SYNCHRONOUS CONDENSERS

THE SMART SOLUTION FOR MODERN GRIDS

ANDRITZ

ENGINEERED SUCCESS
Maintaining the reliability of the grid is becoming more challenging

Demanding new regulatory requirements and a cleaner, more diversified energy mix are giving rise to new issues for electricity grid operators tasked with maintaining a stable energy supply. The Synchronous Condenser is a reliable, proven, and cost-effective solution.

A CHANGING POWER SECTOR
A power sector dominated by renewable resources is fundamental for the global transition to sustainable energy. However, changes in the generation mix from increasing volumes of widely distributed and intermittent renewable energy generation, coupled with the phasing-out of fossil-fuelled resources, is creating a major challenge for grid operators which have to ensure a stable, reliable and secure transmission and distribution network.

For transmission system operators Synchronous Condensers are able to provide these stabilization capabilities that are being lost from the grid because of the transformation of the generation mix.

Rotating electrical machines operated as Synchronous Condensers are experiencing a renaissance as a result. While continental Europe, the UK, Ireland, Australia and the Americas represent the biggest markets for Synchronous Condensers, the trend is global and is increasing at an accelerated pace.

REACTIVE POWER AND MORE
Synchronous machines in general can be used as generators as well as motors. Typically, a Synchronous Condenser is a classical synchronous machine which is operated to provide reactive power only. Synchronous Condensers are typically installed in existing or new substations though there are alternatives.

Due to the electrical design and the large rotating mass of the rotor, Synchronous Condensers can provide a variety of additional services beyond reactive power for the grid though. In fact, over recent years a distinct shift in the grid services demanded from Synchronous Condensers has been observed.

For instance, Synchronous Condensers are also able to provide dynamic voltage support, additional inertia, and strengthen system short-circuit capacity. Synchronous Condensers are thus capable of supporting Transmission System Operators (TSOs) with multiple grid stabilization services.
“Synchronous condensers are an effective solution for the new requirements of the grid.”

PROVIDING INERTIA - IMPROVING STABILITY
In a power system, grid frequency is an indicator of the balance between generation and consumption. Where large imbalances occur, qualities such as the grid frequency can be impacted. However, even if big changes in supply or demand occur rapidly, for example when a generation plant trips off the grid, sufficiently large amounts of inertia can attenuate or avoid any High Rate of Change of Frequency of the Grid (RoCoF) effects. In such cases, TSOs can ensure stable operation and security of supply.

Synchronous Condensers are the perfect instrument to provide such inertia, which can be naturally produced by the rotating mass of the machine or even increased with the addition of external flywheels.

DYNAMIC VOLTAGE SUPPORT
The injection of high reactive currents during and after grid faults is also fundamental to avoid voltage collapse. Synchronous Condensers are designed to deliver such a response and can even provide an extended time-limited overload capability, for example sustaining 200% for 30 seconds.

SHORT CIRCUIT POWER - ESSENTIAL FOR SYSTEM PROTECTION
Short-circuit power plays a vital role in the proper functioning of the protection system of an electricity transmission grid. In fact, in order to be granted a connection permit it is typically mandatory that sufficient short-circuit power is available at the connection point.

Non-synchronous power generation - solar, wind, or HVDC connections for example - cannot significantly contribute to the available short circuit power though. Synchronous Condensers, which are able to provide up to five times more short circuit power than their rated capacity, are therefore able to become a major contributor to the short-circuit power of any grid dominated by renewable generation.

REACTIVE POWER
For decades Synchronous Condensers have been used to provide reactive power, which is needed for static voltage regulation of the grid. Nowadays, this demand for Synchronous Condensers to deliver reactive power remains unchanged.
More than a century of Synchronous Condensers

For more than 120 years ANDRITZ has supplied numerous synchronous and non-synchronous machines, mainly for generation purposes. Today, approximately 5,000 units are still in service all over the world, relying on decades of experience in plant and system integration in the renewable energy business.

The ANDRITZ Synchronous Condenser portfolio covers a range of standardized cylindrical rotor design solutions as well as tailor-made salient pole Synchronous Condenser units. Standardized products are favourable for reduced implementation times, while tailor-made solutions are characterized by reduced losses and optimized operating conditions, for example improved dynamic performance.

ANDRITZ’ engineering excellence is focused on the entire power train, from the Synchronous Condenser unit with its mechanical and electrical auxiliaries right up to the defined Point of Common Coupling (PCC) with the high voltage transmission system.

SPANNING THE WORLD OF GENERATORS
ANDRITZ’ synchronous machines portfolio covers a vast and complex range of applications and illustrates a mastery of a large variety of technologies. ANDRITZ provides state-of-the-art Synchronous Condenser designs, such as those featuring flywheels with reduced friction based on vacuum technology, direct air-cooling systems, sophisticated hydrogen/water cooling systems, and Totally Enclosed Water to Air Cooling (TEWAC). Furthermore, the most advanced salient pole and cylindrical rotor solutions, static and rotating high efficiency excitation systems, advanced monitoring systems and other highly reliable and proven technologies allow ANDRITZ to select the optimum Synchronous Condenser solution to meet the requirements of each particular project.

OVER A CENTURY OF EXPERTISE IN ELECTRICAL AND PLANT
With over a century of expertise in plant optimization while taking full account of current and future grid requirements, new technologies and challenging timeframes, ANDRITZ’ global references in greenfield and brownfield projects confirm our skill in managing highly complex projects throughout the power industry. Acting as the principal contractor or “from water-to-wire” contractor of large hydropower installations, complex associated high voltage systems, pumped storage projects and many others, ANDRITZ’ expertise across the entire span of the power generation sector is unrivalled. To maximize the many benefits of Synchronous Condensors the whole system must be optimized. The starting point for developing a Synchronous Condenser plant is therefore the definition of all critical parameters. These parameters are typically based on simulations of the required characteristics derived...
through transient stability studies and performance analyses, for example. By focusing on modern modeling and simulation tools, which are compatible with Building Information Models (BIMs) for data processing and management, our class-leading engineering across the entire power portfolio delivers the most cost-effective solution. As a result, ANDRITZ is a market leader when it comes to delivering global power sector projects, including Synchronous Condenser solutions.

**OPERATION & MAINTENANCE COMPETENCE**

ANDRITZ’ customers around the world also benefit from our long-term operation and maintenance service contracts. Focused on delivering plant reliability, availability and safety, this service reduces the cost of maintenance and operations through optimization. Metris DiOMera, a digital operations and maintenance solution developed by ANDRITZ, helps to support this goal by constantly monitoring and assessing plant performance. Such advanced remote monitoring systems are able to reduce unplanned outages by means of predictive maintenance.

**AUTOMATION PROFICIENCY**

ANDRITZ’s automation, control, protection and monitoring ensures reliable and safe operation and optimized maintenance of a plant. Synchronous Condensers can be operated in various control modes, for example, and any suitable control algorithm can be implemented as required. Furthermore, seamless switch over between control modes is possible even during operations.

**RESEARCH AND DEVELOPMENT**

Due to changing market conditions, changing customer requirements and advancing technological developments, there are still many research and development challenges in the fields of generator technology, automation, auxiliaries and grid compliance. ANDRITZ’ global R&D activities focus not only on process improvements but also on areas such as the development of new materials and novel designs using the most advanced methods.

For instance, along with tools such as Finite Element Analysis (FEA), 2D and 3D electromagnetic field and frequency analysis, Computational Fluid Dynamics (CFD) tools are used for optimizing cooling airflow and in the investigation of heat transfer.
ANDRITZ’ Synchronous Condensers for a secure and stable future

From greenfield projects to modernization and uprating, ANDRITZ provides top-tier solutions for all kinds of Synchronous Condenser systems. An extensive reference list illustrates the breadth of our experience and technical know-how. It proves the competence of ANDRITZ.

ANDRITZ offers large synchronous salient pole machines with a high capacity and inertia, featuring potentially hundreds of cylindrical rotor units as well as the complete automation system.

In addition, while the global trend to retire fossil-fuelled energy sources has triggered the shut-down of many such power plants these assets can be converted to operate as Synchronous Condenser units. ANDRITZ offers conversion of these existing generation sites which is widely considered the preferred approach to retain the system benefits of a large rotating machine. Reusing existing facilities also results in reduced costs and significantly increases the return on the original plant investment.

Moreover, HVDC substations require exactly the type of system services that can be perfectly provided by Synchronous Condenser facilities. Such systems are already embedded directly within the grid infrastructure and are located precisely where these services are needed.

ANDRITZ technology improves the performance of power generation facilities and grid stability and increases revenue for our customers. For all kinds of Synchronous Condenser systems and from greenfield projects to modernization and uprating, ANDRITZ always delivers top-tier solutions.
MARMELEIRO AND LIVRAMENTO 3, BRAZIL

ANDRITZ is supplying three synchronous condenser systems for reactive power compensation on three new long-distance transmission lines in Brazil. One system will be installed on the existing Marmeleiro 3 525 kV substation with another two systems at the new Livramento 230 kV substation.

The scope of supply also comprises the step-up transformer, circuit breaker, automation, control and protection systems, as well as monitoring systems for the Synchronous Condenser and qualities such as vibration, air gap and partial discharge.

TECHNICAL DETAILS:
Rated Condenser
Output: + 150 / - 90 MVAr
Voltage: 11 kV, resp. 13,8 kV / 60 Hz
Speed: 900 rpm