

Boiler

Doosan owns core technologies and carries out ongoing development with extensive boiler portfolio that includes conventional PC, oil/gas, down-shot and fluidized bed models for thermal power plants.

We boast the technology to design eco-friendly models with:



HIGHER BOILER EFFICIENCY

Doosan supplied best-in-class 274 atg, 613/624°C USC boiler. Doosan boiler provides the lowest OPEX to customers with the highest steam condition and boiler efficiency.



FLEXIBLE & RELIABLE OPERATIONS

Doosan's state-of-the-art boiler technologies allow stable boiler operation even at low and medium loads. In addition to this set of technologies, Doosan's digital solutions reinforce the flexible and optimized operation modes.



WIDER FUEL FLEXIBILITY

Doosan has an extensive line up of boilers and burners, which enables flexible responses to various needs of customers.



ECONOMICAL CAPEX

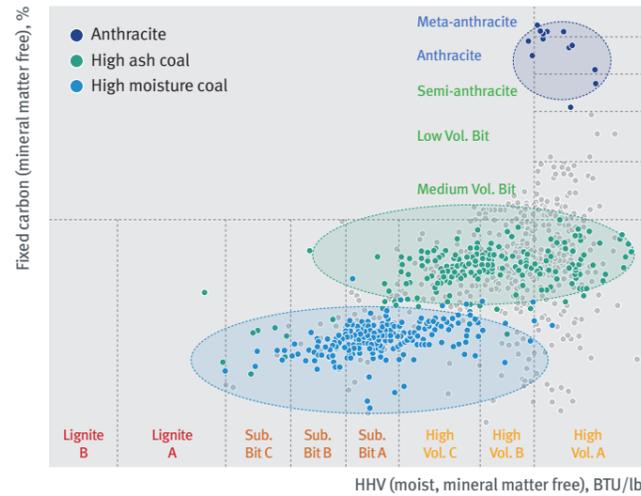
Doosan supplies best-quality boilers at the most competitive prices in the industry to meet customer expectations with its advanced technologies, smart manufacturing facilities and global supply chain.

FUEL EXPERIENCE & CAPABILITY

Doosan is a total solution provider with extensive project experiences in all types of fuel, including a wide range of coals and other fuels such as oil & gas and biomass.

 <p>COAL</p> <ul style="list-style-type: none"> • Anthracite • Bituminous • Sub-bituminous • Lignite 	 <p>OIL</p> <ul style="list-style-type: none"> • Heavy fuel oil • Crude oil • Light fuel oil • Vacuum residual oil 	 <p>GAS</p> <ul style="list-style-type: none"> • Natural gas • Blast furnace gas • Coke oven gas 	 <p>BIOMASS</p> <ul style="list-style-type: none"> • Wood pellet • Wood chip
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In particular, we are a specialist in providing the right solutions for special coals, such as low volatile matter coal (anthracite), high moisture (> 30%) coal, and high ash (> 35%) coal.



- Anthracite (Low Volatile Matter)**
 - Yue Yang (362MW X 2), China
 - Heze (300MW X 2), China
 - Wang Qu (600MW X 2), China
 - Liaocheng (600MW X 2), China
 - Pha Lai (300MW X 2), Vietnam
 - Mong Dung 2 (560MW X 2), Vietnam
- High Ash Coal**
 - Raipur (685MW X 2), India
 - Kudgi (800MW X 3), India
 - Lara (800MW X 2), India
 - Obra C (660MW X 2), India
 - Jawaharpur (660MW X 2), India
 - Haduaganj (660MW X 1), India
- High Moisture Coal**
 - Gheco 1 (700MW X 1), Thailand
 - Erickson (160MW X 1), USA
 - San Miguel (442MW X 1), USA
 - Vinh Tan 4 (600MW X 2), Vietnam
 - Vinh Tan 4 Extension (600MW X 1), Vietnam
 - Nghison 2 (600MW X 1), Vietnam
 - Song Hau 1 (600MW X 2), Vietnam

HISTORY

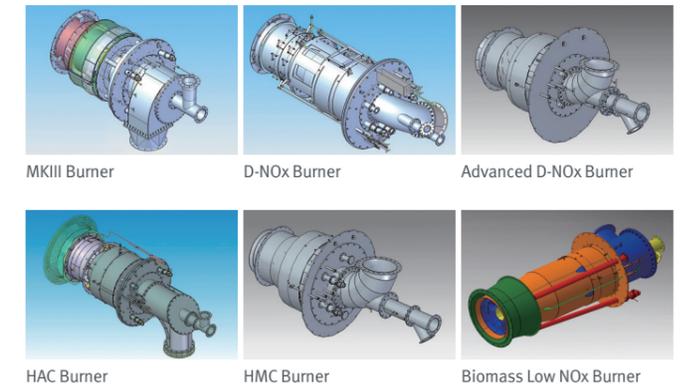
<p>Doosan Babcock</p> <ul style="list-style-type: none"> 1891 • Babcock and Wilcox established 1947 • Subcritical boiler (CARRINGTON 4 x 65MW U.K.) 1960 • First Supercritical boiler (DRAKELOW 1x375MW U.K.) 1978 • Largest Subcritical boiler (DRAX 6x660MW U.K.) 2000 • First Posiflow Subcritical once through boiler (YAOMENG 1x300MW China) 2006 • Acquired by Doosan and renamed "Doosan Babcock" 	<p>Doosan Heavy Industries</p> <ul style="list-style-type: none"> 1962 • Doosan Heavy Industries established 1979 • The first bituminous coal-fired boiler (Samcheonpo #1/2, 560MW, 178atg, 541°C / 541°C Korea) 1993 • The first supercritical boiler in Korea (Hadong #1/2, 500MW, 255atg, 541°C / 541°C Korea) 2004 • The first supercritical boiler in India (660MW, 255atg, 541°C / 568°C Sipat, India) 2010 • The largest oil-fired boiler (700MW, 176.5atg, 541°C / 539°C Rabigh, Saudi Arabia) 2011 • The highest steam condition (1,000MW, 274atg, 613°C / 624°C Shinboryeong, Korea) 2017 • Biomass-firing CFB (75MWe Sodegaura, Japan) 2018 • USC boiler (1,050MW, 262atg, 603°C / 613°C Samcheok, Korea) 	<p>Doosan Lentjes</p> <ul style="list-style-type: none"> 1928 • Ferdinand Lentjes established 1982 • World's first commercial CFB boiler (VAW Lunen, Germany) 1985 • The first CFB with 100MWe and reheat (Duisburg, Germany) 1989 • The first cooled cyclone (196 bar, 540°C Berlin, Germany) 1995 • The largest CFB (250MWe, 169 bar, 565°C Gardanne, France) 2010 • The largest CFB in India (2 x 250MWe Neyveli, India) 2011 • Acquired by Doosan and renamed "Doosan Lentjes"
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BURNER

Doosan is a pioneer in the technologies and trusted partner for the delivery of reliable and efficient steam production. More than a century of experience in burner design enables us to supply combustion technologies that maximize plant performance. We are also able to undertake a full range of projects, from retrofits and upgrades to a full boiler new build.

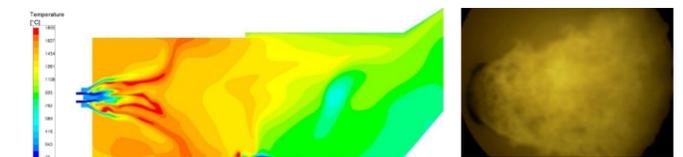
Burner Line-up

- Coal:** Provide the best solution of coal burner to consider coal characteristics
 - Advanced D-NOx burner, D-NOx burner, MKIII burner: Subbituminous~bituminous coal
 - High ash coal (HAC) burner: High ash contents coal above 40% (e.g. Indian Coal)
 - High moisture coal (HMC) burner: High moisture contents coal above 30%
- Oil/Gas:** Provide the optimum oil & gas or combination firing solution
- Biomass:** Provide the renewable fuel firing solution
 - Biomass low NOx burner



Reliability of Burner Performance

We guarantee the best burner performance, based on our advanced technology, state-of-the-art modeling and full-scale burner tests.



MILL

Based on a profound understanding of the mill industry, Doosan offers a full range of mill types, including vertical spindle, tube and hammer mills, along with classifier options. This enables to meet customer requirements with higher efficiency and wider fuel flexibility. we handle all types of solid fuels and fuel blends used in power generation.

Key Features

- Fuel Range : A variety type of coal, wood pellet
- Capacity : 8 ~ 240 t/h
- Fineness : 70 ~ 90% pass through 200 mesh screen
- Classifier Type : Static, dynamic, and dynamic + static
- Rated Motor Capacity : 50 ~ 1,800 kW

Advantage of Dynamic Classifier

- Rotor + swirl vanes
- Control of speed of rotation to control
- High separation efficiency of coarse

References of wood pellet project with vertical spindle mill*

- Ameger, Denmark – 80MW, Straw pellet / Wood pellet
- Avedore, Denmark – 200MW, Wood pellet
- Yeongdong, Korea – 125 MW, Wood pellet

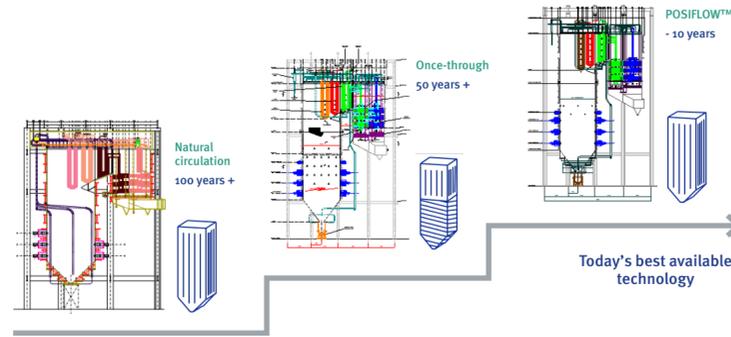
*Doosan licensed with Loesche in Vertical Spindle Mill

Vertical Spindle Mill Dynamic Classifier

Conventional PC Boiler

Conventional pulverized coal (PC) boilers are used in most thermal power plants as the most common way of burning coal in different types of boiler. Recent market requests higher steam conditions in order to minimize OPEX. Doosan has met this needs by boilers to ultra-supercritical once-through boilers with eco-friendly power generation technology, including low NOx emissions and low unburned carbon with minimized excess air.

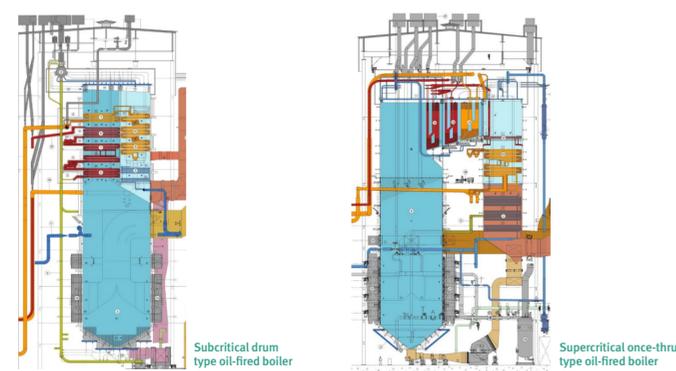
Circulation System Development History



Oil/Gas Boiler

Doosan has a long and successful history in oil/gas-fired power plants, offering customers high quality, low prices and fast delivery in markets ranging from the Middle East to Asia and Africa. New fuels, such as HFO and mazut oils, have high vanadium and sulfur contents, which causes both high and low temperature corrosion. This in turn means that a fuel additive system may be required. Doosan continues to develop technologies for high steam pressures and temperatures, low emissions (especially NOx) and anti-corrosive fuel additives.

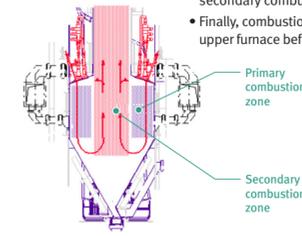
Typical Arrangement



Downshot Boiler

Downshot boilers are employed principally for the firing of fuels with lower volatile contents, typically 10% (dry ash free) or less. A special burner and furnace arrangement ensure long residence times in the high temperature flame zone, and result in combustion efficiencies which substantially exceed those achieved via other firing methods. Doosan owns the original technologies for this method, and continues to develop them to help clients who have issues with fuels which are difficult to handle. We have built 80 downshot boilers - 9,275MWe of capacity manufactured since 1948, with almost 5,000MWe manufactured since 1990.

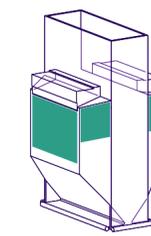
Prolonged Residence Time W-shape Flame



- Downward shot PC makes W-shape flame
- Early ignition is established at the primary combustion zone
- Char burnout takes place at the secondary combustion zone
- Finally, combustion is completed at the upper furnace before exit

Refractory Coverage

- Individual tiles are fitted securely to the primary combustion zone surrounding the flame for added flame stability and reduced furnace heat absorption to give more heat to the fuel particles



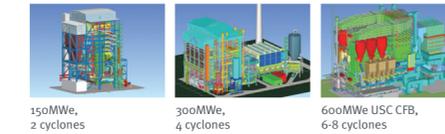
CFB Boiler

Circulating fluidized bed (CFB) combustion is used for a broad range of fuels, but especially for fuels with difficult combustion properties, including low calorific and low reactive values, and fuels with a low ash melting temperature. CFB combustion is inherently flexible and cost-efficient because there is less need for air quality control systems for SOx/NOx emissions. Doosan has provided reliable, high quality CFB boilers, including biomass firing, generating power up to 300MWe, for more than 110 plants around the world.

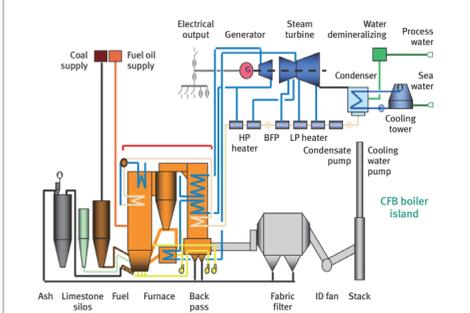
Key Benefits

- Excellent engineering competence with extensive experiences
- World-class CFB combustion solutions for various fuel types
- Effective reduction of SOx/NOx emissions (in most cases, external SOx/NOx emissions control is not required)
- Cost-efficient constructability thanks to modular designs
- In-house manufacturing capabilities
- Reduced investment costs thanks to an integrated plant design which requires less space

CFB Boiler Line-up



Typical Schematic Diagram of CFB Boiler Plant



Recent References



Shinboryeong Korea

Capacity	1,000MWe x 2
Customer	KOMIPO
Contract Award	Nov. 2011
COD	Jun. 2016
Fuel	Sub-bituminous coal HHV = 5,600 kcal/kg (Min. 5,200 kcal/kg) Moisture = 17% (Max. 22%) Ash = 7.8% (Max. 18.1%)
Type of Boiler	PC boiler (opposed firing) Ultra supercritical pressure Once-thru Balanced draft
Steam Condition	SH 613°C / RH 624°C, 274atg



Vinh Tan 4 Vietnam

Capacity	600MWe x 2
Customer	EVN
Contract Award	Feb. 2014
COD	Dec. 2017
Fuel	Blending coal (Sub. Bit & Bit) HHV = 4,797 kcal/kg (Min. 4,400 kcal/kg) Moisture = 27.4% (Max. 33.2%) Ash = 4.9% (Max. 8%)
Type of Boiler	PC boiler (opposed firing) Supercritical pressure Once-thru Balanced draft
Steam Condition	SH 569°C / RH 594°C, 252.8atg

Recent References



Rabigh Power Plant No.2 Saudi Arabia

Capacity	700MWe x 4
Customer	SEC
Contract Award	Sep. 2010
COD	Nov. 2014
Fuel	HFO 380 HHV = 10,000 kcal/kg Sulfur = 3.7% (Max. 3.7%)
Type of Boiler	Oil boiler (opposed firing) Subcritical pressure Drum Balanced draft
Steam Condition	SH 541°C / RH 539°C, 176.5atg



Ain Sokhna Egypt

Capacity	650MWe x 2
Customer	EDEPC
Contract Award	Feb. 2010
COD	Jan. 2014
Fuel	Mazout oil HHV = 10,032 kcal/kg Sulfur = 3.5% (Max. 3.5%) Natural gas
Type of Boiler	Oil & gas boiler (opposed firing) Supercritical pressure Once-thru Forced draft
Steam Condition	SH 540°C / RH 540°C, 264.5atg

Recent References



Mong Duong II Vietnam

Capacity	600MWe x 2
Customer	AES-VCM
Contract Award	Dec. 2010
COD	Nov. 2014
Fuel	Anthracite HHV = 4,630 kcal/kg (Min. 4,228 kcal/kg) Volatile matter = 5-7 % Ash = 31-38 %
Type of Boiler	PC boiler (downshot firing) Subcritical pressure Drum Balanced draft
Steam Condition	SH 569°C / RH 569°C, 174.5atg



Zhenxiang China

Capacity	600MWe x 2
Customer	HBC for Huadian Company
Contract Award	Mar. 2007
COD	Dec. 2011
Fuel	Anthracite HHV = 5,630 kcal/kg (Min. 5,269 kcal/kg) Volatile matter = 5-9-6.3 % Ash = 20-30 %
Type of Boiler	PC boiler (downshot firing) Supercritical pressure Once-thru Balanced draft
Steam Condition	SH 569°C / RH 569°C, 250.7atg

Recent References



Starobeshevo Ukraine

Capacity	210MWe x 1
Customer	Donbasenergo
Contract Award	Apr. 2000
COD	2005
Fuel	Anthracite coal LHV = 5,600 kcal/kg Volatiles = 4% Ash = 16.7%
Type of Boiler	Circulating fluidized bed boiler Subcritical pressure Drum Balanced draft
Steam Condition	SH 545°C / RH 542°C, 134atg

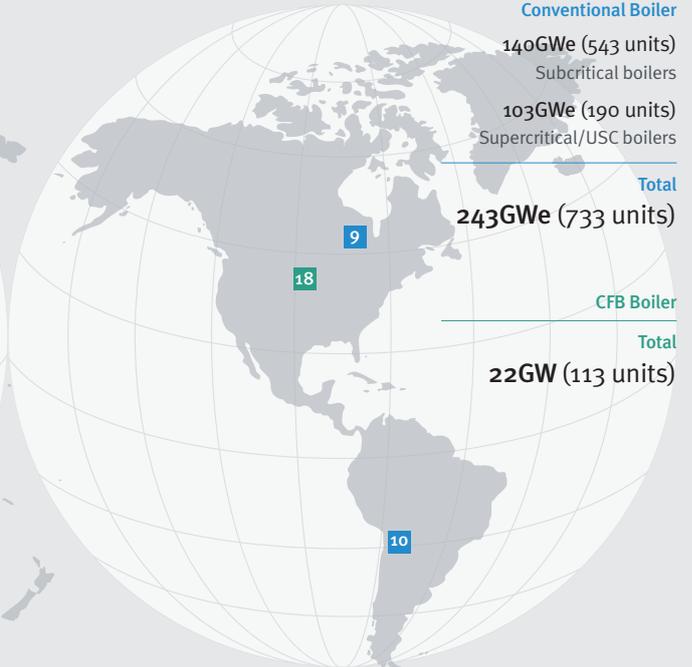


Strongoli Italy

Capacity	23MWe x 2
Customer	BIOMASSE ITALIA S.p.A.
Contract Award	Dec. 2000
COD	Jul. 2003
Fuel	Biomass (imported/local) LHV = 1,900 / 3,200 kcal/kg Moisture = 25 / 50% Chlorine = 0.01 / 0.1%
Type of Boiler	Circulating fluidized bed boiler Subcritical pressure Drum Balanced draft
Steam Condition	SH 515°C, 95atg

MAJOR REFERENCES

Worldwide References



Conventional Boiler
 140GWe (543 units)
 Subcritical boilers
 103GWe (190 units)
 Supercritical/USC boilers

Total
 243GWe (733 units)

CFB Boiler
 Total
 22GW (113 units)

Conventional Boiler

- 1 Libya**
 - Al-Khalij / Oil & Gas (350MW x 4 units)
 - Tripoli West / Oil & Gas (350MW x 4 units)
- 2 Egypt**
 - Ain Sokhna / Oil & Gas (650MW x 2 units)
- 3 Saudi Arabia**
 - Rabigh PP2 / Oil (700MW x 4 units)
 - Marafiq #5,6 / Oil (275MW x 2 units)
 - Yanbu 2 / Oil (276MW x 3 units)
- 4 India**
 - Sipat / Coal (660MW x 3 units)
 - Raipur / Coal (685MW x 2 units)
 - Kudgi / Coal (800MW x 3 units)
 - Lara / Coal (800MW x 2 units)
 - Mundra / Coal (800MW x 5 units)
 - Harduaganj / Coal (660MW x 1 unit)
 - Obra-C / Coal (660MW x 2 units)
 - Jawaharpur / Coal (660MW x 2 units)
- 5 Thailand**
 - Gheco-one / Coal (700MW x 1 unit)
- 6 Indonesia**
 - Cirebon / Coal (700MW x 1 unit)
- 7 Vietnam**
 - Nghi Son II / Coal (665MW x 2 units)
 - Vinh Tan 4 / Coal (600MW x 2 units)
 - Song Hau 1 / Coal (600MW x 2 units)
 - Vinh Tan 4 Ext. / Coal (600MW x 1 unit)
- 8 South Korea**
 - Younghung #5,6 (870MW x 2 units)
 - Shinboryeong #1,2 (1,000MW x 2 units)
 - Gangneung #1,2 (1,040MW x 2 units)
 - Goseong #1,2 (1,040MW x 2 units)
 - Pospower #1,2 (1,050MW x 2 units)
- 9 USA**
 - Trimble County 2 / Coal (800MW x 2 units)
- 10 Chile**
 - Nueva Ventanas / Coal (240MW x 1 unit)
 - Angamos / Coal (240MW x 2 units)
 - Campiche / Coal (240MW x 1 unit)
 - Red Dragon / Coal (375MW x 1 unit)

CFB Boiler

- 11 France**
 - Carling / Coal (100MW x 1 unit)
 - Gardanne / Bit. Coal (250MW x 1 unit)
- 12 Germany**
 - Duisburg1 / Bit. Coal (100MW x 1 unit)
 - Berlin / Subbit. Coal (100MW x 1 unit)
- 13 Czech Republic**
 - Tisova / Lignite (100MW x 1 unit)
- 14 Botswana**
 - Morupule / Bit. Coal (150MW x 4 units)
- 15 India**
 - Surat / Lignite (125MW x 2 units)
 - Neyveli / Lignite (250MW x 2 units)
 - Bhavnagar / Lignite (250MW x 2 units)
- 16 Philippines**
 - Cebu / Subbit. Coal (103MW x 2 units)
- 17 South Korea**
 - Tonghae #1,2 (200MW x 2 units)
 - Yeosu #2 (340MW x 1 unit)
 - Yeosu #1 (350MW x 1 unit)
 - Saemanguem (150MW x 2 units)
- 18 USA**
 - Montville / Subbit. Coal (95MW x 2 units)
 - North Mahony (100MW x 1 unit)
 - Robertson / Lignite (175MW x 2 units)
 - Panama / Subbit. Coal (100MW x 4 units)
 - Warrior / Bit. Coal (210MW x 1 unit)
 - Red Hills / Lignite (250MW x 2 units)
- 19 Others**
 - Vojany / Slovenia (120MW x 2 units)
 - Zonguldak / Turkey (160MW x 1 unit)
 - Starober. / Ukraine (200MW x 1 unit)

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