

# **Power Generation from Coal Wastes: US Experience**

**By**

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**Workshop on Coal Beneficiation and Utilization of Rejects  
Ranchi, India**

- **Coal Waste – An Overview**
- **CFB Combustion Technology Development Status**
- **U.S. Experience in the Use of Coal Wastes for Power Generation**
  - ❖ **Number of CFB Units**
  - ❖ **Fuel Characteristics and Boiler Performance Data**
  - ❖ **Emission Performance**
  - ❖ **Ash Use Options**
- **Similarities Between U.S. Coal Wastes and Indian Washery Rejects**
- **Application of US CFB Experience to Indian Projects**
- **Conclusions**

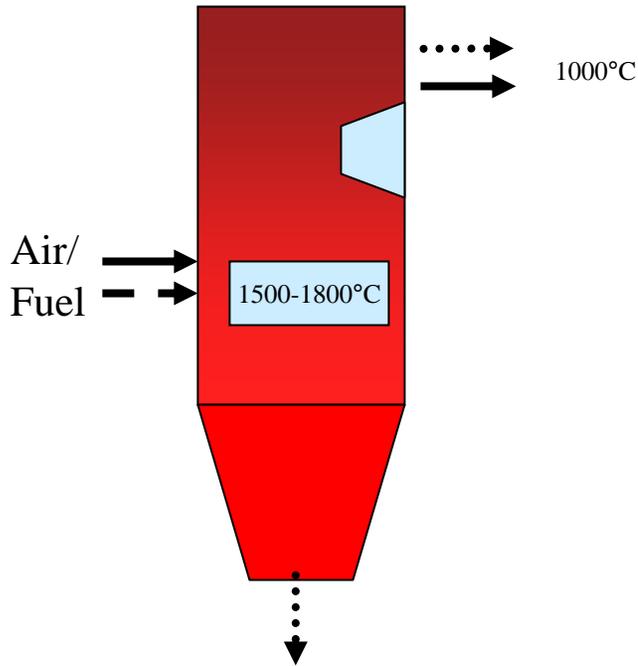
- **Coal wastes were generated by mining and coal beneficiation facilities**
- **Coal waste piles are aesthetically offensive and environmentally contaminating**
- **Acid mine drainage from these sites is a significant polluter of water resources**
- **Each pile occupies vast area of land that could be used in a beneficial manner**
- **Types of coal waste: Coarse refuse, fines and pit cleanings**

- **Waste energy conversion system design needs skilled effort**
  
- **Low heating value and varying quality**
  
- **Low quantity waste production**
  
- **Most washery units near environmentally sensitive areas**
  
- **Possible captive/ small capacity power plants**
  
- **Unsatisfactory experience with bubbling bed combustors\***

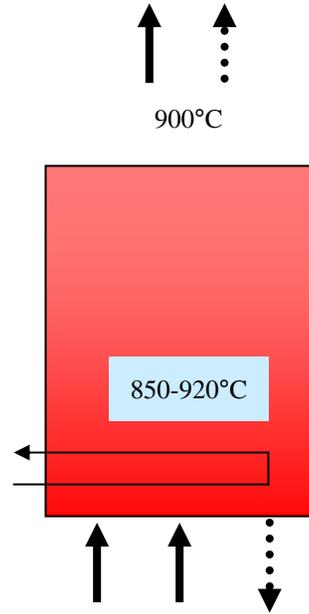
*\* Poor availability reported*



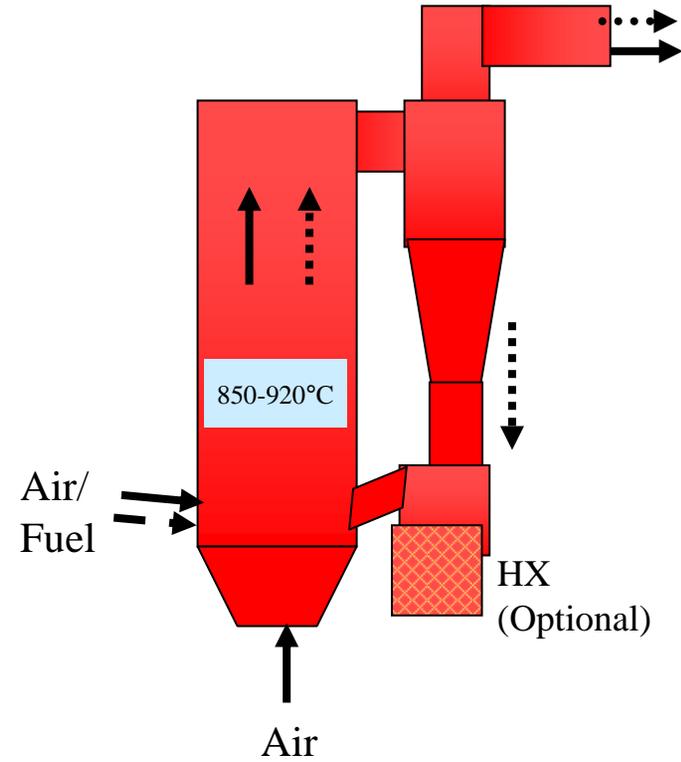
# Coal Combustion Modes: Key Features



**PC**



**BFB**



**CFB**

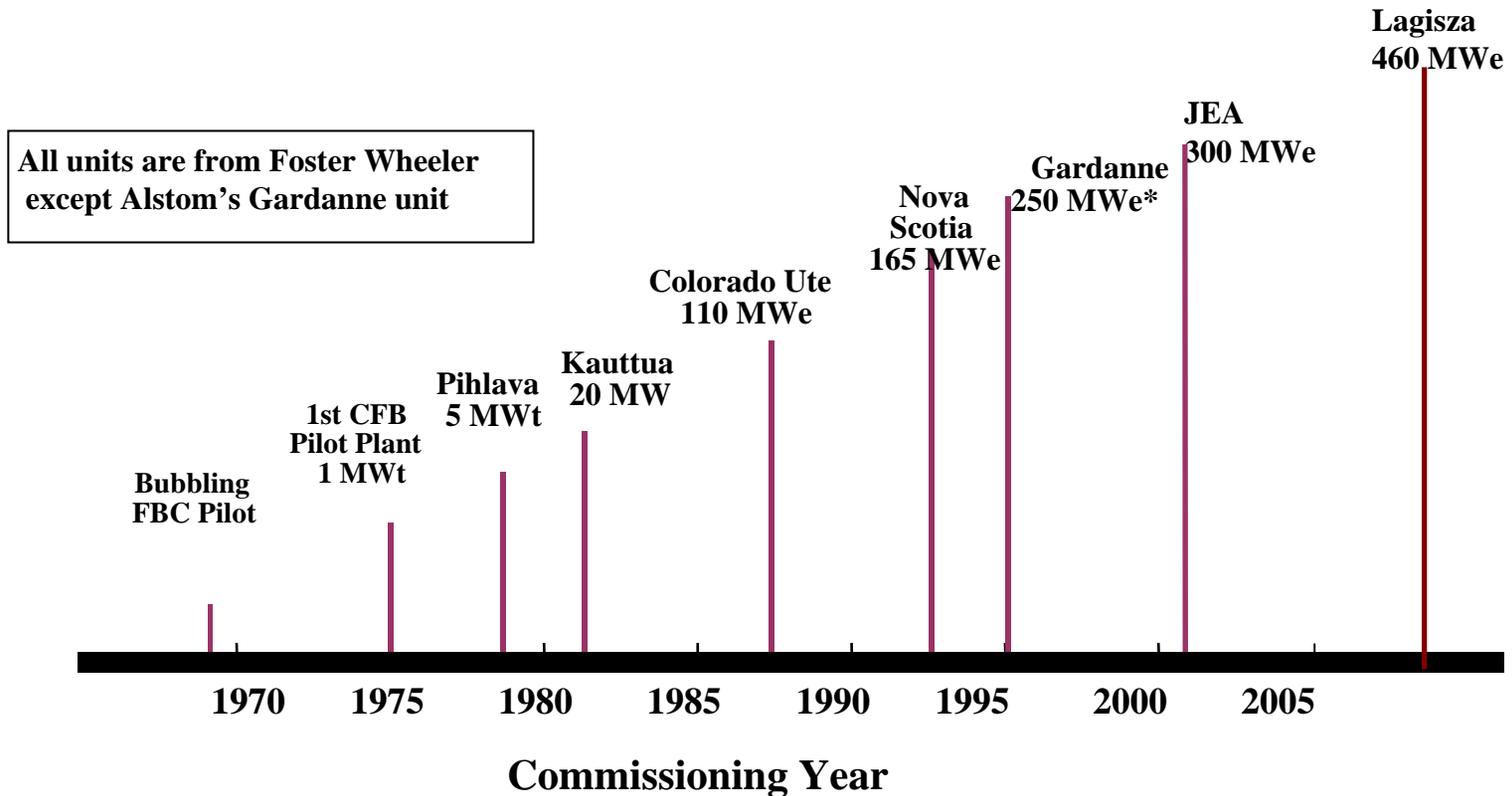
- **Reclamation of coal waste piles**
- **Reclamation of abandoned surface mines**
- **Low cost SO<sub>2</sub> and NO<sub>x</sub> control**
- **Viable option for waste coal, waste coal+other fuel blends**

- **Efficiency**
  - **Maximum carbon burn out**
  - **Low excess air operation**
  - **Low in-house power consumption**
- **Emission**
  - **SO<sub>2</sub>, NO<sub>x</sub>, PM**
  - **Trace Metals**
  - **Ash utilization**
- **Economy**
  - **Cost of electricity**
  - **Land area reclamation**
  - **Low O&M cost**
  - **High availability**

# Chronology of Atmospheric CFB Scale-Up



CFB technology has progressed well over the past 25 years



Ref: Cotton, Darling and Sellakumar, Coal Prep India-2000; Jantti et al, web accessed [www.fwc.com](http://www.fwc.com), Aug 10, 2007

➤ **Boiler designs have been successfully scaled up.**

| Waste Fuel Type | Boiler Rating, MWe (net) |     | # of Units |
|-----------------|--------------------------|-----|------------|
|                 | Min                      | Max |            |
| Culm            | 35                       | 100 | 8          |
| Gob             | 30                       | 261 | 10         |

- Units burn fuels with fines up to 60%\*
- Ash content up to 75%
- Sulfur up to 6%

*\* Li, S., web accessed @ [www.fwc.com](http://www.fwc.com), March 31, 2003*

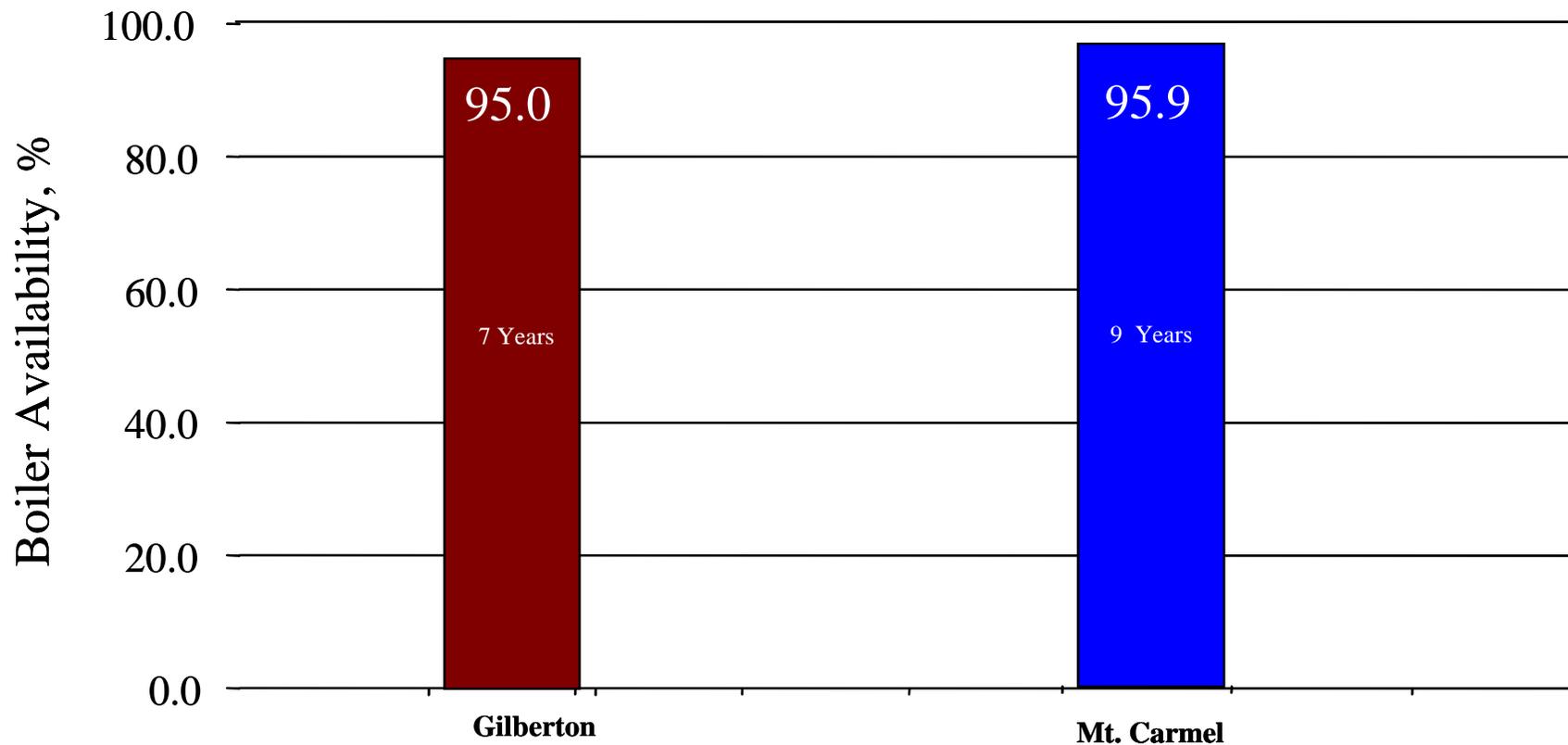
# Waste Coal-fired CFB Boiler Data (typ)

| Parameter                      | Unit    | Gilberton       | Mt Carmel       |
|--------------------------------|---------|-----------------|-----------------|
| Unit Size (net)                | MWe     | 35              | 41              |
| Fuel Type                      |         | Anthracite culm | Anthracite culm |
| Carbon                         | % by wt | 26.82           | 20.62           |
| Hydrogen                       | % by wt | 1.05            | 0.84            |
| Nitrogen                       | % by wt | 0.50            | 0.38            |
| Sulfur                         | % by wt | 0.25            | 0.40            |
| Oxygen                         | % by wt | 3.02            | 4.13            |
| Ash                            | % by wt | 59.38           | 63.63           |
| Moisture                       | % by wt | 8.98            | 10.00           |
| HHV                            | MJ/kg   | 10.10           | 7.56            |
| Boiler Efficiency (guaranteed) | %       | 87.07           | 81.00           |
| Boiler Efficiency (tests)      | %       | 86.53           | 83.13           |

*\* Li, S., web accessed @ [www.fwc.com](http://www.fwc.com), March 31, 2003*

# CFB Boiler Availability (Typ)

➤ Many units have demonstrated >95% availability.



*Ref: Cotton, Darling and Sellakumar, Coal Prep India-2000*



**Coal waste combustion by-product (ash) is not hazardous.**

- **Test data , based on U.S. EPA procedures, indicate that CFB ashes are “cleaner” than pulverized coal ashes.**
- **U.S. EPA has exempted CFB ashes from hazardous waste testing/classification.**
- **Environmental impact of CFB ashes should not affect their utilization potential.**

➤ **Fuels similar to Indian coal wastes are burned in the U.S. CFB units**

| Ultimate Analysis    | Unit             | Anthracite culm (US) | Typical Indian Coal Washery Rejects+other fuel blends | Indian Coal (Typ) |            |
|----------------------|------------------|----------------------|---|-------------------|------------|
|                      |                  |                      |   | Raw Coal          | Sinks      |
| Carbon               | % by wt          | 24.3                 | 31.6  | 50.00             | 15.50      |
| Sulfur               | % by wt          | 0.33                 | 0.4   | 0.30              | 0.26       |
| Ash                  | % by wt          | 65.38                | 44  | 40.00             | 71.00      |
| Moisture             | % by wt          | 4.71                 | 16.01   | 3.24              | 7.84       |
| Higher Heating Value | MJ/kg/ (kcal/kg) | 8.3 (1973)           | 12.56 (3000)  | 19.82(4735)       | 7.3 (1780) |

*Ref: Cotton et al, Coal Prep India- 20000*

- **Technical know-how is available for the beneficial use of washery rejects**
  - **Assess viability and plant capacity selection**
  - **Material handling**
  - **Fly ash, bottom ash splits**
  - **Pollutant formation and control**
  - **HX Surfacing and Material selection**
  - **Ash quality characterization and management options**

- **CFB technology can be successfully applied to Indian washery rejects and U.S. experience can play a vital role.**
  
- **Coal waste generation will be significant in the coming years and clean energy conversion demonstration is needed**
  
- **Over 25 years, the U.S. has developed CFB boiler to demonstrate**
  - ❖ **high availability**
  - ❖ **strong emission performance equal to normal coal burning systems and**
  - ❖ **high turndown and minimal use of premium fuels for start-up and low load operation**
  
- **Long-term commercial design and operating experience can be applied to the efficient use of Indian washery rejects.**

**Thank You**