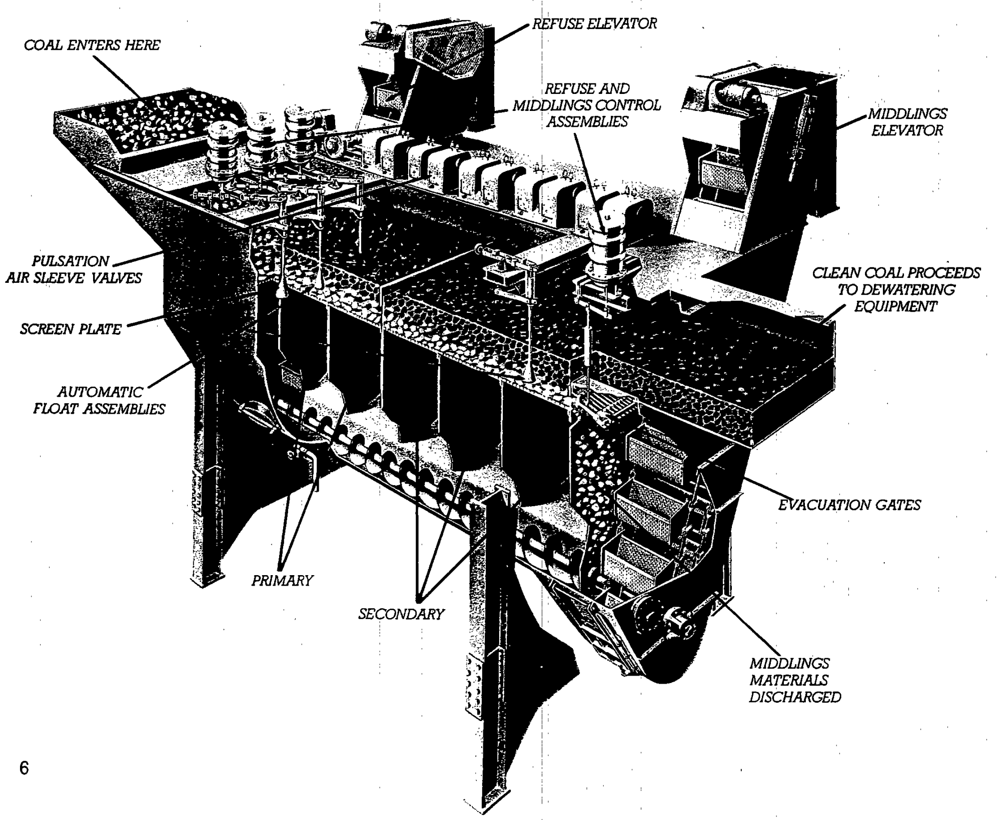


Fig. 7-52. Idealized flow pattern in a dense-medium cyclone.

Jig

(picture courtesy McNally)



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Equipment-Cleaning

- Advanced
  - Large Diameter cyclones (+1.0 meter)
  - CLIMAXX Magnetic Separator
  - Spiral separators
  - Column Flotation
  - Falcon Concentrator
  - Knelson Concentrator
  - Oil Agglomeration

Equipment-Dewatering

- Conventional
  - Screens
  - Centrifugal Dryers
  - Vacuum filters
- Advanced
  - Screen Bowl Centrifuge
  - Hyperbaric Filter

Centrifugal Dryer

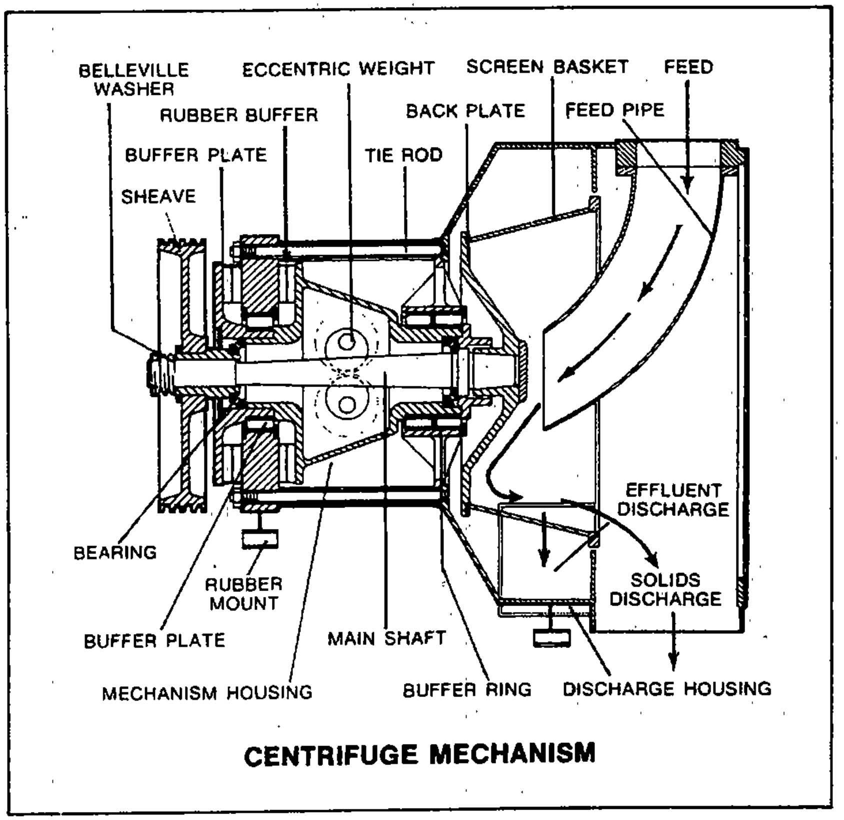

Fig. 8-22. Vibrating-basket centrifuge (*Courtesy:* WEMCO).

Screen Bowl Centrifuge

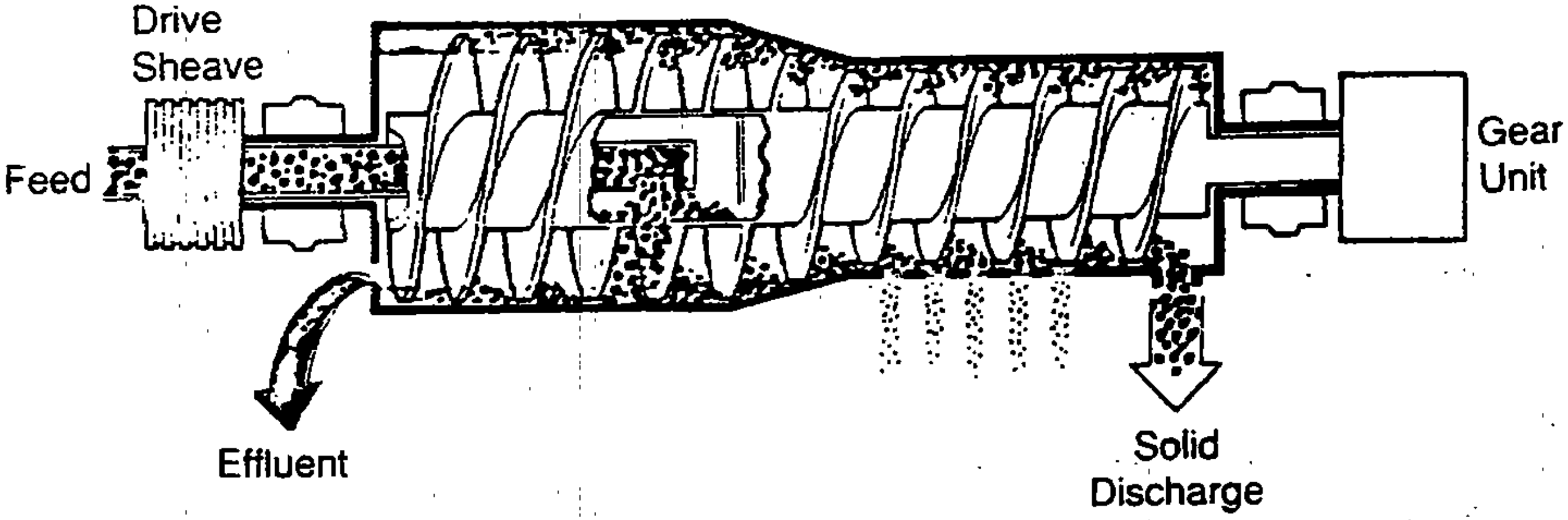

Fig. 8-25. Screen-bowl centrifuge (*Courtesy:* Bird Machine Co.).

Conclusion

- Coal Preparation is a major contributor to the economic and environmental viability of coal as a source of fuel for thermal power generation,
- An unavoidable fact is that the second largest populated country in the world, India, is rich in coal resources and will further develop its utilization for the generation of electricity,

Conclusion (cont.)

- The technologies of coal preparation must be promoted as an integral part of the coal-to-power undertakings in the India.
- Coal cleaning can have the most significant impact on the reduction of “greenhouse gases” in these developing countries.

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THANK YOU