

A photograph of an industrial facility, likely a power plant or refinery. In the foreground, a large, horizontal, cylindrical metal structure, possibly a boiler or heat exchanger, is supported by a metal truss bridge over a body of water. The water reflects the sky and the structures. In the background, there is a large, multi-story brick building with a prominent tower and a spire. To the left of the brick building, there are several large, vertical, cylindrical storage tanks. A tall, thin smokestack is visible on the right side of the image. The sky is clear and blue.

Doosan Lentjes

Circulating Fluidised Bed Boiler Technologies



Doosan Lentjes is a global leader in circulating fluidised bed (CFB) boiler technologies. Our expertise gives you access to advanced, efficient and environmentally sound steam generation solutions that cater to a range of fuel types – delivering reliability and performance when fuel flexibility is critical to your project's viability.

Shaping the future of CFB boiler technology

Doosan Lentjes, part of the global Doosan Group, has pioneered the development of CFB boiler design for almost 40 years. In 1981, we designed, built and commissioned the world's first commercial CFB boiler, featuring the first fluidised bed heat exchanger (FBHE) at a multi-fuel-fired industrial power plant located in Germany.

Our predecessor company filed the basic CFB boiler patents for power plant applications in 1976, so we are the Original Equipment Manufacturer (OEM) of this technology. Given this background, we have extensive experience in providing flexible combustion solutions for a wide range of fuel types.

Our proven track record in designs up to 300 MW_e (~700MW_{th}) reflects the reliable performance of our CFB boilers generating power at more than 110 plants around the world.

What's more, our commitment to improving the value and performance offered by our CFB boilers through investment in new technologies and super and ultra-supercritical capabilities will ensure that we continue to be at the forefront of CFB boiler development, shaping the future of reliable steam generation.

1976

Basic CFB boiler patents for power plant applications were filed

1981

Doosan Lentjes designed, built and commissioned the world's first commercial CFB boiler

Our reliable and cost-competitive CFB boilers generate power at more than **110 plants** around the world.

We put efforts in developing our advanced technologies to shape the future of CFB boiler solutions

Original Equipment Manufacturer (OEM)

In 2016, Doosan Lentjes proudly invited a range of high-ranking professionals from across the circulating fluidised bed (CFB) environment on the occasion of the 40th anniversary of the filing of the basic CFB combustion patents for power plant applications from the firm's predecessor company in 1976.



Delivering flexibility and availability on utility-size circulating fluidised bed (CFB) boilers.

Getting the most from your fuel

Our utility-size CFB boilers focus on high-efficiency generation of power and heat on an environmentally friendly basis. Understanding that your project success can demand the use of poor quality fuels, we are proud to possess a long and proven track record for the combustion of a wide range of fuels, from the straightforward to the most difficult applications.

We have developed our CFB boiler technology for the combustion of a broad range of fuels, but especially for those with difficult combustion properties, such as, low calorific and low reactive values or fuels with low ash melting temperatures.

Examples include:

- High moisture / low calorific fuels (down to 1000 kcal/kg)
- High ash coals (lignite and bituminous)
- Low volatile fuels (e.g. anthracite, petcoke)
- High sulphur coals
- Biomass co-combustion
- Coal to biomass conversion

The challenges of such fuels lie in the handling and processing of the resulting ash, as well as, effective combustion. We have bespoke systems designed to avoid hang up and blockage of handling systems and combustion of fuels where volatile, fixed carbon, ash or moisture levels normally make reliable power generation impossible. More specifically, our CFB process has been tailored to operate with high efficiency cyclone and fluidised bed heat exchangers (FBHE) allowing for:

- Efficient ash recirculation with circular cooled cyclones to ensure efficient burn out
- Efficient temperature control by controlled cooling of recirculated ash, ensuring optimal desulphurisation, burn out and low NO_x formation, resulting in lowest gaseous emissions
- Controlled flow of recirculated ash through the FBHEs and heat exchange respectively, allows for high load flexibility without the need for support fuel, which is essential for meeting varying grid demands

Even with the most difficult and abrasive fuels, our unique Spiess Valves have been developed as robust and reliable devices to ensure safe control of the ash flow through the FBHE thus allowing greater fuel flexibility.



Design

Utility-size circulating fluidised bed

Fuels

All kinds of biomass, coals, waste coals, coal residues, pet coke, as well as, co-firing

References

Over 110 units in operation worldwide

Global experience



Honshu Paper, Japan
126 MW_{th}



Twin Oaks, USA
2 x 474 MW_{th}



Berlin, Germany
242 MW_{th}

Over 110
global
references

More than
22 GW_{th}
installed
capacity

Our combustion solutions help you achieve all your economic and environmental objectives.

Cost-efficient and clean solutions

Compared to other technologies, such as, pulverised coal, our CFB boiler technology is inherently flexible and cost-effective due to the reduced requirement for air quality control systems for SO_x/NO_x emissions control. In addition to this, we have focused on further optimising costs by developing:

- A less expensive, integrated design for minimal boiler footprint
- Standardisation of materials and maximisation of more cost-effective supply chain; and
- Development of supercritical and ultra-supercritical designs

We continue to focus on delivering a range of cost-competitive solutions that maximise availability, reliability and efficiency, while minimising emissions, making us the technology provider of choice for plant operators around the world.

Our CFB boiler technology also offers cleaner, integrated, best-in-class emissions control. More than 90% of the sulphur dioxide (SO₂) released during combustion can be captured by adding limestone to the CFB furnace. The comparatively low and controlled combustion temperature of 850°C and the staged air supply further prevent the formation of thermal NO_x. This negates the need for separate external flue gas desulphurisation and DeNO_x for a wide range of fuels, while still complying with the strictest emissions regulations.

In addition to the effective reduction of SO_x/NO_x emissions, our utility-size CFB boiler technology offers the additional benefit of a cleaner carbon footprint through co-combustion of biomass/biofuels (including waste wood, sawmill residues and green wastes) with a track record in biomass for co-combustion and use as a single fuel.





**Doosan Headquarters,
Changwon, Korea**



**Doosan Vina,
Vietnam**



**Doosan Chennai,
India**

Covering the entire EPC value chain

Part of a strong global corporation

As a fully integrated part of the global, Korea-based Doosan Group, we are in a position to deliver complete process solutions or full turnkey projects from one single source which makes us a reliable one-stop partner for even the most challenging energy generation requirements.

With Doosan's global network, we combine international market know-how with German state-of-the-art engineering — a winning combination for providing innovative solutions for customers the world over.

As a member of Doosan, we benefit from international sourcing and manufacturing capabilities. High quality workshops under the full control of Doosan in Changwon/Korea, Chennai/India and Vina/Vietnam provide best practice procurement of goods and services while maintaining and ensuring compliance with laws, regulatory guidelines and internal control procedures. Procurement hubs in Beijing and Shanghai/China underline our efforts to deliver cost optimised solutions.

Drawing on these extensive in-house capabilities, we are in a position to cover the entire EPC value chain:

- Project management and project control
- Design and engineering
- Manufacturing
- Procurement and logistics
- Construction and commissioning
- Quality, health, safety and environment

Flexible EPC partnering approach

Among extensive in-house EPC capabilities, we can also cooperate with internationally experienced and competent general contractors enabling us to flexibly meet different customer requirements on various global markets. Our vast experience in fruitfully collaborating with global EPCs helps us ensure a successful project execution that reliably meets both quality and time targets.



Twin Oaks, USA

Highest CFB plant availability

Fuels:

Lignite (test operation on pet coke)

Technical data:

Electrical capacity: 2 x 175 MW_e

Thermal capacity: 2 x 474 MW_{th}

Live steam: 500 / 448 t/h; 540 / 540°C; 129 / 27 bar

Doosan Lentjes was awarded the contract by Texas New Mexico Power Commission to provide circulating fluidised bed (CFB) boiler technology, including extended basic engineering and supply of special equipment for the Texas-based power plant running on lignite. Commissioned in 1990, the plant was the world's largest and most modern CFB plant.

Thanks to its flexible design, the boiler can reliably burn other fuels, demonstrated through long-term test operation on pet coke while simultaneously delivering on the most stringent environmental targets. Both the excellent environmental performance and efficiency of the plant were the reasons why the power station won the International Power Plant Award, granted by the renowned magazine Power International.

Twin Oaks is participating in the NERCA program comparing the performance of US-based power plants. In doing so, Twin Oaks has achieved outstanding results in terms of availability since the plant commissioning.



Starobeshevo, Ukraine

Long-running, outstanding performance

Fuels:

Anthracite, anthracite sludge

Technical data:

Electrical capacity: 1 x 210 MW_e

Thermal capacity: 1 x 616 MW_{th}

Live steam: 670 / 538 t/h; 545 / 542°C; 134 / 25 bar

In 2000, Donbasenergo awarded **Doosan Lentjes** the contract to provide the circulating fluidised bed (CFB) boiler island, including design, supply, construction and commissioning for the Starobeshevo anthracite-fired power station, located in the Ukraine.

The boiler applies the economic, bottom supported integrated design, incorporating water-cooled fluidised bed heat exchangers and seal pots. This optimised plant arrangement helps to substantially reduce space requirements which is a critical success factor to reduce the investment costs.



Experts across biomass fuels

Thanks to its flexibility, the CFB technology can also burn sustainable fuels, such as, biomass which helps to reduce future reliance on conventional fuels while improving the environmental performance of your plant.

Green energy concepts

The combustion of biomass as an ecologically acceptable energy source helps to implement sustainable energy concepts shaping a greener and cleaner planet for generations to come. This practically CO₂-neutral fuel reduces the ecological footprint by 10 to 15 times compared to electricity generated from coal while delivering on efficiency targets. Both are critical factors to ensure a reliable power supply in the long-term and compliance with even the most stringent environmental standards – now and in the future.

Individual design adaption

At Doosan Lentjes, we understand that there are different types of biomass ranging from clean, relatively safe wood and forest residues to highly corrosive demolition wood and high alkali agricultural products. Depending on its respective characteristics, we know that each type of biomass requires the CFB design to be individually adapted which is why we are proud to provide our customers with tailor-made solutions that can flexibly meet the most demanding combustion requirements of your individual biomass. With more than 25 years of global biomass experience including new build and conversion projects, we are a competent partner for sustainable energy generation solutions of tomorrow.

Flexible CFB combustion across fuel range

Given the background of the CFB combustion patent event held at Doosan Lentjes in 2016, Dr. Ludolf Plass, former patent holder, outlined why the CFB boiler technology is the solution of choice for future fuel challenges:

“Plant operators face demanding future challenges in terms of their used fuel types, as well as, framework conditions which means power production plants need to be flexible when it comes to efficient combustion of changing fuels – even those with the most difficult properties. CFB plants can reliably deliver on these requirements making them the solution of choice for both efficient and environment-friendly future energy generation.”

Efficiency
meets
sustainability

More than
25 years of
experience

90%
reduction of
the ecological
footprint



Biomass references

Strongoli, Italy

New build

Fuels:

Italian and imported biomass

Technical data:

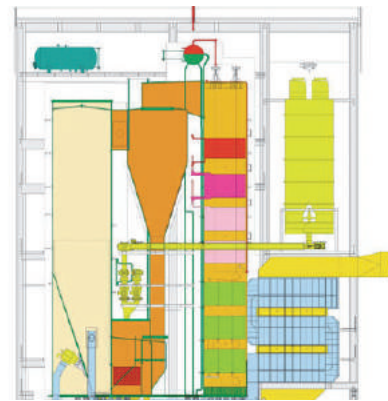
Electrical capacity: 2 x 23 MW_e

Thermal capacity: 2 x 68 MW_{th}

Live steam: 81 t/h; 515°C; 95 bar

In 2000, **Doosan Lentjes** was awarded the contract by Biomasse Italia to design and construct two biomass-fired boilers on a turnkey basis for the Strongoli power station located in Calabria, Italy. Both biomass boilers feed one single turbine. The scope of work included basic and detail engineering, as well as, the supply of the CFB boilers inclusive of auxiliaries.

The project supported Italy in its efforts to achieve a CO₂ neutral energy generation which is a critical part in implementing Kyoto requirements that had been internationally agreed in 1997.



Gardanne, France

Biomass conversion

Fuels:

Biomass, waste wood (11%-th), discard coal (13%-th)

Technical data:

Electrical capacity: 1 x 170 MW_e

Thermal capacity: 1 x 386 MW_{th}

Live steam: 441 t/h; 566°C; 165 bar

Together with its European Doosan partners, **Doosan Lentjes** was responsible for a major biomass retrofit, conversion and turbine upgrade project at E.ON France's coal-fired CFB power station located in Gardanne, Provence. Doosan Lentjes, which supplied the original CFB equipment for the plant in 1992, delivered both an advanced CFB solution enabling the plant operator to efficiently and sustainably generate energy from its biomass fuel, as well as, a reliable flue gas cleaning system. At the same time, Doosan's turbine specialist, Doosan Skoda Power was managing the turbine renovation while Doosan Babcock provided technology for boiler upgrades and plant lifetime extension up to 20 years.

Doosan's integrated solution provided from one reliable, single source helped to create France's largest biomass-fired power station to date as part of the E.ON Group's "cleaner, higher performance energy" strategy. In comparison to the former lignite and coal-fired operation, this investment will reduce the CO₂ balance by 600,000 tons per year – a milestone to keep our planet green and clean in the future.



Working together for tomorrow

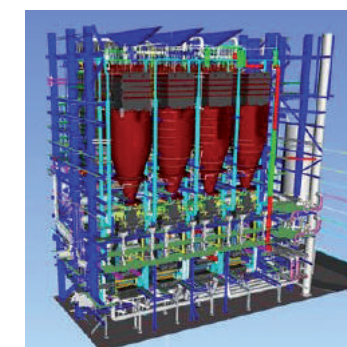
Together with you, we aspire to create a cleaner and greener environment for future generations. With this in mind, we continue to invest in research and development activities that provide our customers with unique and modern technologies. As the global centre of competence for CFB boiler technologies within Doosan Heavy Industries & Construction, we are at the forefront when it comes to new market trends and innovative solutions.

USC-CFB technologies

Together with our colleagues at Doosan Heavy Industries & Construction, our focus is on developing advanced CFB boiler technology capabilities for supercritical (SC) and ultra-supercritical (USC) steam conditions with output of up to 600 MW_e per unit. In contrast to subcritical natural circulation cycles, USC steam conditions achieve net efficiencies of up to 45%. In response to global aspirations to save resources and minimize the environmental impact of power generation facilities, this helps to optimise the use of coal. Simultaneously, emissions and the requirements for consumables used for air pollution control equipment, such as, limestone, are reduced.

People-powered

Because Doosan understands that sustainable business success depends on people performance, it defined its global 2G strategy meaning that growth of people leads to growth of business and vice versa. We, at Doosan Lentjes, strongly believe in this approach which is why we put extensive efforts in recruiting, training and developing the very best talents of tomorrow. Together with our well-committed people, we continue to engineer safe and reliable energy generation solutions that shape a sustainable tomorrow for generations to come.



Your benefits with us at a glance

Customer-orientation

World-class technologies and innovation

Global reach

- Excellent engineering competence combined with vast experience in international project management
- World-class CFB combustion solutions across a wide range of fuel types with even the most demanding properties
- Together with the global Doosan Group, one-stop shop for all energy generation requirements
- Almost 40 years of experience in CFB technology across utility and industrial applications around the world
- Provision of cost-effective and tailor-made solutions from one reliable single source
- Flexible EPC partnering approach
- Reduced investment costs through an integrated plant design with reduced space requirements
- International sourcing and in-house manufacturing capabilities with high quality workshops under the full control of Doosan
- Cost-efficient constructability through modular designs that can be flexibly adapted to individual requirements
- Integrated, best-in-class emissions control, delivering on the most demanding environmental objectives
- High plant availability
- Innovative and tailor-made solutions through continuous investments in in-house research and development activities
- Tailor-made after sales services encompassing maintenance, modernisation and optimization

CFB in 360° at Doosan Lentjes

Visit our homepage and take a virtual journey through our CFB facilities around the world – a great opportunity for you to experience our reference plants in an impressive 360° environment and convince yourself of our capabilities! To start the tours, please type the address below in your internet browser and open the Virtual Doosan World.

www.doosanlentjes.com

Doosan Lentjes

Doosan Lentjes is a global provider of processes and technologies for energy production from sustainable and conventional fuels. Our specific areas of expertise include circulating fluidised bed boilers, key technologies for the generation of energy from waste and sewage sludge, as well as, flue gas cleaning systems. We have been pioneering energy solutions for 90 years and convert millions of tonnes of waste into energy every year.

Doosan Lentjes is part of a powerful combination of companies united under the Doosan Group to deliver complementary technologies, skills and value to customers the world over.



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