Experiences with the Construction of a Chinese supplied Power Plant in Europe from an Owner's Engineer Perspective

Benedikt Tressner 1)
Georg Kraft 1)
Thomas Will 1)
1) Steinmüller Engineering GmbH, Gummersbach, Germany

Speaker: Thomas Will
Index

1. Introduction
   - Steinmüller Engineering (SE)
   - Development of the Stanari Power Generation Project

2. CFBC Technology at a Glance
   - Technology
   - SE CFBC References

3. Project Execution
   - Project Organisation
   - Selection of the Owner’s Engineer
   - Design
   - Manufacturing
   - Erection
   - Commissioning

4. Conclusion
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
</table>
| 1874 | L. & C. Steinmüller (LCS) Company founded by Lebrecht and Carl Steinmüller  
Development and supply of firing systems, steam generators and flue gas treatment plants over more than 125 years. |
| 2003 | **Steinmüller Engineering GmbH**  
Foundation of a new company by a group of experienced former LCS engineers one year after the insolvency of Babcock Borsig AG.  
Providing engineering excellence to the power industry as consultant and as a reputable solution provider for firing systems, steam generators and flue gas treatment plants. |
| 2014 | **Integration into the IHI Group of Companies**  
Continuing the expansion into the power industry and generating synergies with one of the leading know-how owners in this field of technology. |
| 2015 | **SA Branch**  
Steinmüller Engineering Branch in South Africa since 1st of July 2015  
Address: Building 13, The Woodlands, Woodlands Drive, Woodmead, Sandton 2196 |
Steinmüller Engineering GmbH – Integration into IHI Corporation

IHI Corporation

President and Chief Executive Officer
Tamotsu Saito

Corporate

Sales Headquarters

Global Marketing Headquarters

Energy & Plant Operations
- Aioi Works

Nuclear Power Operations
- Yokohama No.1 Works

Aero-Engine & Space Operations

Rotating Machinery Operations
- Yokohama No.2 Works

Vehicular Turbocharger Operations

Machinery & Logistics Systems

Infrastructure Operations

Offshore Project & Steel Structures Operations

Urban Development Operations

Resources, Energy and Environment

Aero Engines and Space

Industrial Systems and General-Purpose Machinery

Social Infrastructure and Offshore Facilities

Mizuho Works

Kure No.2 Works

Soma No.1 Works

Soma No.2 Works

IHI GROUP
Stanari CFBC Plant, Bosnia Herzegovina – Project Development

Stanari CFBC Plant, Bosnia Herzegovina, 1065 t/h

- Client: EFT Energy Financing Team
- Power trading company
- Owner of lignite mine
- Concept for lignite utilisation by power generation since 2006
- Decision for CFBC in 2009
- Notice to proceed to DEC (Dongfang Electric Corporation) in December 2012
- Commissioning in 2015
- Commercial operation planned for 2016

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<tr>
<td>3</td>
<td>4</td>
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</tbody>
</table>

- Feasibility study and pre-design
- Preparation of RFT 420MW<sub>el</sub>
- Preparation of RFT 330MW<sub>el</sub>
- Bid evaluation
- Basic design review
- Detail design review
- Erection supervision
- Commissioning supervision
Index

1. Introduction
   • Steinmüller Engineering (SE)
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   • SE CFBC References

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   • Project Organization
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   • Manufacturing
   • Erection
   • Commissioning

4. Conclusion
CFBC Technology

Main Equipment

- Combustion chamber
- Cyclones
- Ash return with loop seal
- Convective area
- Air heater
- De-ashing system

Technical Aspects

- Low combustion temperature at ~900°C
- Sufficient residence time for complete combustion due to ash recirculation
- $\text{SO}_x$ reduction by direct desulphurisation with limestone injection into the combustion chamber
- Low $\text{NO}_x$ formation due to low combustion temperatures
- Wide fuel range including low grade fuels

Merkenich CFBC Plant, Germany, 300 t/h
## Comparison of built circulating fluidized bed combustors (CFBC)

<table>
<thead>
<tr>
<th>Power Plant Location</th>
<th>Elberfeld Germany</th>
<th>Merkenich Germany</th>
<th>Do-Derne Germany</th>
<th>Go-Werk Germany</th>
<th>Brilon Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Boiler EPC</td>
<td>Boiler EPC</td>
<td>Boiler EPC</td>
<td>Boiler EPC</td>
<td>Boiler EPC</td>
</tr>
<tr>
<td>Fuel</td>
<td>Hard coal</td>
<td>Lignite (granulate)</td>
<td>Hard coal</td>
<td>Lignite</td>
<td>Wood / bark waste</td>
</tr>
<tr>
<td>net calorific value (ar)</td>
<td>28,650</td>
<td>19,500</td>
<td>20,700</td>
<td>8,845</td>
<td>13,490</td>
</tr>
<tr>
<td>Water-steam system</td>
<td>Benson</td>
<td>Natural circulation</td>
<td>Natural circulation</td>
<td>Natural circulation</td>
<td>Natural circulation</td>
</tr>
<tr>
<td>Steam Parameters</td>
<td>HD</td>
<td>RH</td>
<td>HD</td>
<td>RH</td>
<td>HD</td>
</tr>
<tr>
<td>Mass flow steam</td>
<td>t/h</td>
<td>170</td>
<td>170</td>
<td>300</td>
<td>52</td>
</tr>
<tr>
<td>Pressure at outlet</td>
<td>bar</td>
<td>200</td>
<td>200</td>
<td>124</td>
<td>64,3</td>
</tr>
<tr>
<td>Temperature at inlet</td>
<td>°C</td>
<td>260</td>
<td>260</td>
<td>181</td>
<td>105</td>
</tr>
<tr>
<td>Temperature at outlet</td>
<td>°C</td>
<td>535</td>
<td>535</td>
<td>510</td>
<td>480</td>
</tr>
<tr>
<td>Useful heat</td>
<td>MW</td>
<td>126,4</td>
<td>217</td>
<td>42,4</td>
<td>320</td>
</tr>
</tbody>
</table>

**CFBC Boilers designed by Steinmüller Engineering personnel**
Comparison of built circulating fluidized bed combustors (CFBC)

<table>
<thead>
<tr>
<th>Power Plant Location</th>
<th>Tabor Czech Republic</th>
<th>Neyveli India</th>
<th>BECL India</th>
<th>Stanari Bosnia Herzegovina</th>
<th>Papua Indonesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Consortium Member (Engineering)</td>
<td>Pressure Part Design</td>
<td>Pressure Part Design</td>
<td>Owner's Engineering</td>
<td>License &amp; Basic Engineering</td>
</tr>
<tr>
<td>Fuel</td>
<td>-</td>
<td>Lignite</td>
<td>Lignite</td>
<td>Lignite</td>
<td>Lignite</td>
</tr>
<tr>
<td>Net calorific value (ar)</td>
<td>MJ/kg</td>
<td>16,900</td>
<td>9,370</td>
<td>9,338</td>
<td>9,100</td>
</tr>
<tr>
<td>Water-steam system</td>
<td>-</td>
<td>Natural circulation</td>
<td>Natural circulation</td>
<td>Natural circulation</td>
<td>Natural circulation</td>
</tr>
<tr>
<td>Steam Parameters</td>
<td>HD</td>
<td>RH</td>
<td>HD</td>
<td>RH</td>
<td>HD</td>
</tr>
<tr>
<td>Mass flow steam (t/h)</td>
<td>88</td>
<td>-</td>
<td>845</td>
<td>176</td>
<td>845</td>
</tr>
<tr>
<td>Pressure at outlet (bar)</td>
<td>64</td>
<td>-</td>
<td>173</td>
<td>44</td>
<td>173</td>
</tr>
<tr>
<td>Temperature at inlet (°C)</td>
<td>120</td>
<td>-</td>
<td>215</td>
<td>347</td>
<td>250</td>
</tr>
<tr>
<td>Temperature at outlet (°C)</td>
<td>465</td>
<td>-</td>
<td>540</td>
<td>540</td>
<td>540</td>
</tr>
<tr>
<td>Useful heat (MW)</td>
<td>69</td>
<td>-</td>
<td>630</td>
<td>-</td>
<td>642</td>
</tr>
</tbody>
</table>
Index

1. Introduction
   • Steinmüller Engineering (SE)
   • Development of the Stanari Power Generation Project

2. CFBC Technology at a Glance
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4. Conclusion
Stanari PP – Project Organisation

Key Data of Chinese EPC
Dongfang Electric Corporation (DEC)
- Boiler supply by Dongfang Boiler Group Co. (DBC)
- Turbine and generator supply by DEC subsidiaries
- References for supercritical and ultra-supercritical once through boilers
- One reference for 600 MW subcritical CFB boiler
- Minimum two references for 350 MW subcritical CFB boilers
- Minimum five references for 300 MW subcritical CFB boilers (excluding Stanari)

EFT = Energy Financing Team

- China Development Bank
- EFT (Holding)
- EFT – RUDNIK I TERMOELEKTRANA STANARI D.O.O.
- Project company
  - Owner of the Stanari mine
- Dongfang (DEC)
  - EPC
- AFC / SE
  - Owner’s Engineer
- SGS
  - QI (Manufacturing)
Steinmüller Engineering (SE) as Owner’s Engineer

Reasons for Selection of SE

- Project history
- Experiences with CFB
- Participation in projects with Chinese partners
- Deep know-how in boiler technology
- Knowledge about Chinese CFBC projects outside China

Yuan Bao Shan
New once through boiler for 600 MWₑ Unit
- Year built 1982 by L&C Steinmüller GmbH
- P.F. fired
- Lignite NCV = 12.5 MJ/kg
- Steam capacity 1832 t/h
- Steam parameters:
  - 20.4 / 3.5 MPa
  - 545 / 545 °C

Anhui Ping Shan
Boiler concept study & design review
- P.F. fired Power Plant 2 x 660 MWₑ
- Corner firing system
- Performance coal 21.6 MJ/kg
- Supercritical steam parameters:
  - 27.0 / 5.3 MPa
  - 600 / 600 °C

Wai Gao Qiao
Boiler concept study for 1350 MWₑ Power Plant
Double reheat:
- 30 / 10 / 2.6 MPa
- 600 / 610 / 610 °C
Elevated turbine
Design Phase

Tasks
• Review and approval of basic design including pressure part recalculation and boiler process recalculation
• Review and approval of detail design
• Execution of design review meetings

Examples of Improvements
• Adjustments of the boiler design according to the specified coal
• Adjustment of fuel-oil system according to NFPA
• Optimisation of bunker steel structure
• Optimisation of limestone handling system to ensure 100% redundancy
• Change of the full load case for main fans
• Installation of sootblowers
• Additional manholes for ease of maintainance
• Documentation quality improvement
Manufacturing Phase

Tasks

- Random quality inspections at Chinese manufacturing facilities
- Participation in factory acceptance tests in China
- Assistance to EFT in tender preparation for QA company
- Review of QA company reports and documentation

Examples of Success

- Improvement of manufacturing process
- Improvement of welding performance, corrosion protection and packing
- Increase of tests and inspections on critical components
- High quality of inspection execution and inspection reports of QA company
- Improved quality of QA documents provided by the EPC
- Quality of components delivered to site generally acceptable
Erection Phase (ongoing – nearing completion)

**Tasks**

- Supervision of erection execution according to the EPC contract
- Supervision of QA/QC and HSE measures on site
- Review and approval of design documents for the erection
- Review of erection documents such as: Work Plan Procedures, Welding Specifications, Inspection and Test Plans, test protocols and reports, etc
- Organisation of and attendance at regular on-site progress meetings

**Examples for solved Problems**

- Incorrect execution of fixed and sliding supports
- Incorrect heat treatment and insufficient welding preparation
- Unsuitable arrangement of various manual valves (accessibility, operating issue)
- Insufficient duct manholes (maintenance issue)
- Unsafe lifting equipment

**Achievements**

- The boiler hydro test was successfully completed on time
- The total project is currently more than 3 months ahead of the original schedule
Commissioning Phase (just commenced)

Tasks
- Supervision of pre-commissioning, commissioning and performance test
- Review of operation and maintenance manuals
- Review of commissioning documents such as: Commissioning procedures, handover protocols, test reports, performance test procedures

Examples of Success (until now)
- Precisely defined boiler performance test procedure according to ASME PTC 4
- Extension of measurements during refractory drying
- In general clearer and more detailed procedures
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   - Technology
   - SE CFBC References

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4. Conclusion
Conclusion

- Numerous problems occurred during the course of the project however; these could be solved in a cooperative manner between the parties.
- Design reviews and supervision are required from the very beginning and continuously throughout the course of the project.
- International design codes (such as ASME, NFPA, PED) were agreed for critical equipment instead of local/company standards.
- The quality of manufacturing and erection could be enhanced to an acceptable level.
- Flexibility and high efforts have been demonstrated by DEC to fulfill the time schedule and to incorporate recommendations from the investor and the owner’s engineer for improvements.
- The working atmosphere in the multi-cultural project team was determined by respect and appreciation.

- We are convinced that the Stanari Power Plant will be operable on time and to the investor’s satisfaction.
Thank you for your attention!

We also thank EFT warmly for the kind support and approval of this presentation.

Contact:
Benedikt.Tressner@steinmueller.com
Georg.Kraft@steinmueller.com
Thomas.Will@steinmueller.com
www.steinmueller.com