



# TURBO GENERATORS

BEST QUALITY FOR  
THERMAL POWER PLANTS

**ANDRITZ**

ENGINEERED SUCCESS







# Turbo generators with top modern standards

International technology group ANDRITZ is a globally leading supplier of plants, equipment, and services for hydropower stations, the pulp and paper industry, the metalworking and steel industries, and solid/liquid separation in the municipal and industrial sectors.

ANDRITZ Hydro is part of the ANDRITZ GROUP and is a global supplier of electro-mechanical equipment and services for hydro- and thermal power plants. As one of the world's largest suppliers and with 120 years of experience in electrical engineering we are offering a comprehensive product and service portfolio.

Located in Weiz, Austria, the development, design and manufacturing of turbo generators started in the 1950s. Since then our product range developed and covers currently turbo generators up to 350 MVA. Our goal is to deliver turbo generators according to newest technological standards, providing flexibility to changing grid conditions and delivering highest possible efficiency.

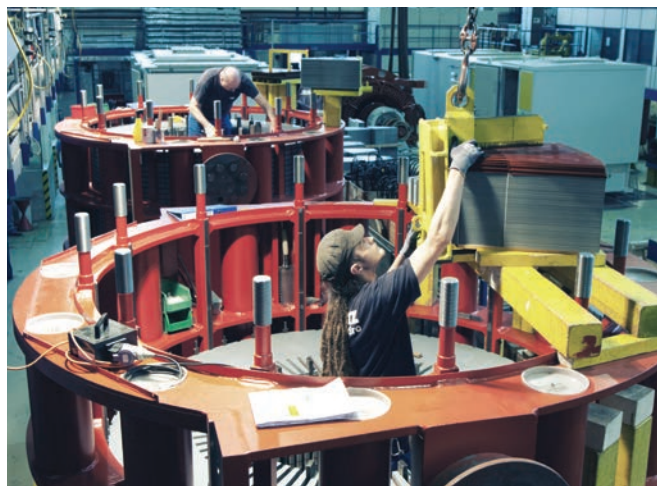
Until today, more than 1,380 turbo generators with a total output of over 147,000 MVA were manufactured and delivered to more than 75 countries by ANDRITZ. Close cooperation and permanent information exchange between the "Center of Competence

for turbo generators" (CoC) and all other research facilities of ANDRITZ guarantee the utilization of latest technological solutions, constant technical enhancement, and state-of-the-art design of our products. Continuous growth and implementation of cost effective manufacturing processes led to the development of manufacturing centers, specialized on specific generator product lines and its different requirements in manufacturing technologies and work processes.

ANDRITZ develops, designs, and manufactures state-of-the-art turbo generators for primary drivers as gas-, steam turbines and combustion engines with long life cycles and focus on highest electrical efficiency with minimal outage time during operation.

## HIGHLIGHTS:

- First turbo generator delivered in 1958
- Over 120 years of experience with electrical rotating machines
- More than 1,380 units manufactured
- More than 147,000 MVA total output
- Operating in more than 75 countries



# We deliver engineered solutions for the thermal industry

The turbo generators of ANDRITZ are utilizing the thermal energy independent of its different types (gas, steam, biogas etc.). We offer an optimal and reliable solution for thermal driven applications depending on the various fields of operation – as in industrial applications to cover own consumption or in combined cycle power plants for generation of electrical power.

The product range covers air-cooled and hydrogen-cooled turbo generators up to 350 MVA. Electrical auxiliaries, such as generator synchronization, protection, and excitation systems, are covered by our own products with optimal alignment to the chosen generator, the electrical layout and grid requirements.

Our expertise in electrical power systems allows full customer support for topics like grid compliance, electrical simulations and electrical plant layout.

During the life cycle of the generators, service and rehabilitation can be provided to the customer, ensuring the preservation of the assets and minimizing standstill, unplanned maintenance and improving the reliability and availability of the plant.

## PRODUCT RANGE

- Multi-pole generators
- 4-pole generators
- 2-pole generators
- 50 Hz and 60 Hz applications
- Primary drive: gas-steam turbines, combustion engines
- Output up to 350 MVA



# Our Generator Control Panel as best fitting expedient automation solution

The Generator Control Panel (GCP) is a solution for excitation, electrical protection, and synchronization for turbo generators and is characterized by space saving installation, a modular concept, standardized design, short delivery times, and competitive prices.

## HIPASE – PLATFORM

ANDRITZ has extensive and long-term experience in the fields of excitation, electrical protection, synchronization, and automation of power plants. Based on this experience the HIPASE platform for digital controllers has been developed. A highly performing and perfectly adapted platform integrating the specific requirements of the different applications in one single engineering and operating tool.

## EXCITATION

We deliver complete THYNE excitation systems for static and brushless exciters, including field current regulator (FCR) and automatic voltage controller (AVR) as well as two channel systems, integrated power system stabilizer (PSS) functionality and excitation systems for a static frequency converter (SFC) start for brushless excitations, depending on the requirements.

## PROTECTION

The electrical protection consists of all standardized functions needed for turbo generator sets. We offer a wide range of self-developed protective relays including required functionality.

## CONTROL AND SYNCHRONIZATION

We provide automation systems including control functions, such as brush control or changing synchronization areas. Furthermore, the automation system is used for interfacing the dispatch centers.

An independent synchronization device will conclude the integrated solution GCP. For operation and displaying all corresponding data from one turbo generator set, a local unit control touch display will be assembled directly in the generator bay. With the long-term experience and a wide installed base for generator control panels, we ensure sustainable solutions for station automation in thermal power plants.





# Efficient economic solution with air-cooled generators

Within our turbo generator portfolio, air-cooled 2-pole generators are a highlight. Not only the appeal of low investment directly connected with the reduction of on-site construction time and low maintenance costs, but also high flexibility to changes of grid conditions and robustness against grid faults together with a high reliability and maximal efficiency are some of their advantages. The initial costs are low by using compact and standardized models, avoidance of complicated auxiliaries and easy "plug & play" installation of the generator delivered in assembled condition. The chosen design of the rotor assures uniform temperature distribution. The stator winding is designed as a bar winding using roebel bars to ensure equal temperature distribution and low losses.

The insulation is based on the ANDRITZ Micatec Insulation System. Together with the Vacuum Pressure Impregnation Technology (VPI), excellent electrical, mechanical and thermal properties are ensured.

Air-cooled 2-pole generators can be equipped with various cooler types. These include totally enclosed water-to-air-cooling (TEWAC), closed air-to-air-cooling (CACAC), or open-ventilated (OV) cooling and can be chosen according to the power plant requirements and conditions. Together with the possibility to use either a static or brushless excitation system a high flexibility can be offered. Our air-cooled 2-pole generators range up to 335 MVA.

## TECHNICAL FEATURES:

- Frequency: 50 / 60 Hz
- Speed: 3,000 / 3,600 rpm
- Voltage: 10 kV - 19 kV
- Cooling: TEWAC, OV, CACA
- Excitation: brushless (w/o PMG), static
- Output: up to 335 MVA



# Hydrogen cooled generators for highest capability

Hydrogen-cooled turbo generators are characterized by a compact design, lowest losses in operation and the highest possible efficiency due to the characteristics of hydrogen ( $H_2$ ) – having better heat dissipation than air, low density and thermal conductivity.

The absence of oxygen ( $O_2$ ) prevents from damaging the generator's high voltage insulation system by any corona activity in the stator windings of the generator.

## TECHNICAL FEATURES:

- Frequency: 50 Hz
- Speed: 3,000 rpm
- Voltage: 15.75 kV
- Cooling: hydrogen ( $H_2$ )
- Excitation: static
- Output: up to 350 MVA

The generator with its compact dimensions provides an output up to 350 MVA.

The generator's interior is sealed from the atmosphere, which minimizes the effects of dust, salt, humidity, and any other aerosols.

Together with a rotor shaft, manufactured from a single piece, solid forging from a vacuum casting, high safety standards are ensured for the daily generator operation. Inside the sealed stator housing hydrogen gas transports the heat of the active parts. It is cooled by gas-to-water heat exchangers.

For filling and removal a gas system comprising compressed air, inert gas and hydrogen is used. It allows a staged and controlled filling and emptying procedure.





# 4-pole generators – our reliable solution for industrial applications

Our thermal driven 4-pole generators offer high efficiency, output up to 60 MVA combined with low weight. A simplified foundation plate allows quick alignment and easy installation.

The generator is available with totally enclosed water-to-air-cooling (TEWAC), closed air-to-air-cooling (CACAC), or open-ventilated (OV) cooling and can be chosen according to the power plant requirements and conditions.

The excitation type (brushless or static) can be adapted to customer demands. Rather than having only a portfolio of “off the shelf” products, one of the main advantages of ANDRITZ turbo generators are the ability to customize products by using various options.

A multiplicity of frame sizes and core lengths gives the possibility to achieve optimal electrical properties and best efficiencies at required operating conditions of the power plant. The robust design of the generator guarantees a long life-time and reduced maintenance costs.

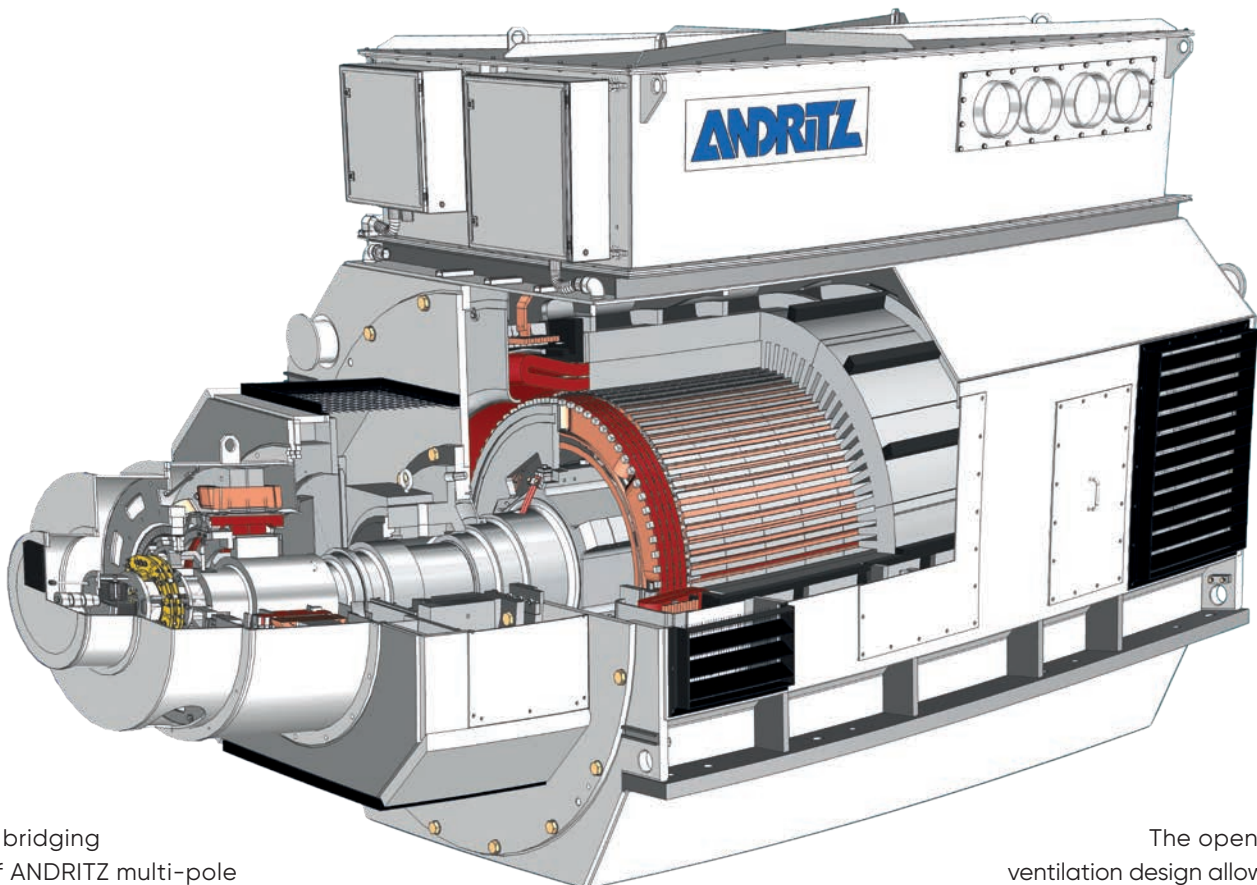
## TECHNICAL FEATURES:

- Frequency: 50 Hz / 60 Hz
- Speed: 1,500 rpm / 1,800 rpm
- Voltage: 3.3 kV – 13.8 kV
- Cooling: TEWAC, OV, CACA
- Excitation: static, brushless (w/o PMG)
- Output: up to 60 MVA





# Multi-pole generators – best compact solution for gas engines



A bridging of ANDRITZ multi-pole generators for hydro applications and our experience in turbo generators results in our ability to design and manufacture various types of air-cooled multi-pole generators, covering any speed, voltage and output. These turbo generators fulfill specific customer demands in terms of vibration resistance, electrical stability, high inertia, mounting arrangement, cooling design and offer the choice between brushless or static excitation systems.

The depicted gas motor driven multi-pole generator was designed for decentralized, small size power plants utilizing combustion engines for power generation. It guarantees high flexibility for changes of grid conditions, robustness against grid faults, and provides stabilization of the grid.

The open ventilation design allows a quick and simple installation also in remote areas. Dual terminal outlet design includes dual internal wiring and allows an easy switch of the outlet terminals from left to right side. This allows maximum flexibility during plant set-up.

## TECHNICAL FEATURES:

- Frequency: 50 Hz / 60 Hz
- Speed: 900 rpm / 1,000 rpm
- Voltage: 3.3 kV - 13.8 kV
- Cooling: open ventilation
- Excitation: static, brushless (w/o PMG)
- Output: up to 15 MVA

# Service portfolio for long life-time and best performance

ANDRITZ has reached remarkable milestones on implementing latest developments and technologies of the turbo generator design, enabling our customers to cope with the new market demands and conditions.

## LIFE-CYCLE SERVICES

### INSPECTION AND OVERHAUL

To preserve best availability and to minimize risk of unwanted standstills and maintenance, ANDRITZ with its long term experience provides inspections of turbo generators, its electric and mechanical auxiliaries, diagnosis and analysis, as well as planned maintenance. With the direct contact to the design and research departments, the provided engineered service solutions always incorporate state-of-the-art technology for serviced generators while increasing reliability and prolonging the lifecycle.

We perform turnkey inspections and overhauls of turbo generators from outage preparations, dismantling and reassembly to diagnosis and execution of the necessary repairs.

Our portfolio for turbo generator inspections and overhauls includes:

- **Inspections (generator, auxiliaries, excitation, protection systems)**
- **Robotic Air Gap Inspection**
- **Diagnosis and analysis**
- **Turnkey overhauls**
- **Delivery of spare parts**
- **Refurbishment**
- **Trouble shooting**

Our extensive know-how enables us to support our customers in optimizing their earnings over the lifetime of the generating unit and contributes to:

- **Reducing the risk of unscheduled outages**
- **Optimizing outage planning maintaining sustainable high availability and reliability**
- **Monitoring of trends and analyzing the changes in the different operation parameters**

### MAINTENANCE

We offer numerous services for scheduled and unscheduled maintenance activities. We offer planning, management and execution of minor and major revisions and overhauls including condition assessment, repairs and spare part management. Long-term service agreements with customized services complement our portfolio.

### ONLINE MONITORING - DiOMera

Supply, installation, and commissioning of online monitoring packages are important when safeguarding the overall functionality of generating units, ensuring sustainable operation of electric power plants. We are supporting our clients in identifying the most economical solution for their turbo generators.

The tailor-made solution is a combination of dedicated modules developed by ANDRITZ integrating third-party packages available on the global market.

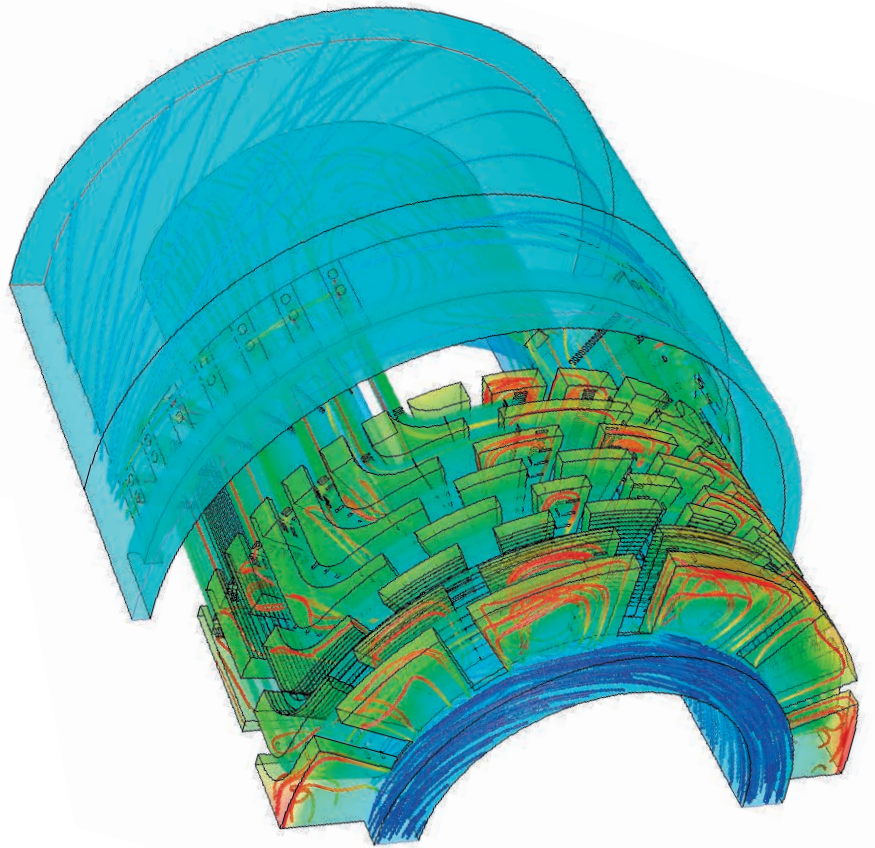
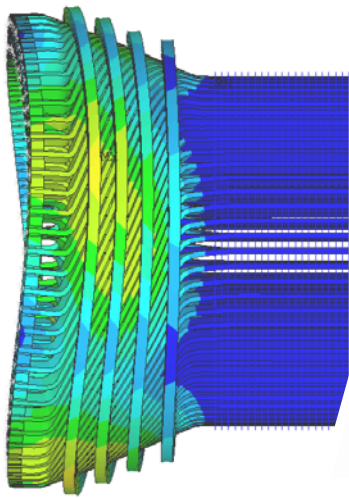


## HIGHLIGHTS

- Turnkey inspections and overhauls
- Robotic Air Gap Inspection
- Repair of third party generators
- Reduced risk of standstills and unplanned maintenance







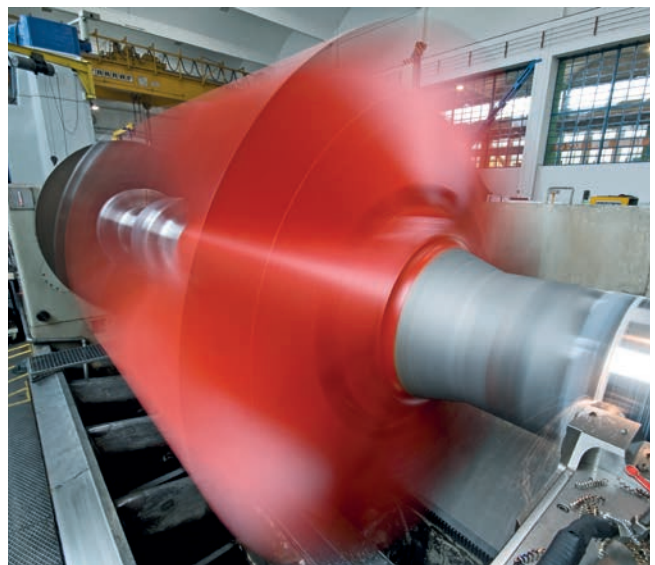
# Improving leading generator technology

Due to the changing market conditions, customer requirements, and technological developments, there are still many challenges for research and development (R&D), comprising generator technology, automation, auxiliaries and grid compliance.

Our global R&D activities are focused on achieving improvements in processes, materials and design methods. Besides the Finite Element Analysis (FEA), which has become a standard tool for static and dynamic stress analysis, 2D and 3D electromagnetic field and frequency analysis, the Computational Fluid Dynamics (CFD) is used for optimizing cooling air flow and investigations on heat transfer.

Flexibility of operation and robustness of electro-mechanical equipment over a long life cycle are today's major challenges. Therefore, the research activities are targeted at the optimization of mechanical and electrical performance. By developing and applying numerical simulation methods and verification by measurements using internal test facilities (generator-, bar- and other high-voltage

test fields, miscellaneous laboratories, balancing and overspeed facilities) and on-site as well by cooperation with universities we maintain a steady technological progress meeting the high expectations of our customers.





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