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PureNOx Prime

EGR water treatment system for operation with low-sulphur fuel



Application

High focus on emissions from ships is driving the stringent regulations for reducing NOx emissions beyond current levels (Tier II). Vessels with a keel-laid date on or after 1 January 2016 that travel in NOx Emission Control Areas (ECAs) will require engines certified for IMO Tier III.

PureNOx Prime cleans the circulation water in an Exhaust Gas Recirculation (EGR) process operating on low-sulphur fuel. EGR is one of the solutions for compliance with Tier III NOx reduction demands and has the potential to be the NOx abatement frontrunner, especially as it requires very limited space in the engine room and has lower operating costs compared with other technology.

Alfa Laval is collaborating with MAN Diesel and Turbo on the EGR process and has developed a PureNOx Prime as a dedicated EGR water treatment system (WTS).

Benefits

- *A well-established solution* underpinned by more than 3 500 hours of real-world operation at sea
- *Saved space and installation expenses* thanks to compact and simple installation
- *Increased uptime* thanks to the possibility of operating EGR with reduced capacity during maintenance of PureNOx Prime
- *Reduced operating costs* due to reduced EGR sludge generation volumes (lower onshore disposal costs) and power consumption when operating at engine partial load

System description

PureNOx Prime is a modular system designed for cleaning water in low-sulphur EGR systems for marine applications. The low-sulphur fuel used shall fulfill the international distillate fuel specification according to ISO 8217-2010 (DMX/DMA/DMZ/DMB).

Main functions:

- Cleaning of EGR water for engine protection
- Cleaning of overboard discharge water in compliance with IMO Resolution MEPC.184(59)

All components in the PureNOx Prime water treatment system are mounted on three separate units:

- Buffer tank unit (BTU)
- Water treatment unit (WTU)
- Waste reduction unit (option)

The main equipment comprises the following:

- SWPX-type separators with ancillary equipment
- Water buffer tank
- Control cabinet
- Control system for wash water overboard (option)
- Waste reduction function (option)

Process

The complete EGR solution consists of two main water circulation lines: the EGR water line and the water cleaning line. The water in both lines is circulated through a common buffer tank (2).

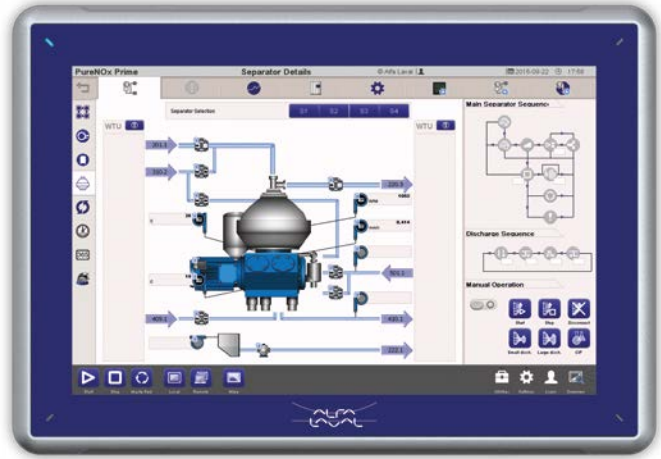
The EGR circulation water, along with condensate from the combustion process, is collected at the bottom of the EGR system's pre-spray (1) and then flows down to a receiving tank unit (RTU), (not supplied by Alfa Laval) placed under the pre-spray. A feed pump (not supplied by Alfa Laval) forwards the water to the buffer tank (2) on the BTU.

A feed pump with variable-frequency drive control directs polluted water from the buffer tank on the BTU to the WTU. On the WTU a high-speed centrifugal separator (7) continuously processes the polluted water. To increase the separation efficiency, coagulant is added to the water circulating line. The coagulant causes particles to aggregate, creating flocs that are easier to separate. A coagulant tank is installed on the WTU. The cleaned water is directed back from the WTU to the buffer tank.

A pump (not supplied by Alfa Laval) in the EGR water line takes the clean water from the buffer tank back to the EGR system's pre-spray unit (1).

The sludge from the separator is directed to an EGR sludge tank. If the EGR sludge tank is not close to the separator, an optional sludge removal kit (OP1) may be installed.

If an optional overboard control system (OP2) is installed and wash water criteria are fulfilled as monitored by water quality sensors (8, 10, 11), an overboard discharge can be performed. If the criteria are not fulfilled, the water is directed to the EGR drain tank instead (12).



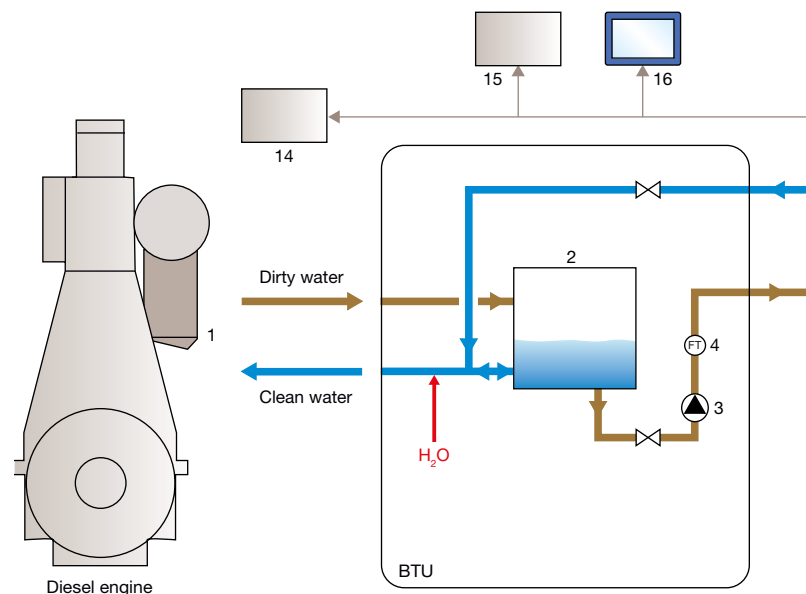
Alfa Laval Touch Control interface.

Control functions

PureNOx Prime is equipped with the Alfa Laval Touch Control System, which has a graphical touchscreen interface. Alfa Laval Touch Control offers fully automatic monitoring and control of the water treatment process, thereby minimizing the workload for the crew. The discharge of cleaned water overboard can be approved via the control panel by authorized personnel.

The PureNOx Prime control system communicates with the diesel engine's EGR control system. Remote monitoring from

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|----------------------------|---------------------|
| 1. EGR unit with pre-spray | 6. Coagulant tank |
| 2. Buffer tank | 7. Separator |
| 3. Feed pump | 8. Turbidity sensor |
| 4. Flow transmitter | 9. Three-way valve |
| 5. Coagulant pump | 10. pH sensor |



the engine control room is possible via the installation of a remote Alfa Laval Touch Control panel. The system can also be connected via computer bus communication (Modbus TCP, Modbus RTU, Profibus etc.) or hardwired signals directly into the ship's integrated automation system.

All functions and values are logged in the control system, which greatly enhances the potential for troubleshooting. The control system is prepared for connection to the vessel's GPS receiver, with sync of the ship's position and times for overboard discharges of cleaned water. The log data can be exported and viewed in a user friendly way via Alfa Laval visuALog software, enabling data analyses and creation of overboard event reports.

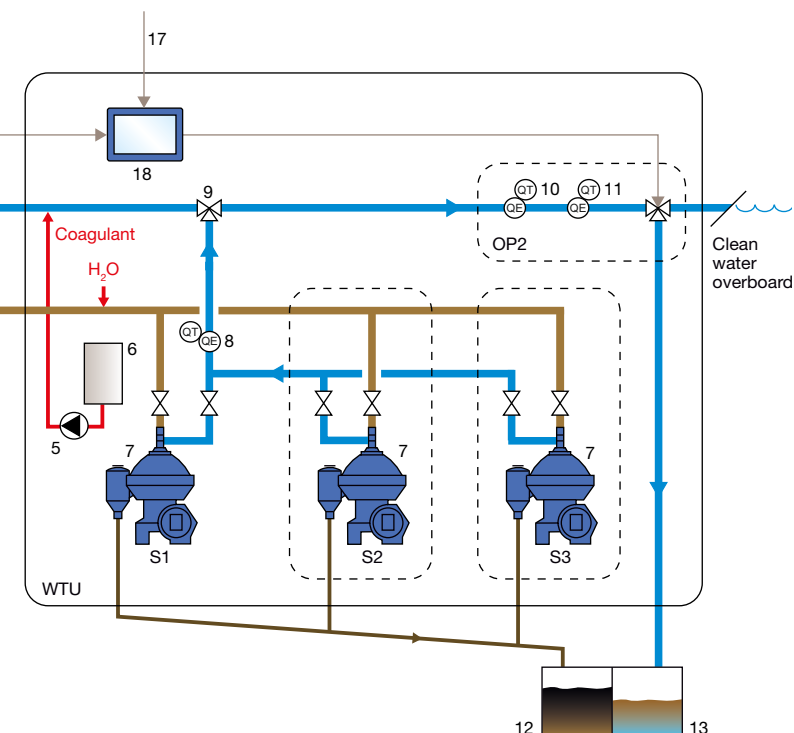
Regulations

PureNOx Prime fulfils all applicable requirements and rules from IMO and classification societies.

The compliance of the cleaned water being discharged overboard with IMO resolution MEPC.184(59) is monitored by the system's sensors and control system. The measured values are recorded and stored for later inspection by authorities, if required. All discharge data required by IMO (PAH, pH and turbidity values) is stored in the system for 18 months in a tamper-proof file format.

The water quality sensors themselves (PAH, pH and turbidity sensors) also fulfil IMO's requirements.

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|---------------------|---|
| 11. PAH sensor | 15. Ship's integrated automation system |
| 12. EGR sludge tank | 16. Remote Alfa Laval Touch Control panel |
| 13. EGR drain tank | 17. GPS connection |
| 14. EGR control | 18. Alfa Laval Touch Control panel |



Exhaust Gas Recirculation

PureNOx Prime operates as an integrated part of a diesel engine's Exhaust Gas Recirculation (EGR) pre-spray system. An EGR system recirculates up to 40% of the exhaust gas into the charge air chamber, lowering the oxygen content in the cylinder and increasing the specific heat capacity. This reduces the combustion temperature and suppresses the formation of NOx emissions.

To prolong the service life of engine components, a pre-spray circulates water to remove soot and sulphur oxides (SO_x) from the recirculated exhaust gas. PureNOx Prime effectively cleans the pre-spray water, removing impurities that may interfere with the process and also fulfilling IMO water purity requirements to enable discharge into the sea. Only a small amount of additive in form of NaOH is required, depending on the sulphur content in the fuel.

Compared to other NOx emission reduction systems, an EGR system offers these advantages:

- *Compact footprint and simple installation.* An EGR system including Alfa Laval PureNOx Prime is designed as an integral part of a MAN two-stroke marine diesel engine.
- *Easy operation and operation at very low engine loads.* A fully automated EGR control system ensures quick and correct response to engine load variations, providing immediate compliance with NOx legal requirements when switching on the EGR system.
- *Long-term economy.* EGR is the best alternative considering operating expenses.
- *Peace of mind.* An EGR system fully tested and certified according to NOx code at the engine builder.

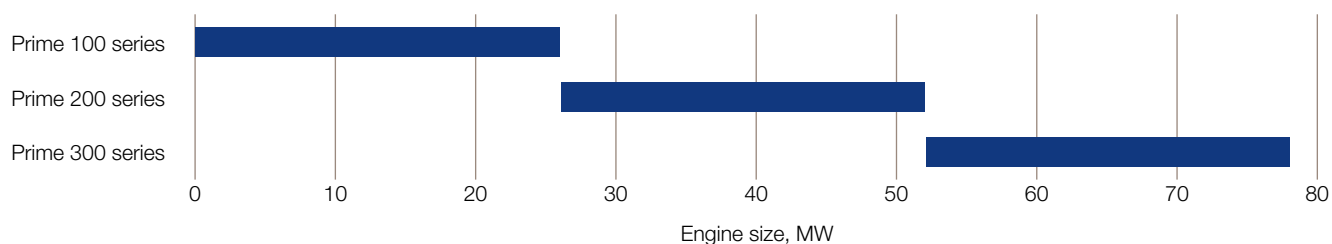
Existing installations

Several EGR installations with Alfa Laval water treatment systems are in operation today. Ships belonging to major shipowners like Maersk Line, Chevron and NYK have all been equipped with Alfa Laval PureNOx water treatment technology.



Vessel Equipped with Alfa Laval PureNOx technology.

PureNOx Prime capacities



Technical data

PureNOx Prime type	Total weight (dry), BTU + WTU (prel.)	WTU dimensions	BTU dimensions
Prime 100 series	1180 + 3130 ± 500 kg	2900 × 1800 × 2250 mm	1800 × 1700 × 2272 mm
Prime 200 series	1400 + 6120 ± 500 kg	2900 × 3600 (1800 × 2) × 2250 mm	1950 × 1850 × 2525 mm
Prime 300 series	1630 + 9120 ± 500 kg	2900 × 5400 (1800 × 3) × 2250 mm	2050 × 1850 × 2740 mm

PureNOx Prime type	Power consumption (nominal)	Water consumption	Air consumption
Prime 100 series	18–39 kW	5 l/h make-up water + 1 l/discharge, for each separator	140 NI/h
Prime 200 series	72 kW	5 l/h make-up water + 1 l/discharge, for each separator	200 NI/h
Prime 300 series	104 kW	5 l/h make-up water + 1 l/discharge, for each separator	260 NI/h

Media to be treated	EGR pre-spray circulation water, containing mainly soot with salt content
Fuel to be used in diesel engine	Low-sulphur distillate fuel fulfilling ISO 8217-2010 (DMX/DMA/DMZ/DMB)
Main supply voltage	According to order
Optional equipment	OP1 – Sludge removal kit, OP2 – Overboard control system, OP3 – Waste reduction kit, OP4 – Space heating for electric motors

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