Quick and Low Temperature Drying Technology

CRADLE®
(Coal Rapid Air Dry Leading Equipment)

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Mitsubishi Hitachi Power Systems Group
Babcock-Hitachi K.K.

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Main Products

- Power Boilers
- HRSG
- Industrial Boilers
- Incinerators
- Industrial Plants
- FGD
- SCR
- Nuclear Power

Integrated & Dedicated Product Line-up for Power and Industrial Plant
Industry Recognition (BHK Benson Boiler)

EPCOR/
Genesee Power Station Unit 3, Canada

*World’s Top 12 Power Plants / 2005 Platts Global Energy Awards*
- Power Magazine (July/Aug 2005)

*Best Coal Fired Project of the Year Award*
- Power Gen International 2005 in Las Vegas, USA

MidAmerican Energy/
Walter Scott, Jr. Energy Center Unit 4, USA

*POWER’s 2007 Plant of the Year*
- Power Magazine (Aug 2007)

*Best Coal Fired Project of the Year Award*
- Power Gen International 2007 in New Orleans, USA
1. Introduction

Why apply a Coal Pre-Drying System?

- High moisture in coal has negative impacts for:
  - Boiler efficiency
  - Coal consumption
  - Emissions including SOx, NOx, CO2

- Coal pre-drying system achieves;
  Higher boiler efficiency, reduced coal consumption and reduced emissions.

Diagram:

- Raw Coal (High moisture) → Pre-Drying System → Dried Coal (Low moisture) → Boiler → Flue Gas → AH → ESP → IDF → FGD → Stack

Reduce Coal Consumption  Improve Boiler Efficiency  Reduce Flue gas flow  Lower Capacity Auxiliary Equipment  Less Emissions
2. Theory of Drying

Atm. Air

Exhaust Air

Hot Air

Constant drying

→ Not to exceed saturation temperature 100°C

Psychometric chart

Absolute humidity

Relative humidity

Temperature

Moisture absorption

Absorb moisture in raw coal

Like a hair dryer...

Coal Rapid Air Dry Leading Equipment

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CRADLE: Structure

Coal Rapid Air Dry Leading Equipment

1) Fluidized Bed with Turbulent Hot Air → Rapid Drying
2) Bucket Conveyor → Uniform Residence Time

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3. CRADLE Pilot Test

Outline of Pilot-scale Test

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>4.8 ton/day</td>
</tr>
<tr>
<td>Max. Total Coal Moisture</td>
<td>50%</td>
</tr>
<tr>
<td>Target Total Coal Moisture</td>
<td>10%</td>
</tr>
</tbody>
</table>

Blower

Heater

CRADLE (Dryer)

Bag Filter

Control panel
4. Pilot Test Result (1): Drying Characteristics

The following test results are within our expected range.

- The Moisture in coal can be dried quickly by increasing Air Flow
- The Moisture in coal can be dried quickly by increasing Air Temperature

Test Result of **Changing Air Flow**

Test Result of **Changing inlet Air Temperature**

The Moisture in coal can be dried quickly by increasing Air Flow

The Moisture in coal can be dried quickly by increasing Air Temperature
5. Pilot Test Result (2): Efficiency

Need

Drying efficiency

Power Plant efficiency

/ Large amount of heat is required in the low moisture
/ Plant efficiency increases by Pre-drying

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6. Placement

1. CRADLE may have small storage hopper of dried coal (only store dried coal for the control change).

2. CRADLE can be installed within the boiler area because it can dry the coal rapidly.
7. Outline of Drying System Operation(1)

Moisture 60% Lignite

Min. Load Operation 50-70%

Min. Load Operation 15%

Dry Lignite (Moisture <30%)

Wide range of loads operations by Pre-dry

Load(%) Time
7. Outline of Drying System Operation(2)

Min. Pre-dry system (New Boiler)

Events

- Start Turbine
- Synchronize
- 5%
- 30%
- 50%
- 100% Load

Fuel

- Raw Lignite
- Dry lignite
- Oil or Gas
- Cost saving
- No to need large Start up fuel system

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7. Outline of Drying System Operation(3)

Min. Pre-dry system (Existing Boiler)

Events

- Start Turbine
- Light off Boiler
- Synchronize
- 100% Load
- 15–30% (Min. Load)

Fuel

- Cost saving
- Only use Dry Lignite at low load operation
- Dry lignite
- Raw Lignite
- Oil or Gas

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8. Effects

Customer Needs

Low Min. Load Operation
With pre drying, the boiler min. load can be reduced by approx. half from the min. load of conventional lignite boilers. The capability to operate lignite plants at lower loads may be favorable, as alternative power sources (e.g. renewable energy) are being added to the systems.

Efficiency Increase by Economical Dryer
Drying technology exists for Lignite coals. But too expensive!
- High quality material.
- Large Aux. equipment.
- Need large space.
Dry lignite will improve efficiency, but not significant cost saving since lignite is cheap.

Lignite Use for IGCC
Lignite is high volatile matter and low Ash melt temperature.
Lignite has good properties for IGCC, except for the high moisture.

Goals
(1) Product Price Ratio of 30% compared to Other Dryers
(2) It will be installed in boiler room
   Ratio of the construction costs = 20 ~ 30% compared with Other Dryers
(3) Drying temperature of 60 °C
(4) Efficiency is improved
### 9. Schedule

**We want to verify CRADLE technology**

<table>
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<tr>
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<th>STEP 1 (2014)</th>
<th>STEP 2 (2015-7)</th>
<th>STEP 3</th>
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<td><strong>Basic and Pilot test</strong></td>
<td>Basic test (Australian, German, Indonesian Lignite) and Pilot test (German Lignite) done at 2011.</td>
<td>Design and Election 1.5 years</td>
<td>IGCC for Poland lignite</td>
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<tr>
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<td>Demonstration test (120t/d = 5t/h)</td>
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<tr>
<td><strong>Use Pre-Dry system</strong></td>
<td>IGCC for Poland lignite</td>
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10. Demonstration Plant (120t/d=5t/h) Planning
Conclusion

CRADLE is the most ECONOMICAL dryer in the world.

CRADLE will change the future of Lignite.

Dziękuję za uwagę

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