

GLOBAL LEADER IN POWER & WATER





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INTRODUCTION



Doosan is Korea's sole supplier of utility and industrial power boilers for both domestic and overseas market. Over the past two decades, we have served as an EPC contractor or an equipment supplier with a long list of references in thermal plants. We continue to set new records in term of cost-effectiveness, cycle time, efficiency, reliability, and emissions.

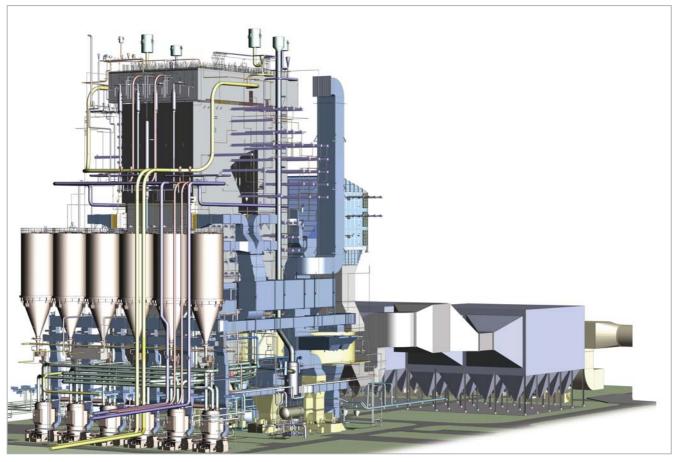
Ever since our first utility boiler of 560 MWe class in 1978, we have won numerous orders for thermal power projects totaling in excess of 47,854 MWe in Korea, Chile, Thailand, Indonesia, Libya, Taiwan, Malaysia, Australia, the United States, Saudi Arabia, India, and other markets. Specializing in

drum and once through boilers of up to 870 MWe as well as Circulating Fluidized Bed(CFB) units of up to 340 MWe, We design and manufacture a full range of subcritical and supercritical boilers that are designed to burn coal, oil, or gas efficiently.

Doosan Heavy merged Mitsui Babcock and established Doosan Babcock in Dec, 2006. Doosan Babcock has supplied boilers to over 30 countries including the U.S, Brazil and China as well as Europe, and has a license agreement with Harbin Boiler, the largest boiler maker in China and producer of 26,000MW of boilers to date.

Younghung #3,4 2 x 870 MWe Supercritical Power Plant in Korea

/ by DOOSAN (*)



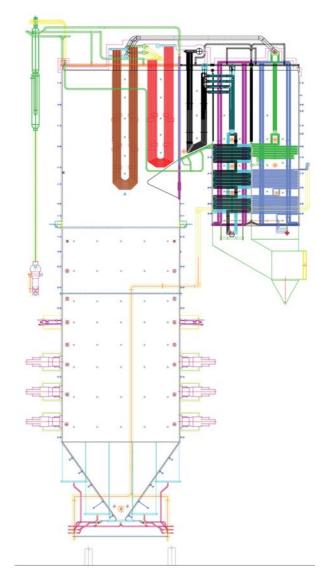
DOOSAN has provided a number of innovative technology solutions available to customers and integrated advanced field-proven design features into our steam generators technology for their power generation asset base. Many of these are exclusive to DOOSAN. DOOSAN offers innovative, intimately crafted and proven reliability to our customers.

Once Through Supercritical

DOOSAN has developed world class capabilities in clean coal power plant technology and we fully understand our customers' legislative requirements obligation to meet emissions targets. We have invested significantly in developing our once through supercritical technology to address issues of improving plant efficiency and are globally acknowledged as a leader in the design, manufacture and supply of once through supercritical boilers.

DOOSAN has been supplying once through Benson type boilers since the 1950s. Over the years we have proved that we have the ability to utilize our world-class technology. Our technology has continued to develop and change to keep pace with changing markets and customer needs.

The once through boiler is the only type that can be used to operate at supercritical pressures and is, therefore, crucially important for more modern high efficiency, lower emission power plants. DOOSAN supplies both the 'conventional' spiral wound furnace and the modern vertical Posiflow™ furnace once through designs.



Side elevation of a Doosan Once Through Supercritical Steam Generator

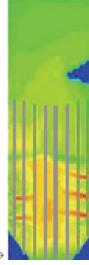
Posiflow™ (Vertical Tube Low Mass Flux) Steam Generator

The Posiflow™ steam generator has a lower capital cost and is also more efficient than conventional steam generator technology. DOOSAN has been pioneering crucial develop-ments in once through boiler design for more than 50 years. We have globally recognized expertise in the design and manufacture of once through supercritical technology using our proprietary Posiflow™ system with internally ribbed boiler tube technology. Along with our vision partners, DOOSAN has propelled once through steam generator technology forward, with the single most important innovative step since the once through Benson concept was first proposed.

By reducing mass flux levels to below 1,200 kg/m²s / 884,805.8 lbs/ft²h, Posiflow™ steam generators minimize furnace dynamic pressure losses and the thermo-hydraulic behavior of the furnace becomes similar to that exhibited by Natural circulation steam generators. The use of optimized internally ribbed tubing is a key ingredient in the success of these designs.

DOOSAN offers Posiflow[™] technology in both once through supercritical wall fired and once through downshot fired steam generators. The vertical orientation of the furnace tubes simplifies the structural support system and reduces manufacturing and installation times. In addition, with furnace pressure losses only 30% of an equivalent high mass flux design, due to significant feed pump power saving, DOOSAN Posiflow[™] steam generators represent the best available once through technology.





Thermal image of Posiflow $^{\text{TM}}$ Furnace \rightarrow

Features:

- Utilizes optimized "ribbed" tubing
- Provides Positive Flow characteristics
 - Flow in boiler tubes automatically increases with increasing heat flux
 - Stable self compensating system
- Can be applied to sub or supercritical steam generators
- Suitable for wall, tangential and downshot firing steam generator configurations

Benefits:

- Suitable for both steam generator retrofit and new build
- Lower Capital & Through Life Costs
- Lower consumed feed pump power resulting in higher overall power plant efficiency
- Lower construction costs
- Conventional structural support system (with no need for steam generator support straps)

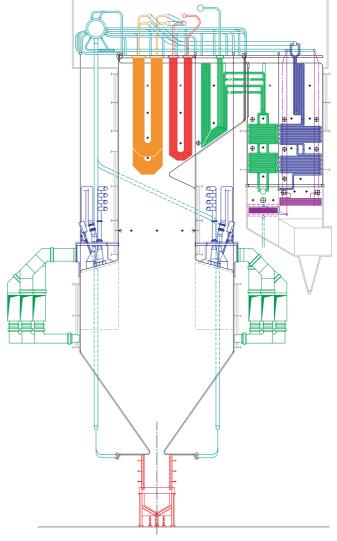
Downshot Steam Generator for Low Volatile Anthracite Fuels

At DOOSAN, we apply our knowledge and experience to help plant operators and owners get the most out of their assets. Often this involves maximizing the use of local fuels, even ones with challenging characteristics. Our unique resources enable us to develop advanced downshot steam generators to support the firing of low volatile coals and anthracites with volatilities as low as 1-2%dmmf (dry mineral matter free) and ash weights of up to 45%.

Low volatile anthracite coals present particular combustion challenges in terms of achieving low unburned carbon levels, good ignition, flame stabilization and minimum load without oil support firing. DOOSAN has a unique furnace and burner technology that integrates the furnace into the combustion process. The features inherent in DOOSAN downshot firing furnaces are specifically designed to achieve optimum combustion conditions.

We offer both natural circulation and once through supercritical downshot steam generator designs.

DOOSAN has supplied over 10,000 MWe of this type of steam generator in locations as diverse as Mount Isa, Australia and Pha Lai, Vietnam. Pha Lai is Vietnam's first large coal fired power station and also burns the lowest volatile anthracite, in a wall-fired unit, in the world.



Side elevation of a Doosan Downshot Steam Generator

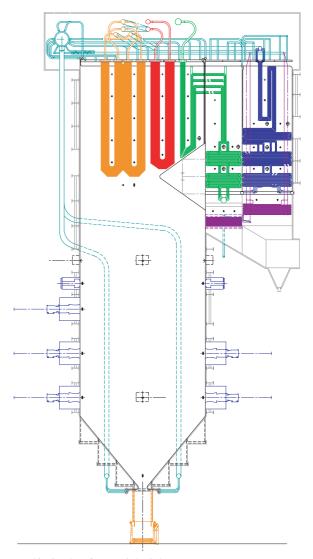
Natural Circulration Steam Generator

DOOSAN is the world's leading specialist in the design and engineering of the products required to generate steam generating products.

We have particular expertise in manufacturing high temperature natural circulation boilers.

DOOSAN's extensive world wide experience of designing, manufacturing and installing natural circulation boilers includes over 66,000 MW of coal fired units and over 33,000 MW of oil and gas fired units. Currently unit sizes offered are from 250MW upwards generally for the electricity supply industry to fire a range of coals, oil, gas or a combination of these three fuels.

Natural Circulation Boilers utilize the naturally occurring difference between the density of water and the density of steam to provide the motive force to ensure fluid circulation within the furnace tubes. Key advantages of this method of circulation include the fact that a circulation pump is not required, and that it is inherently safe and self compensating because any additional heat absorption results in additional circulating flow.



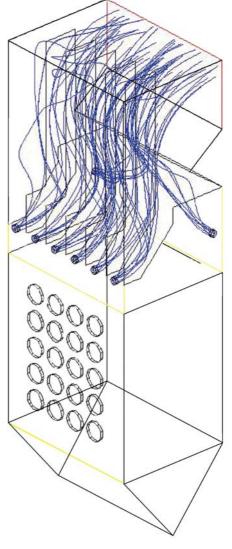
Side elevation of a Natural Circulation Steam Generator

Integrated Low Emissions Approach

Our emissions control solutions enable us to help our utility customers meet their individual emissions requirements. Our knowledge and experience of the emissions from fossil fired utility steam generators and the impact of the various control technologies available, give us an excellent advantage in the specification and supply of Air Quality Control Systems (AQCS).

We have the world's largest multi-fuel burner test facilities, which enables us to offer a wide range of solutions for the control of combustion-related NOx emissions.

These include Advanced Low NOx Burners, Separated Over Fire Air (SOFA), Boosted Over Fire Air (BOFA), and Selective Catalytic Reduction (SCR) control technologies.



CFD model of Over Fire Air (OFA) system

Circulating Fluidized Bed(CFB) Boiler(*)

Its Applications ...

The CFB system is well suited for power plants with capacity of 60 to 1,000 MWth using single combustor.

... and its advantages

Fuel flexibility

CFB firing systems can burn low-quality fuel with high ash and sulfur contents. In particular, fuels which are either difficult to burn or cannot be burnt at all in conventional boiler may lend themselves well to CFB system.

High combustion efficiency

High carbon burnout can be achieved due to intimate gas/solids mixing and the long retention time of the fuel in the circulating fluidized bed.

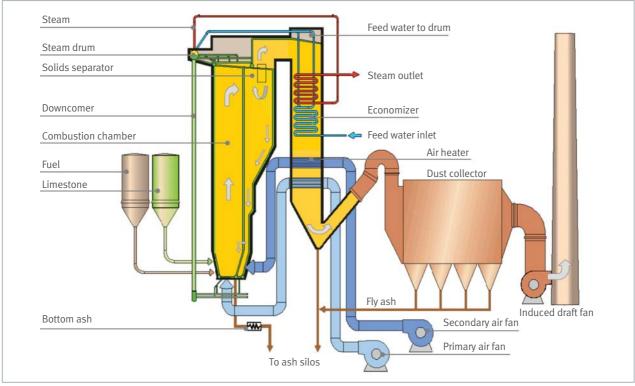
Low SOx emissions

Desulfurization is accomplished in the combustion zone itself by the addition of small quantities of limestone.

Low NOx emissions

Low combustion temperature in combustion with staged combustion, a typical Feature of the CFB process maintains low NOx emissions.

CFB Process Diagram



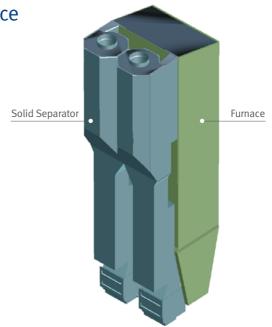
*Note : Licensed by Foster Wheeler

Solids Separator Integrated with Furnace

The solids captured in the separator are recirculated through a non-mechanical sealing device back to the combustion chamber.

The advantages of the Solids Separator are:

- Small space requirements
- Maintenance and availability problems due to furnace/cyclone expansion joints eliminated
- Thin refractory anchored with dense studding

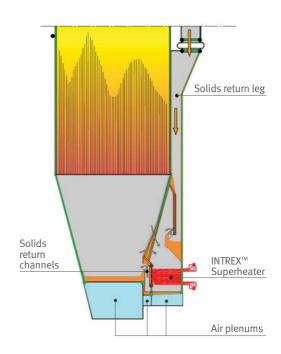


■ INTREX™ System Designs

Use of the Integrated Fluidized Bed Heat Exchanger (INTREX) in the CFB design is a unique technique which distinguishes if from other CFB boilers.

The advantages of the INTREX are:

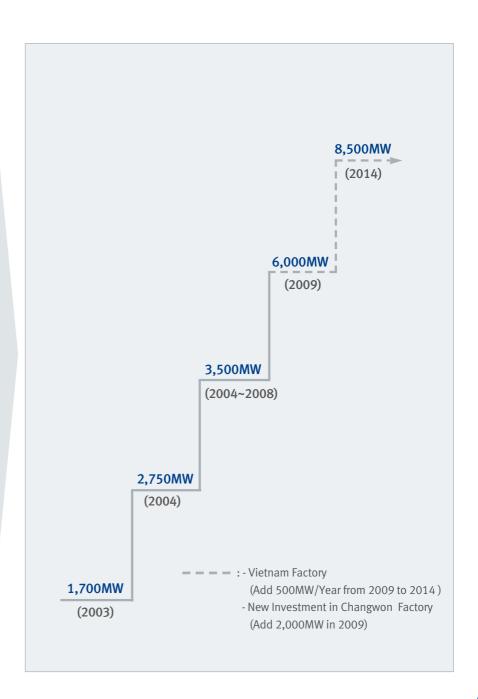
- Heat exchange from solid bed material to tube surface
- High heat transfer rate
- Heat transfer controlled with fluidization
- Simple Design (No moving parts: no wear)
- Resistant to Erosion (Low fluidization velocities, fine particles)
- Resistant to Corrosion (Cl-free environment)



MANUFACTURING

Boiler Production History and Capacity Securing Plan

ltem	Capacity (MW/Year)
Coil (Element)	3,400
Panel	4,000
Header	3,500
Pipe (Link)	4,000



EXPERIENCES





Samchunpo #1,2,3,4 4 x 560 MWe, Korea

Samchunpo #1,2,3,4 4 x 560 MWe Power Pla	nt Project /by DOOSAN(*)
Client	Korea Electric Power Co.(KEPCO), Korea
Location	Samchunpo, Korea
Туре	4 x 500 MWe Controlled Circulation (Drum) Tangential Fired Boiler
Main Steam Flow @ BMCR	1,796 tons/hr
Superheater Outlet Pressure	178 kg/cm²g
Superheater Outlet Temperature	541 °C / 1,006 °F
Reheater Outlet Temperature	541 °C / 1,006 °F

GHECO ONE 1 x 700 MWe Power Plant Project	/by DOOSAN
Client	GHECO ONE, Thailand
Location	Rayong City, Thailand
Туре	1 x 700 MWe Once Through Supercritical Wall Fired Boiler (POSIFLOW ™)
Main Steam Flow @ BMCR	2,148 tons/hr
Superheater Outlet Pressure	255 kg/cm²g
Superheater Outlet Temperature	569 °C / 1,056 °F
Reheater Outlet Temperature	569 °C / 1,056 °F

^{*} Licensed by ALSTOM



Hadong #7,8 2 x 500 MWe, Korea

Younghung #3,4 2 x 870 MWe Supercritical Power Plant /by DOOSAN(*		
Client	Korea Southern Power Co.(KOSEP), Korea	
Location	Younghung, Korea	
Туре	2 x 870 MWe Once Through Supercritical Tangential Fired Boiler	
Main Steam Flow @ BMCR	2,637 tons/hr	
Superheater Outlet Pressure	255 kg/cm²g	
Superheater Outlet Temperature	569 °C / 1,056 °F	
Reheater Outlet Temperature	596 °C / 1,105 °F	

Hadong #7,8 2 x 500 MWe EPC Supercritical Power Plant Project /by DOOSAI		/by DOOSAN(*)
Client	Korea Southern Power Co.(KOSEP), Korea	
Location	Hadong, Korea	
Туре	2 x 500 MWe Once Through Supercritical T	angential Fired Boiler
Main Steam Flow @ BMCR	1,605 tons/hr	
Superheater Outlet Pressure	255 kg/cm²g	
Superheater Outlet Temperature	569 °C / 1,056 °F	
Reheater Outlet Temperature	596 °C / 1,105 °F	



Sipat Stage-I 3 x 660 MWe, India

Sipat Stage-I 3 x 660 MWe Supercritical Power Plant /by DOOSAN(
Client	National Thermal Power Co.(NTPC), India
Location	Sipat, India
Туре	3 x 660 MWe Once Through Supercritical Tangential Fired Boiler
Main Steam Flow @ BMCR	2,225 tons/hr
Superheater Outlet Pressure	255 kg/cm²g
Superheater Outlet Temperature	540 °C / 1,004 °F
Reheater Outlet Temperature	568 °C / 1,054 °F

Ultra Mega Power Project 5 x 830 MWe Supercritical Power Plant /by DOOSANG		
Client	TATA Power Company Limited, India	
Location	Gujarat, India	
Туре	5 x 830 MWe Once Through Supercritical Tar	ngential Fired Boiler
Main Steam Flow @ BMCR	2,526 tons/hr	
Superheater Outlet Pressure	256 kg/cm²g	
Superheater Outlet Temperature	569 °C / 1,056 °F	
Reheater Outlet Temperature	594 °C / 1,101 °F	

^{*} Licensed by ALSTOM



Tonghae 2 x 200 MWe, Korea

Tonghae 2 x 200 MWe Power Plant Project		/by DOOSAN(*)
Client	Korea Electric Power Co.(KEPCO), Korea	
Location	Tonghae, Korea	
Туре	2 x 200 MWe CFB Boiler	
Main Steam Flow @ BMCR	694 tons/hr	
Superheater Outlet Pressure	176 kg/cm²g	
Superheater Outlet Temperature	541 °C / 1,006 °F	
Reheater Outlet Temperature	541 °C / 1,006 °F	

Yosu 1 x 340 MWe CFB Power Plant Project		/by DOOSAN(**)
Client	KOSEP, Korea	
Location	Yosu, Korea	
Туре	1 x 340 MWe CFB Boiler	
Main Steam Flow @ BMCR	1,025 tons/hr	
Superheater Outlet Pressure	171.5 kg/cm²g	
Superheater Outlet Temperature	541 °C / 1,006 °F	
Reheater Outlet Temperature	541 °C / 1,006 °F	



Changshu 3 x 600 MWe, China

Changshu 3 x 600 MWe Supercritical Power Plant /by Doosan Bab	
Client	China Resources
Location	Jianshu Privince, PRC
Туре	3 x 600 MWe Once Through Supercritical Wall Fired Boiler
Main Steam Flow @ BMCR	542.278 kg/s / 4,299,015 lbs/hr
Superheater Outlet Pressure	24.80 MPa(a) / 3,684 PSI
Superheater Outlet Temperature	543 °C / 1,009 °F
Reheater Outlet Temperature	571 °C / 1,056 °F

Wangqu 2 x 600 MWe Supercritical Power Plant	/by Doosan Babcock
Client	Shanxi Lujin Wangqu Power Gen Co., Ltd
Location	Shanxi Province, PRC
Туре	2 x 600 MWe Once Through Supercritical Wall Fired Boiler
Main Steam Flow @ BMCR	540.185 kg/s / 4,188,784 lbs/hr
Superheater Outlet Pressure	24.80 MPa(a) / 3,684 PSI
Superheater Outlet Temperature	571 °C / 1,060 °F
Reheater Outlet Temperature	569 °C / 1,056 °F



Drax 6 x 600 MWe, UK

Drax 6 x 600 MWe Power Plant	/by Doosan Babcock
Client	Central Electricity Generating Board (CEGB)
Location	North Yorkshire, United Kingdom
Туре	6 x 600 Mwe Natural Circulation (Drum) Wall Fired Boiler
Main Steam Flow @ BMCR	562.222 kg/s / 4,462,157 lbs/hr
Superheater Outlet Pressure	16.90 MPa(a) / 2,451 PSI
Superheater Outlet Temperature	568 °C / 1,054 °F
Reheater Outlet Temperature	568 °C / 1,054 °F

Pha Lai 2 x 300 MWe Downshot-Firing Power Plant Units /by Doosan Babo		
Client	Electricite de Vietnam (EVN)	
Location	Pha Lai, Hai Duong Provinces, Vietnam	
Туре	2 x 300 MWe Natural Circulation Downshot Firing Boiler	
Main Steam Flow @ BMCR	234 kg/s / 2,032,662 lbs/hr	
Superheater Outlet Pressure	17.07 MPa(a) / 2,538 PSI	
Superheater Outlet Temperature	541 °C / 1,006 °F	
Reheater Outlet Temperature	541 °C / 1,006 °F	



Yaomeng 1 x 300 MWe, China

Yaomeng 1 x 300 MWe Vertical Tube(Posiflow™) Power Plant Unit /by Doosan Babco			
Client	Yaomeng Power Generation Ltd		
Location	Henan Province, PRC		
Туре	1 x 300 MWe Once Through Posiflow™	1 x 300 MWe Once Through Posiflow™ Wall Fired Boiler	
Main Steam Flow @ BMCR	263.9 kg/s / 2,094,392 lbs/hr		
Superheater Outlet Pressure	18.65 MPa(a) / 2,495 PSI		
Superheater Outlet Temperature	545 °C / 1,013 °F		
Reheater Outlet Temperature	545 °C / 1,013 °F		

Hemweg 1 x 650 MWe Supercritical Power Plant Unit /by Doosan Babco	
Client	IVO now NUON Power Generation
Location	Amsterdam, The Netherlands
Туре	1 x 650 MWe Once Through Supercritical Wall Fired Boiler
Main Steam Flow @ BMCR	550 kg/s / 4,365,153 lbs/hr
Superheater Outlet Pressure	26.0 MPa(a) / 3,844 PSI
Superheater Outlet Temperature	540 °C / 1,004 °F
Reheater Outlet Temperature	568 °C / 1,054 °F

^{*} Licensed by ALSTOM **Licensed by Foster Wheeler

QUALITY ASSURANCE

DOOSAN is dedicated to produce equipment which meets or exceeds applicable codes, standards and customer specific demands. DOOSAN is well equipped with X-ray generator, magnetic particle examination equipment, pressure testing equipment, wear tester and emission spectrometer. DOOSAN also carries out chemical analysis, physical, physical test, precision measurement, electrical measurement, non-destructive examination and material analysis.

As a strong testimony to its outstanding quality control system, DOOSAN was awarded with ISO 9001 and ISO 14001 certification for all its power generation facilities and industrial plants. In addition, DOOSAN has received main certificates of authorization from the American Society of Mechanical Engineers to use the applicable ASME code symbol stamp for various types of manufacture.







GLOBAL NETWORK

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