

# Mitsubishi Shipbuilding's Environmental Solutions to Contribute toward a Sustainable Society - DIA-SOx<sup>®</sup> Exhaust Gas Cleaning System and LNG Fuel Gas Supply System (FGSS)-



Mitsubishi Shipbuilding Co., Ltd.

*Environmental protection initiatives such as measures against global warming are also underway in a wide variety of fields involving maritime logistics. Mitsubishi Shipbuilding Co., Ltd. has provided environmental solutions to various issues. Among these, as technologies that can meet the pressing needs for satisfying SOx regulations and reducing greenhouse gas (GHG) emissions, the DIA-SOx<sup>®</sup> Exhaust Gas Cleaning System and the liquefied natural gas (LNG) Fuel Gas Supply System (FGSS) are presented in this report.*

## 1. DIA-SOx<sup>®</sup> Exhaust Gas Cleaning System

### 1.1 Background

As a measure to prevent air pollution from the exhaust gas of ships, the International Convention for the Prevention of Pollution from Ships (known as the MARPOL Convention) has introduced progressively tighter regulations regarding the sulfur content in fuel oil.

Even in undesignated general sea areas where the use of fuel oil with a sulfur content of 3.5% was conventionally accepted, it has become compulsory to use fuel oil with a sulfur content of less than 0.5% since January 1, 2020. However, if a suitable onboard exhaust gas cleaning system is installed to reduce the SOx level in exhaust gas to the set standard or below, fuel oil with a sulfur content as high as before is allowed to be used.

### 1.2 Our current status

Having launched the DIA-SOx<sup>®</sup> brand in 2018, we strengthened our production and marketing systems for the exhaust gas cleaning systems that were jointly developed with Mitsubishi Kakoki Kaisha, Ltd. and Mitsubishi Hitachi Power Systems, Ltd. In terms of the scrubber tower, which is the main component, a supply chain has been created through cooperation with multiple factories inside and outside Japan in such a way that even orders with a short lead time can be handled.

### 1.3 Product line-up

Our scrubber system line-up consists of two types: the DIA-SOx<sup>®</sup> C-SERIES with a cylindrical tower and the DIA-SOx<sup>®</sup> R-SERIES with a rectangular tower (**Figure 1**).

The DIA-SOx<sup>®</sup> C-SERIES is suitable for use on marine vessels (such as tankers and bulk carriers) with an engine output of up to approximately 30 MW. Its tower shape with a minimum height also makes it relatively easy to install on marine vessels such as vehicle carriers and RoRo ships (roll-on/roll-off ship). The DIA-SOx<sup>®</sup> R-SERIES of products is intended for use on container ships with an engine output of approximately 30 MW or higher. The shape is specially designed in such a way as to be fitted in a space for installation inside the existing engine casing located away from the living quarters, enabling installation without reducing the space for container loading.

Both series employ a multi-stream configuration that can simultaneously treat exhaust gas from multiple engines, and the exhaust gas cleaning system can operate in either open-loop mode or hybrid mode.



Figure 1 DIA-SOx<sup>®</sup> line-up

## 1.4 Characteristics

### (1) Ship-friendly scrubber systems

In addition to reliable performance for exhaust gas cleaning, our scrubber systems realize ship-friendly scrubber systems minimizing the impact on the ship and the tower by seawater used for cleaning in accordance with the optimal quantity of seawater for cleaning and setting the exhausting gas flow rate in consideration of mist scattering. .

### (2) Installation engineering services

We not only supply the DIA-SOx<sup>®</sup> system equipment, but also provide engineering services for scrubber installation. Based on the technologies and knowledge cultivated through the design of new ships for construction, we target the optimal installation satisfying classification societies' regulations in our product designs (Figure 2).

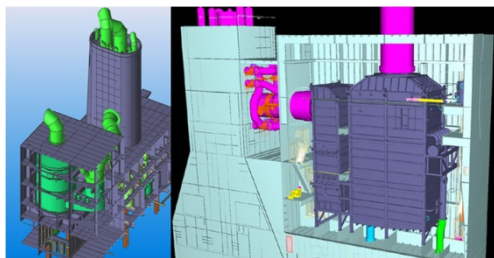


Figure 2 Actual example of scrubber installation engineering

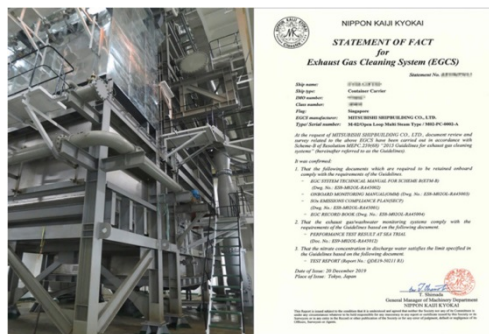


Figure 3 Actual example of DIA-SOx<sup>®</sup> system installation and certificate of approval

## 1.5 Delivery records

Developing our business around these two pillars (i.e., supply of system equipment and installation engineering services), we have received orders for nearly 60 units as of the end of February 2020. Among these, roughly 20 units have been delivered, and roughly 10 units have gone through the run-in process and are already operating on the ships of our customers. Figure 3 gives an actual installation example of our DIA-SOx<sup>®</sup> system and the certificate of approval issued by the classification society.

For the system installation and running-in process, an operation tune-up team consisting mainly of our company's personnel is dispatched to perform optimal tuning for individual ships. So far, all the ships including those with the first model of the DIA-SOx<sup>®</sup> system have been continuously operating in a stable manner, thereby helping customers to conduct stable ship operation.

## 1.6 Future prospects

In addition to developing next-generation systems, we will further work on the projects to expand our overseas business operations and strengthen our production system. The DIA-SOx<sup>®</sup> Exhaust Gas Cleaning System will continue to evolve as a brand of customer choice.

## 2. LNG Fuel Gas Supply System (FGSS)

### 2.1 Background

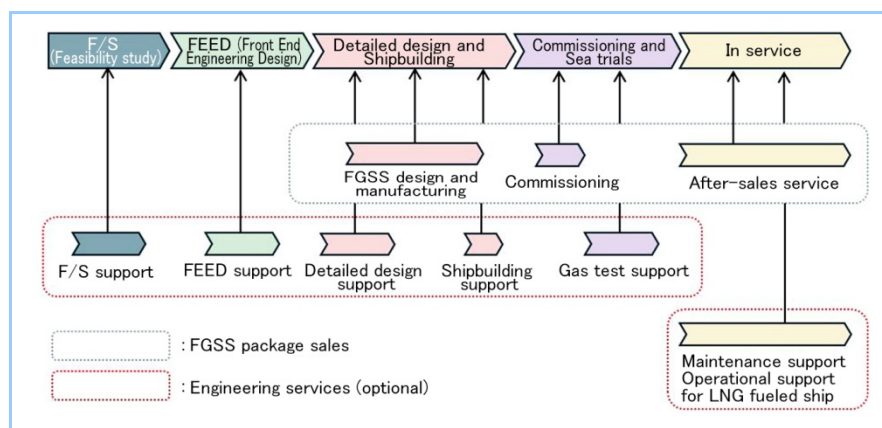
In 2018, the International Maritime Organization (IMO) adopted a GHG reduction strategy toward achieving zero GHG emissions from international maritime transport by the end of this century. Specifically, it targets a 40% efficiency improvement by 2030 and a 50% reduction in total emissions by 2050.

Of various measures taken to reduce GHG emissions, LNG fuel is considered to be the most promising and realistic solution at this point in time, because it is already applicable for use in large propulsion plants and the strengthening of its supply system is being carried out. The number of LNG fueled ships is expected to increase in the coming years. This chapter introduces the products and services we can offer for FGSS, which is essential for LNG fueled ships.

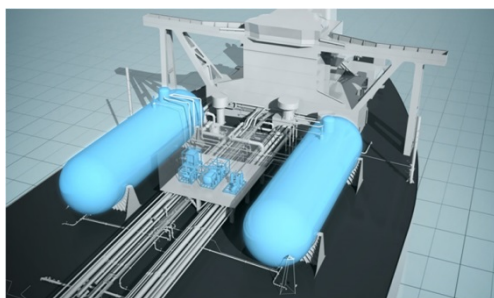
### 2.2 Our current status

Making use of the liquefied gas handling technologies cultivated through our many years of business experience in building and repairing LNG carriers and liquefied petroleum gas (LPG) carriers, we serve our domestic/overseas customers engaged in building/operating LNG fueled ships by offering FGSS packages and gas engineering services for LNG fueled ships with our FGSS installed (hereafter referred to as the “engineering services”).

**Figure 4** summarizes the FGSS package sales and engineering services. **Figure 5** shows an example of how FGSS modules and LNG fuel tanks (hereafter referred to as “modules” and “tanks,” respectively) are installed on an LNG fueled ship.



**Figure 4** Outline of FGSS package sales and engineering services



**Figure 5** Example of installation on LNG fueled ship (modules and tanks)

### 2.3 Characteristics

We supply the components required for LNG fuel gas supply include the modules, tanks and control system, which are offered as a package. These are characterized by the following:

(1) Optimal layout design through modular approach

The major components (such as LNG vaporizer and gas compressor) are incorporated into a space-saving module with superior operability and maintainability, and are provided as such.

(2) Various types of tanks applicable

The applicable types of tanks include not only IMO type C, but also ISO tank containers and membrane type tanks, thus enabling the proposal of optimal solutions.

(3) Plant design with superior load following control and operability

The applied plant designs are those with superior load following control over a wide range of operation modes including main engine load change and emergency shutdown while offering superior operability, and are based on advanced dynamic analysis technologies and design expertise.

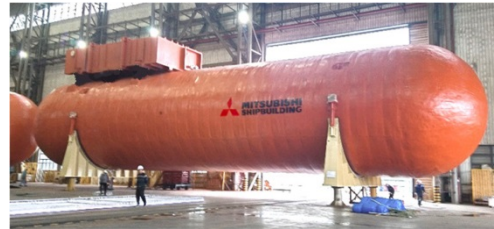
(4) Control system design that can meet customer needs

By utilizing our proprietary experience in developing the integrated automation system (IAS) for LNG carriers, i.e., cargo handling and propulsion plant control systems, we can provide customized control systems in accordance with the needs of individual customers.

In terms of engineering services, throughout the stages of an LNG fueled ship project from feasibility study through design/shipbuilding/sea trials to in-service operation, we offer customers total support from our engineers who are knowledgeable about gas handling. Specifically, the services available include on-site support for tank installation and pipe outfitting, as well as gas handling operation support such as gas tests, LNG bunkering after ship delivery, and tank operation support before/after entering or leaving the dock. **Figures 6 and 7** illustrate our company's module and tank (already delivered to customers), respectively.



**Figure 6 Our company's module (delivery completed)**



**Figure 7 Our company's tank (delivery completed)**

## 2.4 Future prospects

By making use of our design, analysis technologies and quality control system, we provide high-quality FGSS and fine-tuned engineering services to promote the increasing use of LNG fueled ships.

For product information, please visit the following websites:

DIA-SOx: [http://www.msb.mhi.co.jp/en/products/AF/dia\\_sox/](http://www.msb.mhi.co.jp/en/products/AF/dia_sox/)

FGSS: <http://www.msb.mhi.co.jp/en/products/FGSS/>

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