CREATING VALUE FOR THE WORLD

DOOSAN GENERATORS
The generator is the heart and soul of the power plant, and Doosan satisfies customers with top-quality generators built with world-class technology. The company boasts advanced generator production facilities backed by cutting-edge technology and extensive fabrication experience. Generators from Doosan are your best choice.
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INTRODUCTION
Modern society is almost entirely dependent upon electricity for industrial purposes, leisure and daily living. Furthermore, the demand for electric power is growing at an accelerating rate. In order to meet these demands, DOOSAN Heavy Industries & Construction, in close cooperation with domestic utility companies, is providing a wide range of generators to its customers. The first generator ever supplied by DOOSAN is now operating at Seochon Thermal Power Plant in Korea. Since then, DOOSAN has been manufacturing generators with ratings from 100 MW to 1,450 MW.

These world-class units are driven by steam turbine, gas turbine, and operate at frequencies of 50 or 60 Hz. Since our start in this business we have produced various machines from fossil power plants to nuclear power plants. Our output truly covers most of the range of utilities.

In the field of design and manufacturing, DOOSAN generators are among the most up-to-date machines of their kind, utilizing the latest technology and providing unbeatable quality. Presently, DOOSAN is applying advanced state-of-the-art technology that integrates all necessary factors of design, manufacturing and quality control, to supply customers not only with a machine but also total satisfaction. DOOSAN generators are the ideal choice for your facilities, thanks to our internationally renowned technology and our determined pursuit of customer satisfaction.
One of the advantages offered by a DOOSAN generator is the opportunity to personally select the generator that best fits your plant requirements from a complete line of our products.

DOOSAN generators are categorized into three major cooling types: Air-cooled, Hydrogen-cooled and Water-cooled. After you have determined the parameters for your job site - either utility or industrial - we will recommend the most appropriate unit to suit your particular needs from a complete line of DOOSAN generators. Our machines are manufactured from proven components. Each type of generator has its own unique characteristics and can either meet or exceed all of your requirements.
Air-cooled DOOSAN generators are available in two configurations - open ventilated (OV) and totally enclosed water-to-air cooled (TEWAC) - to most effectively complement your plant layout. They can be combined with either a gas turbine or steam turbine. Our advanced technology, obtained after years of producing large steam turbine generators, is dedicated to increasing power output and efficiency. We have also applied the design philosophy of packaging and standardizing the unit to minimize installation time and accelerate spare parts delivery. As a result, in every type of application, DOOSAN air-cooled generators are the best solution for you.

THE DOOSAN PACKAGING ADVANTAGE
1. Factory tested modules
2. Reduced installation time
3. Lowest installation costs
4. High quality installation
5. Simplified foundation work
6. High accessibility for maintenance
Fully assembled package options are available for delivery with the rotor already installed. Packaged air-cooled units include lube oil piping, all wiring routed in conduit, base-mounted neutral grounding equipment and current transformers. Choosing a packaged turbine and generator can cut installation time and costs up to 40%.

Class F insulation on both the rotor and stator provides dielectric and mechanical strength to assure a long life. The use of proven resin-rich tape on the stator secures voidfree ground wall insulation for long-lasting durability. The insulation systems have a 20-year record of reliability and performance leadership.

Direct-cooled field promotes uniform temperature distribution throughout the windings to curb temperature rises and prolong insulation life.

Tilt-pad pedestal bearings minimize vibration during operation, and incorporate a special seal design to prevent oil leakage. Both the generator and turbine are served by a common lube oil system.

Excitation options include: High initial response potential and compound source static exciters.

Cooling configuration may be either Totally Enclosed Water-To-Air Cooled (TEWAC) as shown, or Open Ventilated (OV) with self-cleaning filters and inlet silencers. Top-mounted coolers (TEWAC) simplify maintenance, and safeguard against water injection.

Stator winding support structure features top wedges and ripple springs to secure stator bars in the slot and eliminate bar vibration. This maximizes insulation life and reduces maintenance requirements.

Low-loss stator core made of grain-oriented silicon steel minimizes electrical losses within the core to increase generator efficiency.

Retaining rings of 18-Manganese/18-Chromium in non-magnetic stainless steel resist stress-corrosion cracking.

Flush-mounted fans at each end of the rotor circulate air to cool the unit and boost generator efficiency.

A complete line of DOOSAN air-cooled generators ranging from 100 MVA to 180 MVA are offered for either 50 or 60 Hz applications. All are designed for maximum safety and reliability.
More output requires a more efficient cooling system. Hydrogen as a cooling media can provide a remarkable solution for generator cooling by virtue of its low density and high thermal conductivity. Thanks to these physical properties, a hydrogen-cooled generator has a greater efficiency and smaller size compared with an air-cooled generator of an equal rating.

DOOSAN hydrogen-cooled generators are similar to air-cooled units. They only differ in regard to hydrogen-related systems, thick generator wrapper plates and their rounded generator configuration. All hydrogen-cooled generators are supplied with an auxiliary system to accommodate hydrogen-fill, purge, monitoring and shaft sealing.
Hydrogen-Cooled Generator is an advanced, packaged design used primarily for application with state-of-the-art gas turbines. It is equally applicable to steam turbine installations. Generator features include:

1. **Class F insulation** on both the rotor and stator provides dielectric and mechanical strength to assure a long life. The use of proven resin-rich tape on the stator secures voidfree ground wall insulation for a longer life. The insulation systems have a 20-year record of reliability and performance leadership.

2. **Direct-cooled field** promotes uniform temperature distribution throughout the windings to curb temperature rises and prolong insulation life.


4. **Stator winding support structure** features top wedges and ripple springs to secure stator bars in the slot and eliminate bar vibration. This maximizes insulation life and reduces maintenance requirements.

5. **High pressure frame** is designed in compliance with ASME pressure vessel codes.

6. **Plate-fin simplex coolers** prolong life simplify maintenance.

7. **Low-loss stator core** of grain-oriented silicon steel, minimizes electrical losses within the core to increase machine efficiency.

8. **Fully assembled package** is available for delivery with the rotor already installed, along with lube oil piping and wiring routed in the conduit. The packaged turbine-generator sets can reduce installation time and costs by up to 40%.

9. **Factory assembled collector compartment** houses the hydrogen control with autopurge, hydrogen and carbon dioxide manifolds, a seal oil system, oil feed/drain piping, wiring and junction boxes to reduce on-site assembly.

10. **Self-ventilated collector assembly** features on-line removable brushes to simplify maintenance.

11. **Turning gear** location adds to the overall compactness of gas, turbine-generator installation.

12. **Top-mounted terminal enclosure** contains all neutral grounding equipment and current transformers.

13. **Static start** (not shown) eliminates the need for a starting motor and torque converter in gas turbine applications.

A complete line of DOOSAN hydrogen-cooled generators up to 400 MVA are offered for either 50 or 60 Hz applications. All are designed for maximum safety and reliability.
Generators with rating above 400 MVA require a more efficient cooling method and we adopted the hydrogen-water cooling system for these. The stator windings are directly water cooled by deionized water, supplied by a closed loop auxiliary system, which flows through hollow copper strands located in the stator windings. Cooling of the rotating field is another challenge that must be covered by the generator designer.

Large DOOSAN two-pole generators feature the diagonal flow, gap pick up system. Cold hydrogen circulating through the cooling path by the fans mounted at each end of the generator rotor is picked-up at the surface and passes diagonally through holes machined in rotor copper to the bottom of the coil. Then the hydrogen travels up the field coil diagonally to the rotor surface where it is discharged into the gas gap.

The design of the four pole generators, however, requires less duty in the rotor than two-pole. Thus we employ the radial-flow cooling method.

All liquid-cooling machines are mated with auxiliary system to support safe operation and monitor critical hydrogen and cooling water. Our hydrogen-water cooled machines are on line today in Korea.
A complete line of DOOSAN water-cooled generators up to 1,600 MVA are offered for either 50 or 60 Hz applications. All are designed for maximum and reliability.

1. **Liquid-cooled stator windings** meet the demands of high MVA ratings in a compact configuration. Custom copper strand arrangements are optimized for each application.

2. **Diagonal-flow gap pickup rotor cooling** creates a uniform temperature profile within the generator. Self-pumping system eliminates the need for multi-stage fans or compressors, regardless of unit length.

3. **Stator insulation system** provides the mechanical toughness and voltage endurance needed for even daily start-stop duty. The stator insulation design boasts a proven record of superior performance that spans a full decade of service.

4. **Stator end winding support system** can withstand the severe forces of accidental error, in addition to normal operating pressure and thermal cycles. The stator end winding support systems require little maintenance and have proven 100% in-service reliability.

5. **Spring bar stator core support system** isolates vibration of the stator core to minimize vibration transmitted to the foundation.

6. **Stator winding support structure** features top wedges and ripple springs to secure stator bars in the slot and eliminate bar vibration. This maximizes insulation life and reduces maintenance requirements.

7. **Core-end cooling** is enhanced through proven design concepts to control core temperatures and minimize eddy current losses. Approaches include split tooth, stepped core, flux shields and non-magnetic materials.


9. **Factory assembled collector arrangement** features on-line removable brushes to simplify maintenance.

10. **Plate-fin simplex coolers** prolong life and simplify maintenance.

11. **High-voltage brushings** are either hydrogen-cooled or water-cooled, depending on generator rating.

12. **Low-loss stator core** of grain-oriented silicon steel minimizes electrical losses within the core to increase machine efficiency.
APPLICATION

DS-DEX EXCITATION SYSTEM

Potential Source Static Bus-Fed Type
It is a static type excitation system utilizing the PPT (Power Potential Transformer) as an excitation power source. Its overall size is reduced compared to that of an old-fashioned rotating exciter, and with no moving parts it results in much lower costs for maintenance.

DS-DEX TMR Controller
The Control Module Sub-Rack consists of several VME (Versa Module Eurocard) based electronic cards including a CPU board, and performs all of the regulation and protection functions implemented in the software.

TMR Control Module
- EPDM Card (Exciter Power Distribution Module)
- ECCB Card (Exciter Core Control Card)
- EACB Card (Exciter Application Control Card)
- EIOB Card (Exciter I/O Card)
- EPDB Card (Exciter PCR Drive Card)
- ASIB Card (Analog Signal Interface Board)
- CDIB Card (Customer Digital Interface Board)
- ESIB Card (Exciter Signal Interface Board)
A generator cooling system that uses hydrogen gas and water as a cooling media has three special components: a gas control system, hydrogen seal oil system and stator winding cooling system.

A generator auxiliary system consists of these three components, and each one is carefully modulated for compact arrangement and minimal installation time. Each component has the dedicated function of monitoring and controlling the state of hydrogen gas, cooling water or hydrogen gas leakage, and alarming independently or by interface with other monitoring systems.

Gas Control System
The gas control system has the dual function of supplying hydrogen to the generator as required to maintain selected pressure and to supply carbon dioxide and hydrogen to the generator for purging and filling operations.

Hydrogen Seal Oil System
The prime function of the shaft sealing system is to provide a means of sealing hydrogen gas with the generator casing. Seals are required at each end of the generator rotor. Oil is supplied to the seal casing at a pressure higher than the hydrogen gas in the generator casing. This oil flows bi-directionally between the seal rings and along the shaft through the annular clearances between the rings and the shaft to form a seal.

Stator Cooling Water System
The stator cooling water system is a closed loop system that supplies high purity water to the generator stator windings to remove heat generated by electrical losses. All pipings and components that contact de-ionized water are stainless steel, except for the copper alloys used in the generator winding, heat exchanger tubes and certain instrumentation devices.
There is more to operating a generator than mere installation. Consideration must be paid to the need for reliable service from the supplier, offered hand in hand with minimized maintenance costs and maximum availability.

As previously mentioned, DOOSAN’s prime motto is to give our customers full satisfaction. Our Customer Service team is ready to accomplish this central goal, backed up by a generator design department and a fully equipped factory. We are with you from initial installation right up to the day you decide to replace your existing generator.

Each field engineer was trained at our factories and on the jobsite, and is ready to offer experienced craftsmanship for scheduled or emergency maintenance. This encompasses all aspects of diagnostics, performance appraisals, craft labor coordination, and repair overhaul as required to maintain top generator performance. Customer Service also provides the technology and parts required to upgrade or replace your existing generator, with the help of generator design engineers and our shops located at Changwon in Korea. With installation and planned outage maintenance service to upgrading or replacing your existing machinery, you can get everything you need from DOOSAN Customer service.
Manufacturing Line for Generator Rotor & Stator Frame

**Manufacturing Range**
- Casting & Forging
- Machining
- Fabrication & Welding
- Assembling, Stacking, Winding, Balancing

**Major Manufacturing Facilities**
- Casting Facilities - Melting Equipment, Molding Equipment, Heat Treatment Equipment and Others
- Forging Facilities - Forging Presses (Max. 10,000 Tons), Heating Furnaces, Heat Treatment Furnace and Others
- Machining Facilities
  - CNC Horizontal Lathes
  - Special Complex Machine for Milling & Slotting Operation
  - Massive & Sophisticated Plano Millers for Milling Operation
  - Special Horizontal Boring Bar Machine for Inside Bore Machining
- Assembling Facilities - Winding Room, Stacking & Winding Room and Others
- Balancing Facilities - High Speed Balancing Machine
- Testing Facilities

**Generator Rotor**

- **Casting**
- **Forging**
- **Turning**
- **Slot Machining**
- **Field Coil Assembly**
- **Balancing**
GENERATOR STATOR FRAME

**FABRICATION**

**INTERNAL MACHINING**

**PUNCHING**

**STACKING**

**STATOR BAR MFG.**

**TAPING**

**COMPOUNDING**

**ASSEMBLY**

**WINDING**

**GENERATOR STATOR**
GLOBAL NETWORK

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