Pressurized Steam Fluidized Bed Drying (PSFBD) of Lignite - State of the Development and selected Results of 15 Years R&D

Matthias Merzsch, Dr. Matthias Klatt, Prof. Hans Joachim Krautz
Chair of Power Plant Technology, BTU Cottbus – Senftenberg

Dr. Olaf Höhne
LEAG - Lausitz Energie Kraftwerke AG

Berlin, 05.06.2018
9th International Freiberg Conference on IGCC & XtL Technologies
Table of Contents

- Brief introduction
- PSFBD Facilities
- Development activities
- Outlook
Why to Dry Lignite?

Proximate analysis of Lusatian processing coal

<table>
<thead>
<tr>
<th>Raw</th>
<th>Moisture</th>
<th>Ash</th>
<th>Volatile matter</th>
<th>Fixed carbon</th>
</tr>
</thead>
<tbody>
<tr>
<td>57%</td>
<td>3%</td>
<td>23%</td>
<td>17%</td>
<td></td>
</tr>
</tbody>
</table>

Net calorific Value [MJ/kg]

- Raw: 9.2
- W=19%: 19

Net calorific Value

- Raw: 9.2
- W=19%: 19

Proximate analysis of Lusatian lignite briquettes (w=19%, 1.15 kg)

- Evaporated water from raw lignite (0.967 kg)
- Water remaining in briquettes (0.219 kg)
- 2 Lusatian lignite briquettes (w=19%, 1.15 kg)
Why to Pre-Dry Lignite in a (Pressurized) Steam Fluidized Bed?

- Increasing the efficiency by up to 5 percentage points in lignite fired power plants (44% → 49%)
  - Drying with heating steam at low temperature in place of hot flue gases
  - use of vaporized lignite water energy
- more intensive heat & material transmission in contrast to conventional tube dryers (upgrading/processing facilities)
- Up to 80% less energy consumption
- Precondition for CCS technologies in power plants
PSFBD Facilities

BTU Cottbus-Senftenberg – Chair of Power Plant Technology

<table>
<thead>
<tr>
<th>Raw lignite throughput</th>
<th>&lt; 550 kg/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>commissioning</td>
<td>2003</td>
</tr>
</tbody>
</table>

Industrial Park Schwarze Pumpe – Lausitz Energie Kraftwerke AG

<table>
<thead>
<tr>
<th>Raw lignite throughput</th>
<th>8…10 t/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>commissioning</td>
<td>2008</td>
</tr>
</tbody>
</table>
PSFBD Facilities - development activities

**rotary feeder**

**Challenge:**
- High moisture of raw lignite in combination with the small particle size
- Minimize the leakage steam of the pressurized vessel (efficiency, particle moisture)

- Test of different Manufacturers and different sealing methods (conical rotor, sealing faces, minimum gap)
  - Reduction of leakage steam by 75% compared with commissioning
  - 5-10% losses of vapor by leakage
PSFBD Facilities - development activities

performance improvement (fluidized bed heat transfer / process stability)

1. Change over to a finer grained lignite (0-6 mm → 0-2 mm)

2. Installation of a dust recirculation (average particle diameter ↓, average moisture ↓)
3. Detailed investigation of different heat tube bundle geometries (tube diameter, tube arrangement & pitch)

But: stability criteria for higher moisture contents??
PSFBD Facilities - development activities

Fluidizing stability

4. Raw lignite distribution → from laboratory investigation to industrial application

- Reduction Fluidization blower power of 50%
- Minimizing of dust discharge
PSFBD Facilities - development activities

Pressurizing and technology extension

5. Increasing heat transfer rates and efficiency through pressurizing

- Successful installation and testing of a steam converter and a steam recompression plant

![Graph showing overall heat transfer coefficient vs. system pressure with data points for PSFBD - Schwarze Pumpe.](image)

![Images of LEAG – Schwarze Pumpe.](image)
PSFBD Facilities - development activities

Pressurizing and technology extension

- Re-use of 90% of the vaporized lignite water
- Reduction of 65…80% thermal energy demand
- Reduction of 40…50% primary energy demand

(Electrical energy demand compressor)
**PSFBD Facilities - development activities**

**further R&D activities**

**Fundamental research – heat of binding at pressures up to 6 bar**

- Numerical modeling of hydrodynamics and heat/mass transfer

**Experimental investigation of condensation in horizontal pipes at pressures up to 10 bar (heat transfer & pressure drop)**
Outlook

- PSFBD as prestage for further lignite refinement (e.g. activated carbon production for mercury capture from stack gas of power plants)

- Further optimization of the dryer design (performance increase by innovative pipe structures)

- PSFBD as Retrofit for existing power plants (depends on political circumstances)
Many thanks for your attention!

Dipl.-Ing. (FH) Matthias Merzsch
Chair of Power Plant Technology
Brandenburg University of Technology Cottbus – Senftenberg
Telefon: +49 (0) 355 69 4007
E-Mail: matthias.merzsch@b-tu.de