RELIABLE AND EFFICIENT POWER GENERATION

POWER BOILERS
## TABLE OF CONTENTS

### POWERBLAST BOILERS
ANDRITZ PowerBlast gas boilers use process gases to generate energy in an environmentally friendly process.

### FLUIDIZED BED TECHNOLOGY
ANDRITZ is a leading supplier of plants based on Bubbling Fluidized Bed (BFB) and Circulating fluidized Bed (CFB) technologies for boilers.

### POWERFLUID CIRCULATING FLUIDIZED BED (CFB) BOILER
Unmatched fuel flexibility – from coal and biomass to alternative fuels and wastes.

### ECOFLUID BUBBLING FLUIDIZED BED (BFB) BOILER
Generating power from renewable fuel sources – the fuel flexibility of an ANDRITZ EcoFluid boiler is an inherent feature.

### SELECTED REFERENCES
References and current projects from ANDRITZ in the field of air pollution control technologies.
Fluidized bed technology – Decades of experience

ANDRITZ is a leading supplier of plants based on Bubbling Fluidized Bed (BFB) and Circulating Fluidized Bed (CFB) technologies for boilers. The different technologies are distinguished by capacity, fuel, and application.

Excellent mixing and heat transfer make fluidized bed technology ideal for a wide range of applications. A variety of coals and lignites can be combusted, as well as clean biomass (bark, agricultural, forestry, and sawmill residuals) and many other fuels (demolition wood, refuse-derived fuels, peat, various sludges, etc.).

BFB TECHNOLOGY
In a BFB unit, fuels are thoroughly mixed in a dense suspension of fluidized bed material in the lower furnace. BFB systems operate at a moderately low fluidization velocity and under controlled temperature conditions. Thanks to the large heat capacity of the fluidized bed material, which is mostly sand, the combustion conditions are ideal for biomass and recycled fuels with varying moisture contents. In many installations, various fuels are fired simultaneously.

CFB TECHNOLOGY
With CFB technology, the flue gas velocity in the furnace is higher and the bed is expanded and entrained with the flow. The bed material flows with the flue gas through the furnace, after which the material is separated by cyclones and returned to the lower furnace. CFB technology also allows an extremely wide range of fuels to be fired in the same unit. The efficient mixing and relatively low combustion temperatures contribute to low emissions of carbon monoxide, hydrocarbons, and nitric oxides.

ADVANTAGES OF ANDRITZ FLUIDIZED BED TECHNOLOGIES
- Fuel flexibility
- High burn-out and conversion rates
- Inherently low emissions
- Excellent availability with long continuous operating periods
- Operational flexibility with good load following capability
- Minimal maintenance
- Proven design
EcoFluid BFB boilers

Generating power from renewable fuel sources - the fuel flexibility of an ANDRITZ EcoFluid boiler is an inherent feature.

FLEXIBLE SOLUTIONS

In addition to typical biomass fuels such as wood (chips, bark, forest residues, and sawdust), more recently short-rotation energy crops, sludges, rejects, agricultural wastes, and Refuse-Derived Fuels (RDF) are being introduced as fuel sources. Common characteristics for these fuels are that they are high in volatile matter and have a high variance in moisture content. These alternative fuels require certain considerations in design as well as in the steam output parameters. ANDRITZ has technical solutions for a broad range of fuels that can be burned in an EcoFluid boiler.

SCALABLE AND RELIABLE

EcoFluid boilers can be either top- or bottom-supported, depending on the desired capacity and site conditions. Scalability and ease of construction are enhanced since the main boiler components are designed as modules. The arrangement of all heating surfaces is tailored to the customer’s requirements. The boilers are conservatively designed with regard to materials of construction, location and spacing of heat surfaces, etc. to ensure high plant availability and low maintenance requirements.

An important feature of the boiler is the design of the fluidizing nozzle grid, which distributes the primary air and drains inert, coarse material such as rocks and other impurities. These materials can cause disturbances in the bed fluidization if not removed from the furnace. The ANDRITZ fluidizing grid can be designed with a unique water-cooled or air-cooled structure, providing可靠 and efficient removal of coarse material from the fluidized bed.

FORTUM TERMEST

A.S. PÄRNU, ESTONIA

Fuels
Wood, peat, and natural gas

Technical data
Steam output: 94 t/h (207 klb/hr)
Steam temperature: 525 °C (977 °F)
Steam pressure: 117 bar (1,700 psig)

Features
SNCR and bag filter combined with sorbent injection

BFB APPLICATIONS

<table>
<thead>
<tr>
<th>EcoFluid Biomass fuels concept</th>
<th>EcoFluid Residues and refuse-derived fuels concept</th>
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</thead>
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<table>
<thead>
<tr>
<th>Type</th>
<th>Size range</th>
<th>Main fuels</th>
<th>Secondary fuels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40-420 t/h</td>
<td>Biomass fuels (bark, chips, sawdust), peat</td>
<td>Sludges, demolition wood, agricultural residues, Coal up to 20%, TDF</td>
</tr>
<tr>
<td></td>
<td>(88-925 klb/hr)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>30-100 t/h</td>
<td>RDF, rejects, sludge</td>
<td>Biomass fuels, demolition wood, agricultural residues</td>
</tr>
<tr>
<td></td>
<td>(66-220 klb/hr)</td>
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EFFICIENT AIR POLLUTION CONTROL

Fluidization air (primary air) supplies part of the total combustion air and creates gasification conditions in the lower furnace. The balance of the air (secondary and tertiary air) is injected higher up in the furnace to complete the combustion process. In combination with an adequate reaction time, this reduces CO emissions to low levels, while the gradual addition of oxygen also ensures minimal formation of NOx emissions. Further NOx reduction can be achieved by injecting ammonia into the furnace. This system can also be combined with ChlorOut, a patented process (licence from Vattenfall) that reduces corrosive alkali chlorides as well as NOx in flue gases, effectively reducing fouling and corrosion of the superheaters. These measures provide enhanced steam parameters and boiler reliability using more challenging fuels, while keeping operating costs to a minimum. Particulates are removed from the flue gases in an electrostatic precipitator or fabric filter, depending on customer preference and environmental requirements. Additional emissions control can be achieved via sorbent injection to reduce acid gas emissions (SO2, HCl, Hg, and dioxin/furans).

ECOFLUID FEATURES

- Fuel flexibility
- High efficiency
- High availability
- Modular design
- Low emissions

EcoFluid technology, Fortum, Parnu, Estonia
ASH HOPPER SCREWS
Radiation pass
**PowerFluid CFB boilers**

Unmatched fuel flexibility – from coal and biomass to alternative fuels and wastes. CFB technology is the state-of-the-art technology for multi-fuel combustion.

**FREEDOM OF CHOICE: MULTI-FUEL DESIGN**
This enables the PowerFluid boiler to employ fuels of differing quality and source – giving plant operators the freedom to take advantage of changing market conditions and fuel supplies.

The modular CFB design of an ANDRITZ PowerFluid boiler enables the boiler to utilize conventional and alternative fuels. The core components are standardized to deliver efficient, reliable performance.

In addition, many features can be custom tailored for optimal performance in each installation. In addition to firing conventional fuels (coal, lignite, and biomass), PowerFluid boilers have proven reliable in firing such fuels as biogenous residues, sludge, and rejects or waste fractions with high calorific value (RDF). These can be fired as the primary fuel or in combination with others.

**STORA ENSO, MAXAU, GERMANY**

<table>
<thead>
<tr>
<th>Fuels</th>
<th>Wood, rejects, paper-derived sludge, bituminous coal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical data</td>
<td>Steam output: 198 t/h (436 klb/hr) Steam temperature: 520 °C (970 °F) Steam pressure: 95 bar (1,360 psig)</td>
</tr>
<tr>
<td>Features</td>
<td>Hybrid fuel concept for the treatment of fuels with higher chlorine content</td>
</tr>
</tbody>
</table>

**SUPERIOR ENVIRONMENTAL PERFORMANCE**

The removal of nitric oxides (NOx) and sulfur oxides (SOx) is easily accomplished with CFB combustion. PowerFluid boilers can meet strict emission requirements without adding post-combustion cleaning equipment, such as flue gas desulfurization and selective catalytic reduction systems. The low temperatures and staged combustion in the furnace prevent thermal NOx formation and suppress the oxidation of fuel nitrogen – resulting in low NOx formation and high fuel burn-out rates. Low cost limestone, used as a sorbent in the furnace, captures the fuel’s sulfur components in a simple and efficient manner during the combustion process.

**POWERFLUID FEATURES**

- Multi-fuel combustion
- Highest fuel flexibility
- Inherently low emissions
- High boiler efficiency
- Proven reliability

**CFB APPLICATIONS**

<table>
<thead>
<tr>
<th>PowerFluid</th>
<th>PowerFluid Residues and refuse-derived fuels concept</th>
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<tbody>
<tr>
<td>Conventional fuels concept</td>
<td>refuse-derived fuels concept</td>
</tr>
<tr>
<td>Type</td>
<td></td>
</tr>
<tr>
<td>Size range</td>
<td>50–800 t/h (110–1,760 klb/hr)</td>
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<tr>
<td>Main fuels</td>
<td>Biomass fuels, coal</td>
</tr>
<tr>
<td>Secondary fuels</td>
<td>Sludge</td>
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</tbody>
</table>

**CFB APPLICATIONS**

- Type
- Size range
- Main fuels
- Secondary fuels

The large heat capacity and turbulent intermixing of the fluidized bed compensate for fluctuations in fuel variations and maintain complete combustion, even with low-grade fuels with high moisture and ash contents.
POWERBLAST features

- Fuel flexibility
- High efficiency
- High availability
- Low emissions

PowerBlast boilers
Combustion of process gases with low emissions

Against a background of stricter emission requirements and the desire to reduce operating costs, certain industrial facilities require reliable solutions for the disposal of process gases.

CUSTOMIZED SOLUTIONS
ANDRITZ PowerBlast gas boilers use these process gases to generate energy in an environmentally friendly process. PowerBlast boilers are customized for the combustion of blast furnace gas, coke oven gas, and LD converter gas. There are standardized designs for single-drum concepts, and the El Paso concept for larger units. The PowerBlast boiler offers an efficient solution for converting waste gas into electric power and heat. The high-pressure steam can be fed to a turbine for electricity generation. After partial expansion, the exhaust steam can be used as process steam or for district heating.

VOESTALPINE UNIT 07, LINZ, AUSTRIA

Fuels
Blow furnace gas, coke oven gas, natural gas, and light fuel oil

Technical data
Steam output: 460/422 t/h (1,012/928 klb/hr)
Steam temperature: 543/562 °C (1,010/1,040 °F)
Steam pressure: 142/35.5 bar (2,060/510 psig)

Features
High-pressure system with reheat

APPLICATIONS

<table>
<thead>
<tr>
<th>PowerBlast – Single-drum concept</th>
<th>PowerBlast – El Paso concept</th>
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</thead>
<tbody>
<tr>
<td>Type</td>
<td></td>
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<tr>
<td>Size range</td>
<td></td>
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<tr>
<td>Main fuels</td>
<td></td>
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<tr>
<td>Reheat</td>
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PowerBlast boilers are flexible by design in handling a wide range of process gases with different heating values and compositions. Advanced multi-burner technology helps the boilers achieve extremely low emissions. The El Paso concept can incorporate a reheat system to attain the highest efficiencies. As a result of ANDRITZ’s years of experience with blast furnace gas firing in combination with modern engineering tools and design methods, customers can benefit from know-how at the highest technological standard.
**ANDRITZ Power Plant Service**

**for fluidized bed technologies:**

**extend asset life and lower cost**

Put our in-depth knowledge of fluidized bed technologies and years of experience to work at your plant to get the maximum return out of your investment.

Our ANDRITZ Power Plant Service specialists are skilled in helping you upgrade and renew the essential components of your bubbling fluidized bed (BFB) or circulating fluidized bed (CFB) boiler. With our wide range of value-added service, replacement parts, enhancements and upgrades, we can improve your plant’s performance and reliability.

- ANDRITZ specialists engineer and deliver Replacement™ pressure parts such as the double-pitch superheater or the bed material heat exchanger that offer much more than traditional replacements.
- ANDRITZ offers retrofit solutions such as Advanced bed material recirculation that can be tailored to any boiler’s combustion requirements to optimize air flows, remove coarse impurities and ensure homogenous fuel intake.
- In order to reduce NOx emissions, ANDRITZ ensures exact control of the firing process through air staging or installs SNCR technology to reduce emissions even further.
- Where corrosion cannot be totally avoided, ANDRITZ offers proven upgrade solutions such as sulphur dosing and ChlorOut® to dramatically slow the process.

Whether you want to reduce emissions and minimize corrosion or integrate challenging fuels, ANDRITZ can be by your side in an instant, either physically or through remote diagnostics.

### Selected References

- **IGGESUND WORKINGTON, UK – ECOFLUID BFB BOILER**
  - Steam conditions: 195 t/h (4,000 klb/hr), 540 °C (1,004 °F), 102 bar (1,480 psig)
  - Fuel: Forest residues, recycled saw-mill chips, bark, sludge, sawdust
  - Start-up year: 2013

- **HÄMEENKYRÖN VOIMA, FINLAND – ECOFLUID BFB BOILER**
  - Steam conditions: 105/115 t/h (232/253 klb/hr), 510 °C (950 °F), 85 bar (1,230 psig)
  - Fuel: Forest residues, bark, sawdust, peat, natural gas for start-up
  - Start-up year: 2012

- **STORA ENSO, MAXAU, GERMANY – POWERFLUID CFB BOILER**
  - Steam conditions: 198 t/h (437 klb/hr), 520 °C (968 °F), 95 bar (1,378 psg)
  - Fuel: Coal, bark, rejects
  - Start-up year: 2010

- **ADULARYA, YUNUS EMRE, TURKEY – POWERFLUID CFB BOILER**
  - Steam conditions: 440/414 t/h (970/913 klb/hr), 543 °C (1,009 °F), 139/37 bar (2,016/537 psg)
  - Fuel: Lignite
  - Start-up year: 2013

- **PROPOWER, EISENHÜTTENSTADT, GERMANY – POWERFLUID CFB BOILER**
  - Steam conditions: 176 t/h (388 klb/hr), 470 °C (878 °F), 70 bar (1,015 psg)
  - Fuel: RDF, rejects, sludge, coal, Light fuel oil
  - Start-up year: 2011

- **BOLLNÄS ENERGI, SWEDEN – ECOFLUID BFB BOILER**
  - Steam conditions: 467 t/h (1,030 klb/hr), 562 °C (1,043 °F), 143 bar (2,074 psig)
  - Fuel: Forestry wood, bark, peat, wood pellets, wood dust, bituminous coal
  - Start-up year: 2016

- **RIIKINVOIMA, FINLAND – POWERFLUID CFB BOILER**
  - Steam conditions: 71 t/h (156 klb/hr), 500 °C (932 °F), 85 bar (1,233 psig)
  - Fuel: RDF, Light fuel oil
  - Start-up year: 2016

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**ANALYSE OPERATIONS**

- **ASSESS CONDITION OF EQUIPMENT**
- **ADVISE HOW TO IMPROVE EFFICIENCY / PERFORMANCE**
- **INSTALL EQUIPMENT (IF NEEDED)**

**We are passionate about engineering success for our customers: Let us help you engineer it!**

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**BENEFITS OF ANDRITZ SERVICE**

- Efficient production
- Increased throughput
- Increased reliability and availability
- Reduced Total Cost of Ownership
- Shorter/more effective shutdowns
- Longer service intervals
- Improved safety
- Increased energy efficiency
- Minimized emissions

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ANDRITZ POWER PLANT SERVICES

With service and manufacturing centers around the world, ANDRITZ is well-positioned to offer full support before, during, and after the installation of its products. The goal is to achieve the highest overall production efficiency (OPE) of a power plant by increasing safety, availability, efficiency, and throughput over the entire life-cycle.

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