ANDRITZ SeaSOx

Exhaust gas cleaning systems for the maritime industry

www.andritz.com

The ANDRITZ GROUP
and air pollution control

▲ Seawater FGD plant in Venezuela

ANDRITZ is a globally leading supplier of plants, equipment, and services for various industries in the public, municipal, and private industrial sectors. The publicly listed technology Group is headquartered in Graz, Austria, and has a staff of almost 25,000 employees. ANDRITZ operates over 250 sites worldwide and is a leading global supplier of innovative air pollution control technologies. Our product range combines 30+ years' experience with the specific knowledge gained from hundreds installations around the world. ANDRITZ offers high-end technologies and is a partner you can rely on.

Clean air is the basis of a healthy life

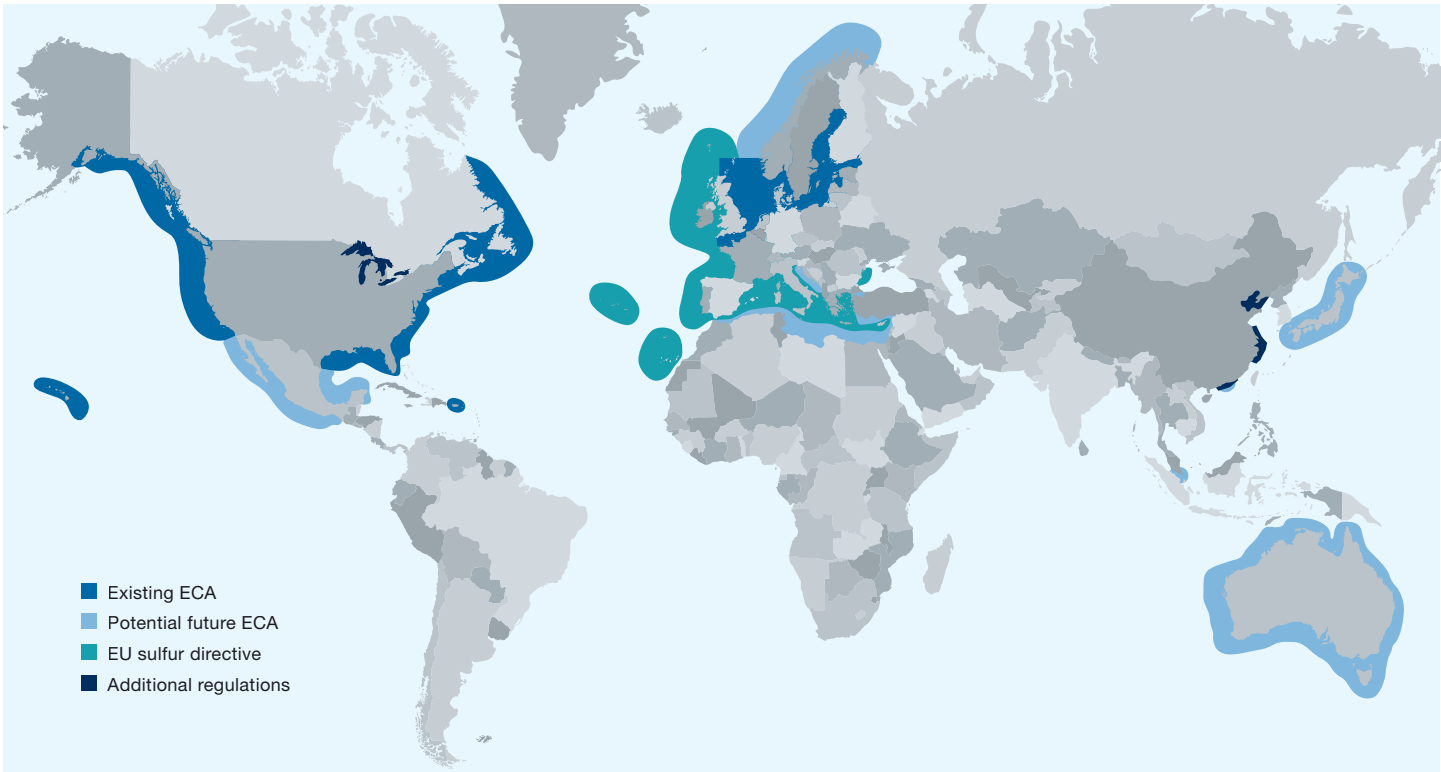
Air pollution causes discomfort or harm to people and other living organisms. It is our mission to prevent air pollution from shipping fleets, power generation, and industrial processes. Thanks to our broad portfolio of air pollution control technologies and extensive experience from completed projects, ANDRITZ is able to handle any challenge your project may pose.

Our product portfolio ranges from flue gas scrubbers, dust and soot separation, to SCR/DeNOx systems and complex flue gas cleaning equipment for waste-to-energy and industrial plants. Our scrubber technologies are tailormade solutions developed for highest efficiencies and used either with seawater as absorption media or wet limestone suspensions and NaOH.

ANDRITZ has numerous references for both technologies, and we are proud to say that all of our reference plants are working to the full satisfaction of our customers. The cutting-edge engineering tools used and global R&D collaboration with a network of recognized partners and universities are the foundation upon which we build our work. Exhaust gas cleaning for shipping is a challenge that can be solved perfectly with the know-how ANDRITZ has gained by designing and optimizing hundreds of installations around the world. Keeping in mind the demand for high availability, the simple but effective scrubber system is the ANDRITZ solution for efficient and reliable exhaust gas desulfurization on board ships. By identifying each client's needs at an early stage, we can make a long-term contribution towards cleaner air and a clean environment.

With offices in the USA, Europe, South America and Asia, ANDRITZ is able to provide our well-proven solutions globally and has the dedicated personnel to meet all clients' needs. A global service network is available for all of our products, so wherever you are – we are available to provide support to our clients.

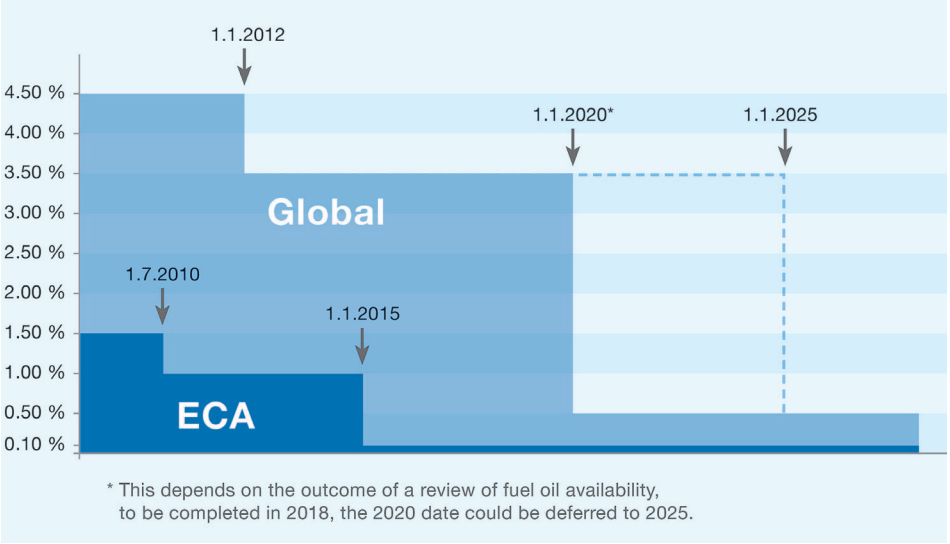
Legislation and regulatory framework
The environmental impact



▼▲ Existing and future regulations

Exhaust gas emissions from marine diesel engines, mainly containing nitrogen oxides, sulfur oxides, carbon dioxides and complex Particulate Matter (PM), are a big concern for human health and the environment.

In response to these concerns, the International Maritime Organization (IMO) has introduced regulations for emission control under Annex VI of the MARPOL Convention. Annex VI imposes a framework of mandatory limits on emissions of sulfur oxides (SOx) and nitrogen oxides (NOx), both globally and within designated sea areas known as Emission Control Areas (ECA).

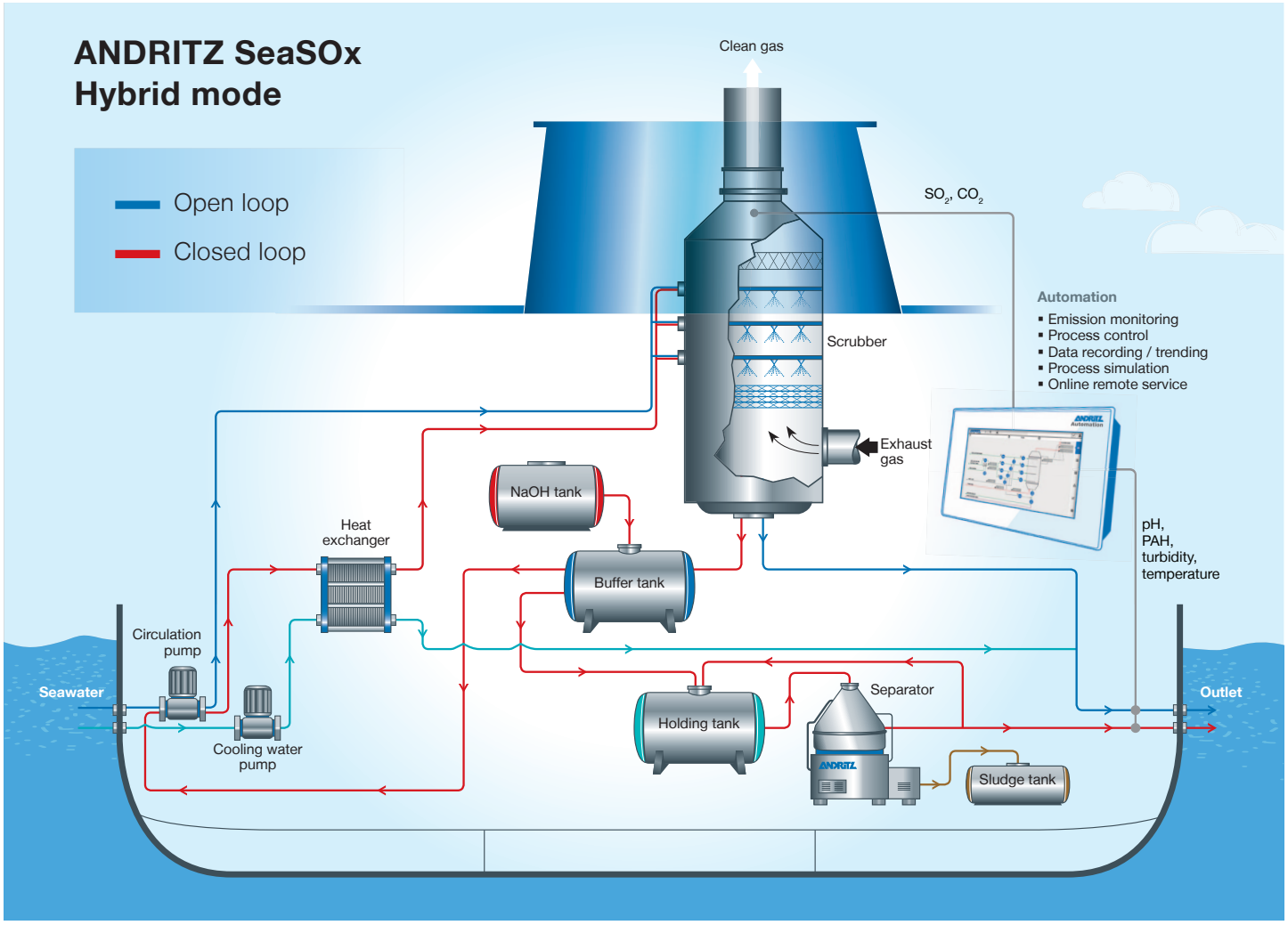


* This depends on the outcome of a review of fuel oil availability, to be completed in 2018, the 2020 date could be deferred to 2025.

The regulations specify the sulfur content allowed in the fuel to limit the SOx emission. A ship may burn fuel with a higher sulfur content, providing that SOx emissions are controlled to a level that is not higher than the levels emitted when using compliant fuel.

In order to comply with the new regulations, ships must either use expensive, low-sulfur fuel, or install exhaust gas cleaning units. Based on the operating profile of ships, exhaust gas cleaning can secure enormous savings in fuel costs and thus provide payback periods of between one and three years. The ANDRITZ SeaSOx technology is the right answer to meet the new requirements and can be installed on all types of ships, either on a new build or retrofit basis thanks to its flexibility.

Process description
Hybrid, open loop, and closed loop



Open loop mode

In open loop mode, seawater is used as a washing medium to clean the exhaust gas. This simple process makes use of the natural alkalinity of the seawater in chemical absorption of the SOx. For this reason, the washing medium is pumped from sea chests to the absorber, where the absorption process takes place by means of spray scrubbing. The treated exhaust gas can then be released to the environment, and the effluent is also discharged. Both the exhaust gas and the effluent have to meet several critical, environmental constraints, which are validated by continuous emission monitoring.

Closed loop mode

If the natural alkalinity is too low or discharging of effluent is not allowed, SOx scrubbing is performed in closed loop mode. In this mode, the washing medium is recycled, and a neutralizing agent (50% wt. NaOH, Na2CO3, MgO) is added in metered doses to obtain a certain absorption capacity. In order to control the absorption temperature and maintain the water balance, an inline heat exchanger is provided on request to cool down the washing medium. Downstream of the absorption stage, the washing medium passes through a buffer tank from where it is pumped back to the absorber again. When the gas is treated, soot particles and salts accumulate in the washing medium. Consequently, the effluent has to be cleaned periodically depending on the engine load, the ship's route, and its fuel specification. For this application, a washing water treatment unit is installed to separate the particles and salts from the washing medium, in accordance with the MARPOL Convention, before it is discharged into the sea. The sludge generated is collected in a separate tank, while the treated washing water is either stored in the holding tank or discharged into the sea, depending on local discharging restrictions.

Hybrid mode

A combination of open and closed loop operations is called hybrid mode. In hybrid mode, it is possible to switch between these two processes depending on the predominant basic conditions (seawater alkalinity, discharge restrictions, etc.). This option provides high flexibility and enables customers to choose the best process, both economically and technically.

Advanced ANDRITZ SeaSOx scrubber

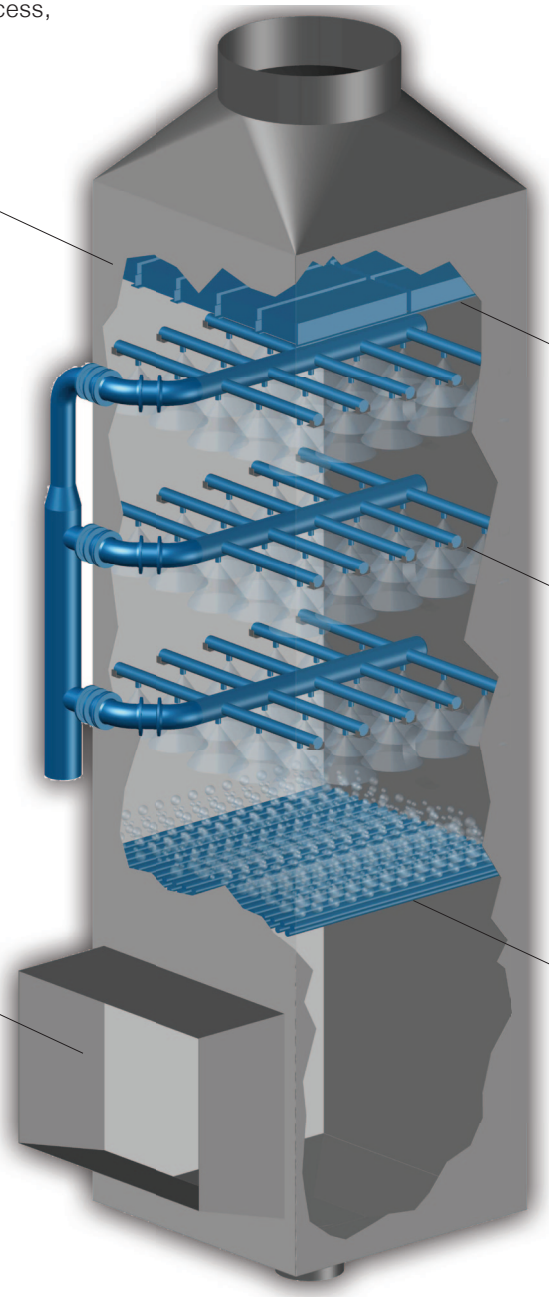
Designed on the basis of more than 30 years of experience in scrubber design and using the most developed CFD models to simulate and optimize flow distribution and SOx mass transfer, the scrubber offers some decisive benefits:

Advantages

- Simple and robust design suitable for inline and by-pass installation
- Substantial noise reduction: The size of the silencer can be reduced if operated in the inline mode.
- Exhaust gas can pass through safely, even when the absorber pumps are not operating
- Highest removal efficiencies with lowest operating costs, combining ANDRITZ proprietary FGDplus technology and optimized spray bank design

Scrubber material concept

Scrubber shell and internals made of alloys with a high Cr, Ni, and Mo content. Perfectly resistant to high chlorine content and high temperatures in the inline operating mode.



Mist eliminator cleaning system

Lamella plates minimizes droplet emission.

Spray bank

The position of the spray nozzles is determined by CFD modeling. The nozzles and spray banks are made of an alloy containing Cr, Ni, and Mo.

Absorber inlet duct

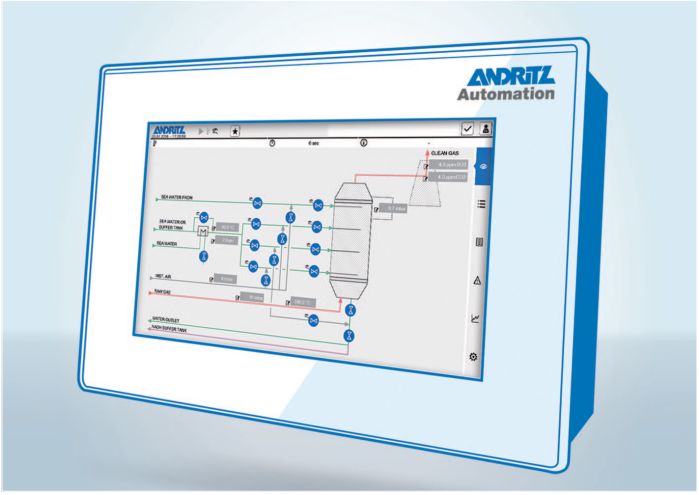
Either side entry or central entry is possible, depending on layout constraints.

FGDplus layer

The patented FGDplus technology from ANDRITZ has proven its advantage over conventional mass transfer systems for power plants up to 600 MWel. For small FGD systems, it shows excellent performance, with the focus on flow equalization in general.

▲ Rectangular design - Due to optimum use of space in ships, ANDRITZ decided to use rectangular cross section as standard

ANDRITZ competences
and key equipment



Automated control

The close cooperation between ANDRITZ AUTOMATION and all business areas of the ANDRITZ GROUP creates significant advantages, such as concentration of process know-how available throughout the Group and customer-focused solutions.

In-house specialists at ANDRITZ AUTOMATION provide an overall control system for ANDRITZ SeaSOx applications, individually tailored to the specific characteristics of each ship and able to communicate with the ship's superior, main control systems, also as an upgrade.
Data from any equipment can be processed in order to optimize procedures:

1. The optimum water feed is supplied to pre-selected spray banks based on empirical knowledge.
2. The emissions analysis also influences control of the circulation pump according to MARPOL.
3. In regions where zero discharge is obligatory, closed loop mode is activated automatically (via GPS) or manually.
4. Data recording/trending of gas emissions and wash water
5. Process simulation add-on increases efficiency during training, maintenance, and Factory Acceptance Test (FAT).
6. Onboard performance, system diagnostics, as well as online remote service

The ANDRITZ SeaSOx control system makes your plant reliable, efficient, and economical.

ANDRITZ disc separators for scrubbing water

Scrubbing water collects a certain amount of insoluble solids each time it passes through the scrubber unit. Much of this solids content can be removed from polluted scrubbing water by processing it with a high-efficiency disc separator.

The clean water from the separator will have a significantly reduced suspended solids content and can then be recirculated back to the scrubbing system. It is also possible to reduce the insoluble content to below 25 FTU in order to discharge the scrubbing water overboard where allowed.

All parts in contact with the scrubbing water are made of special stainless steel suitable for the process conditions. The design of the ANDRITZ separator allows easy and cost-saving operations and maintenance.

Research and development
CFD and wet FGD

▲ Scrubber test facility, University of Leoben, Austria

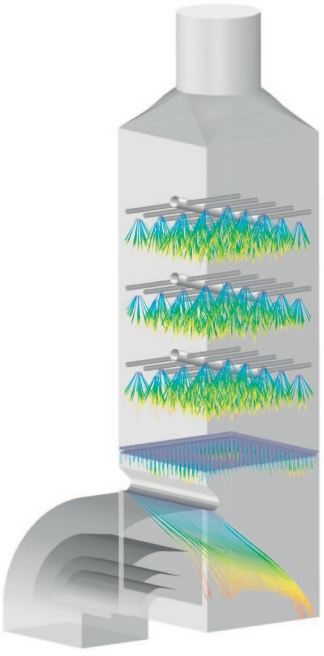
Our lifeblood is a strong, ongoing R&D program. We use state-of-the-art engineering and realization tools to find new and improved environmental processes for today, tomorrow, and further into the future.

Laboratory testing

We have excellent R&D facilities for continuous optimization of our processes and products. A corporate laboratory with extensive test equipment, as well as access to technical centers and lab-scale plants at selected universities in combination with our own pilot plants put us in an excellent position to perform development work for our customers and ourselves. The photo shows one of our test facilities for investigating seawater and NaOH scrubbing for SO_2 reduction. A wide range of parameter variations, highly sophisticated measurement equipment, and the means of testing different types of absorption regimes (packings, spray scrubbing, FGDplus) help us to design and optimize the best suited scrubber configuration for each application.

CFD simulation

Computational Fluid Dynamics (CFD) simulation provides local and/or time-resolved visualization of flow and transport in multiphase processes. For example, pollutant concentrations in apparatus can be pinpointed locally and temporally. Over the years, CFD simulation has enabled us to improve our processes, using calculation models developed in-house. CFD simulations for SO_2 abatement technology on board ships is used to avoid maldistribution of the fluids. It is very important to prevent this in spray scrubbing systems. Additionally, we predict the noise reduction achieved as a result of the geometry and internals of the scrubbing system, both in dry and in wet mode. Simulation is also important in verifying the pH value of the washing water, which can be discharged into the sea in open loop mode. CFD simulations are admitted as evidence according to the Annex VI to the MARPOL Convention (May 2015), and know-how on this application is necessary for the plant certification process.



▲ CFD model of ANDRITZ SeaSOx scrubber

Worldwide ANDRITZ service network

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