

K-ECOS

Kawasaki-ECO System

IMO NOx Tier 3 Compliant,
Environmentally-friendly
Low Emission System



Kawasaki Heavy Industries, Ltd.

Gas Turbine & Machinery Company Machinery Division

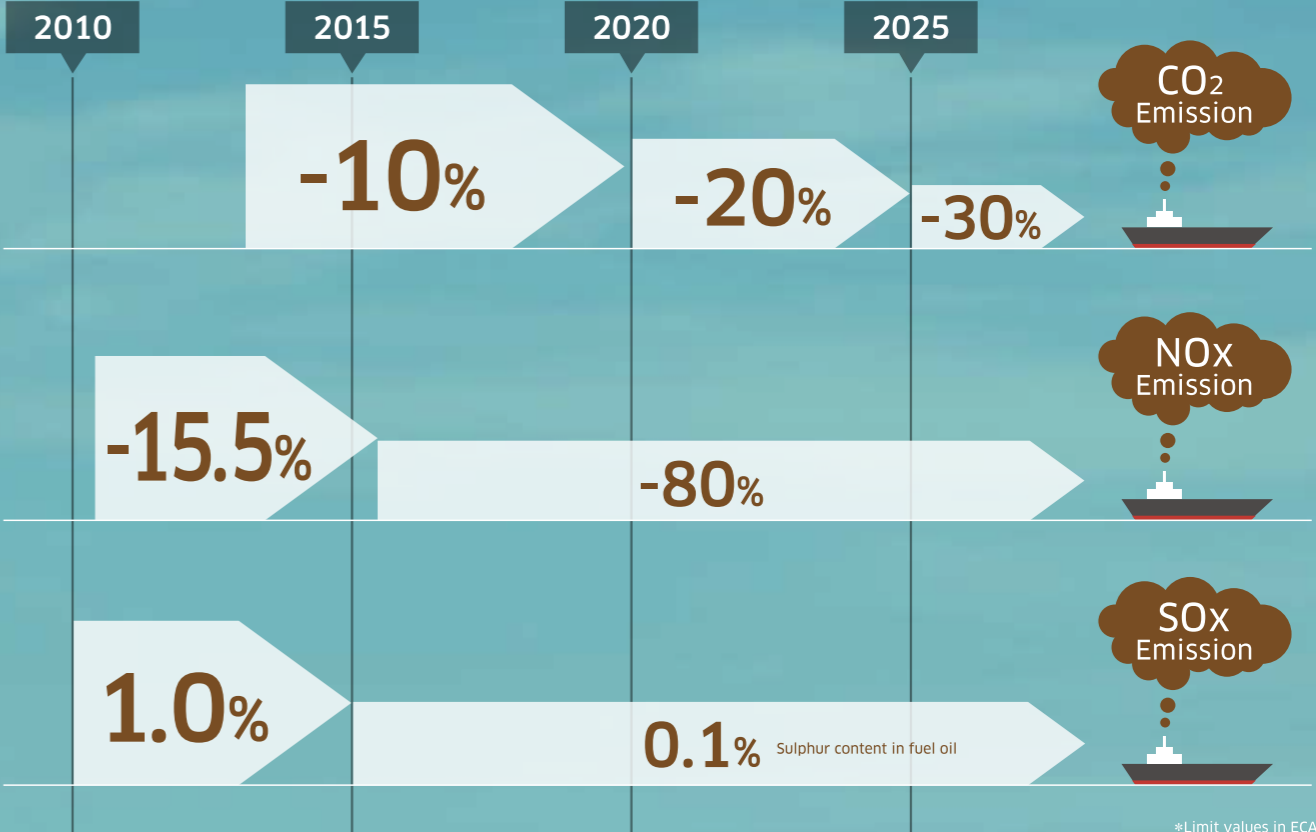
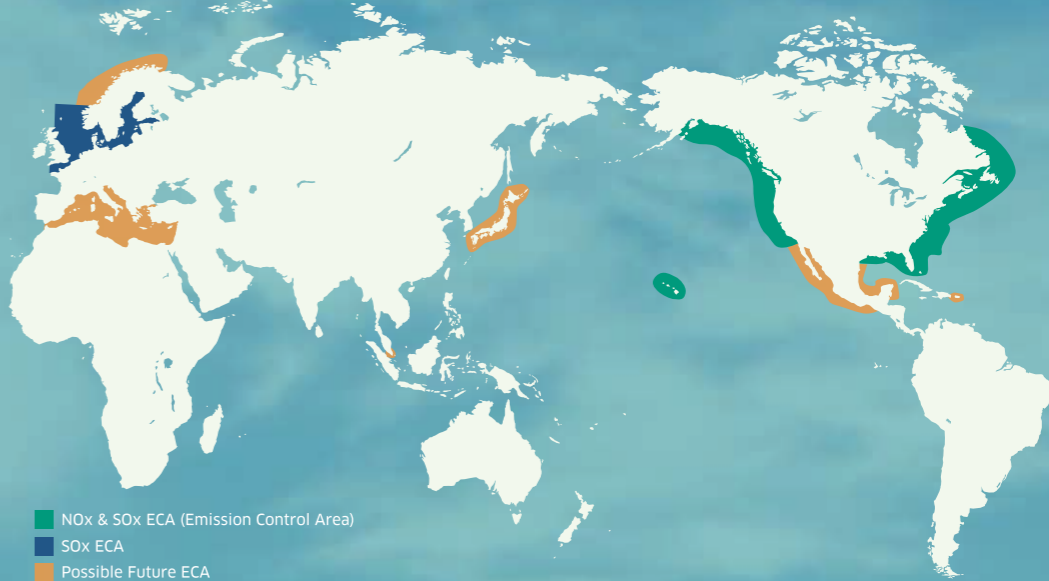
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Kawasaki pursues “Earth-friendly” manufacturing

Together with about 100 group companies in Japan and overseas, Kawasaki Heavy Industries oversees the formation of a “technology corporate group”. Our technological capabilities, polished over a history that exceeds a century, send diverse products forth into wide-ranging fields that go beyond land, sea, and air, extending from the ocean depths to space. Through the development of unique and broad businesses unmatched elsewhere, we will continue to create new values that solve the issues facing our customers and society.

Powering your potential

Environmental Regulation



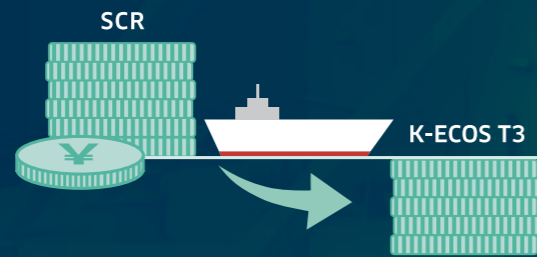
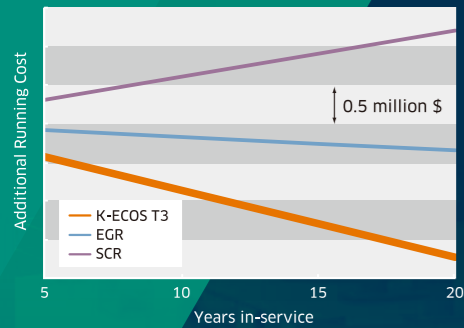
*All data contained in this brochure are subject to change without prior notice.

“K-ECOS” Created by Kawasaki Advanced Technologies

K-ECOS is an environmentally-friendly low emission system compliant to IMO NOx Tier 3 regulation. K-ECOS created by Kawasaki advanced technologies has achieved a highly economical running and the compactness.

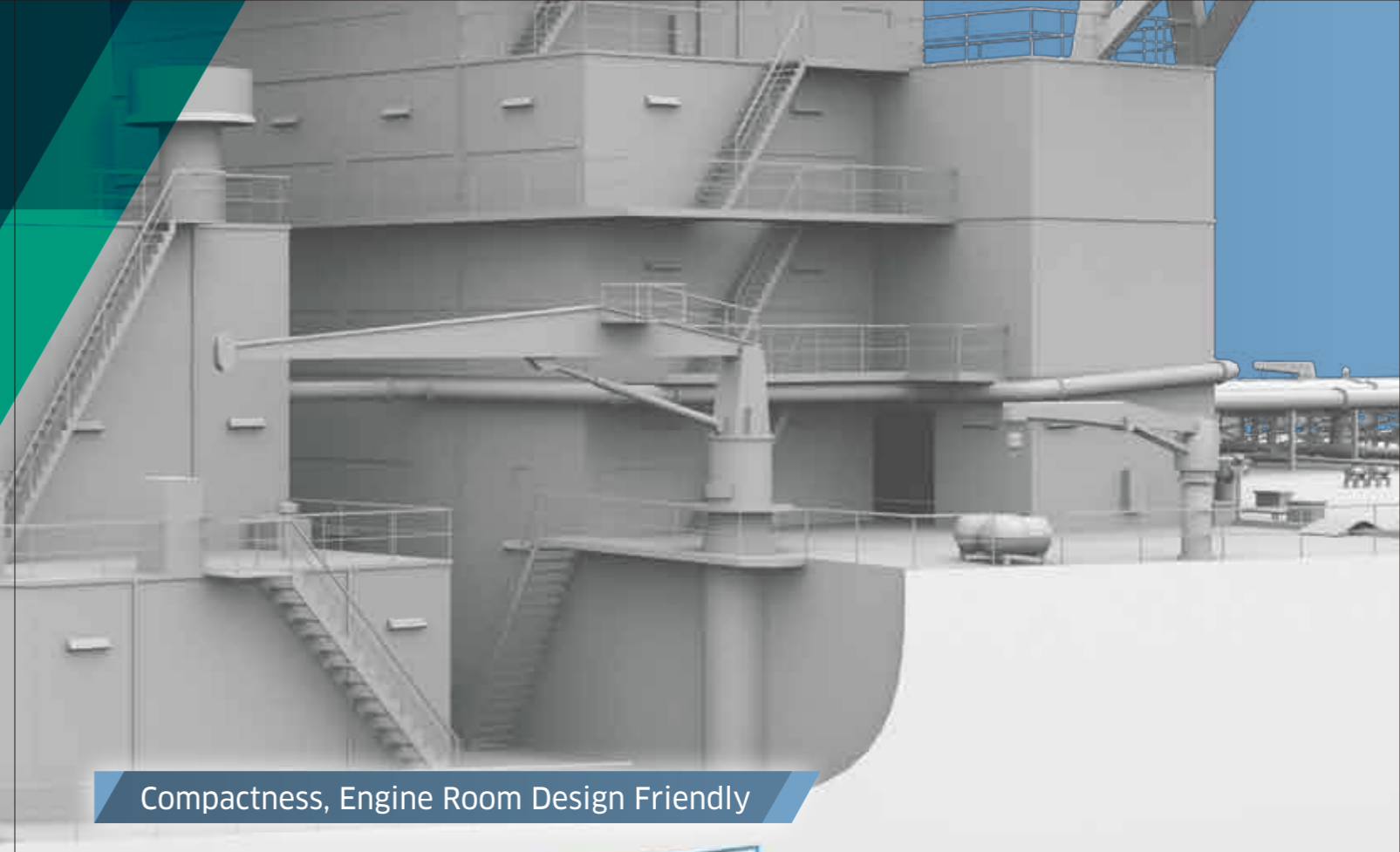
Economical Running

■ Additional running cost compared with IMO NOx Tier 2 compliant engines

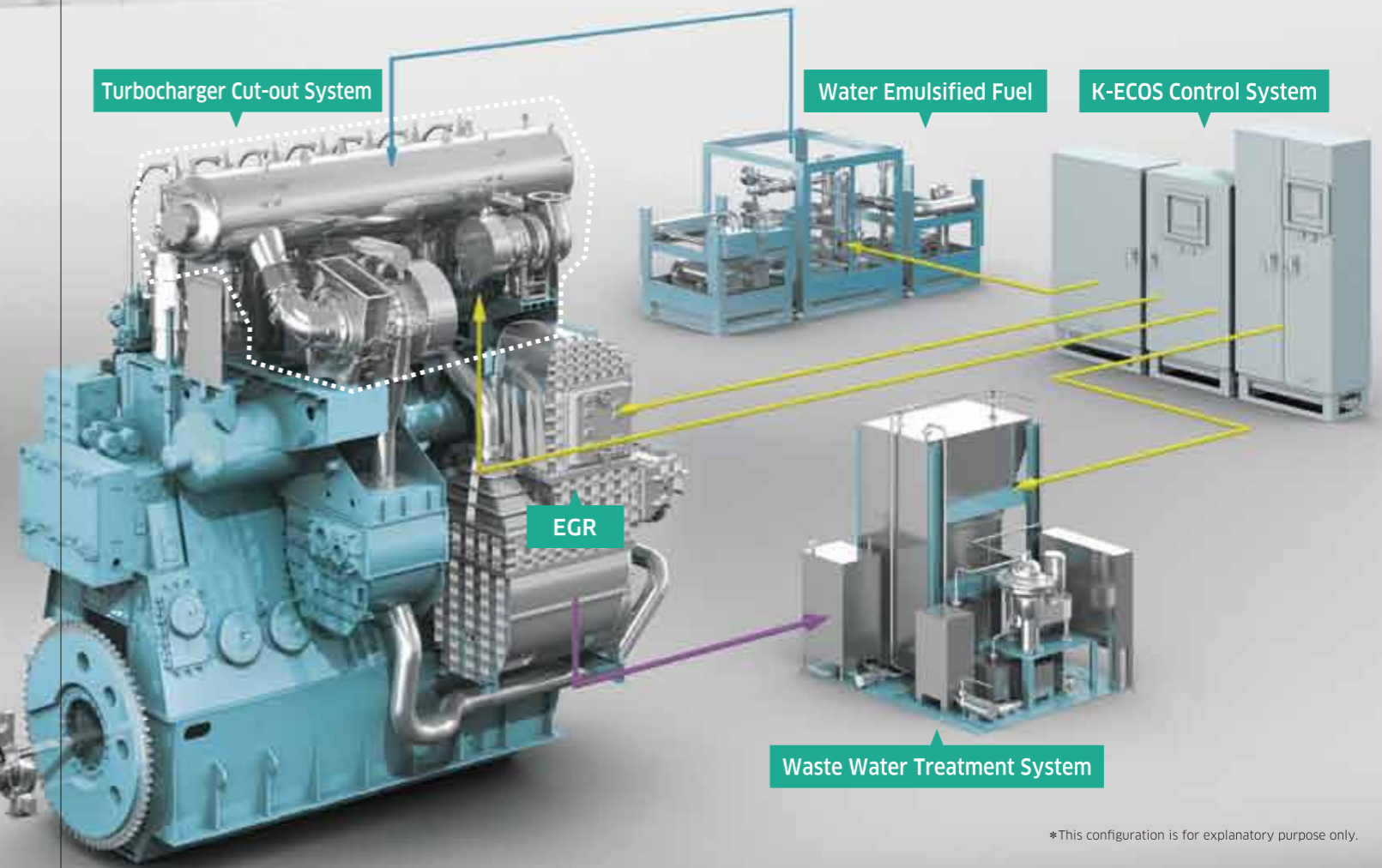
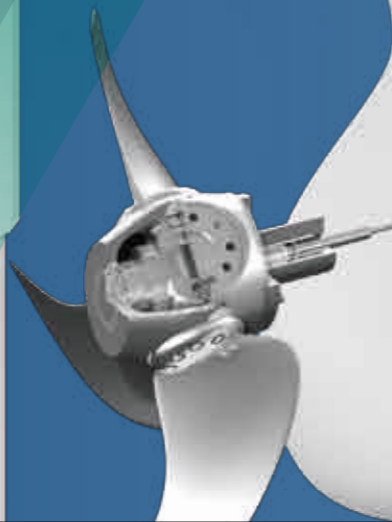


*The costs are calculated by our estimates, and can vary depending on the conditions.

Saving
2.9 million \$



Compactness, Engine Room Design Friendly



*This configuration is for explanatory purpose only.

K-ECOS LINE-UP

Two kinds of K-ECOS system are lined-up to meet customer demands.

K-ECOS T3

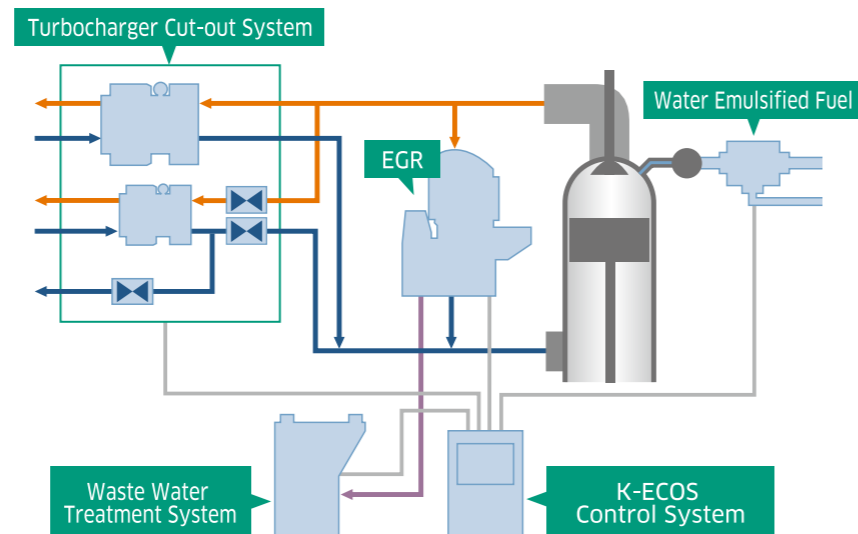
High-end Model for Economical Running

Economy is pursued to the utmost by optimizing features of individual system. Specific fuel oil consumption is dramatically improved compared with EGR solution only.

System Configuration

K-ECOS integrates four or five systems in the frame organically and achieves both low emission and economical running.

Component	T3	T3 Lite
EGR	○	○
Water Emulsified Fuel	○	○
Turbocharger Cut-out System	○	○
Waste Water Treatment System	○	○
K-ECOS Control System	○	○

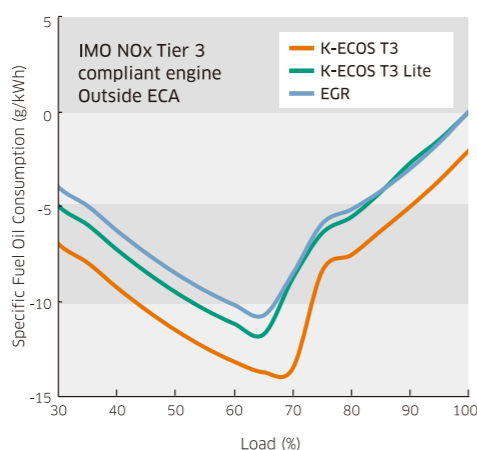
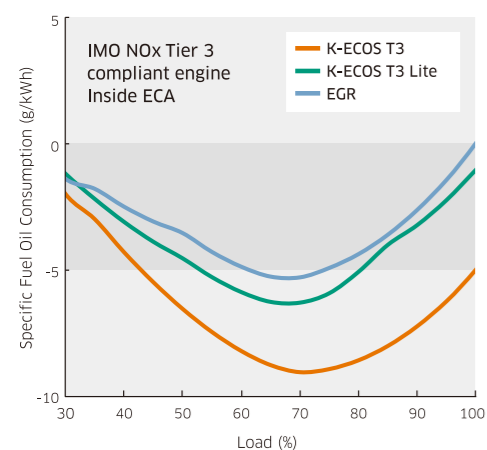


K-ECOS T3 Lite

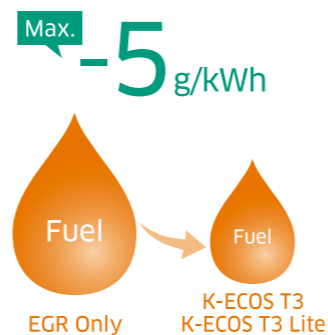
Dedicated Model for Low Sulphur Fuel

System is simplified and dedicated for low sulphur fuel with maintaining the economy.

Fuel Saving



Comparison between EGR only solution and K-ECOS T3 inside/outside ECA

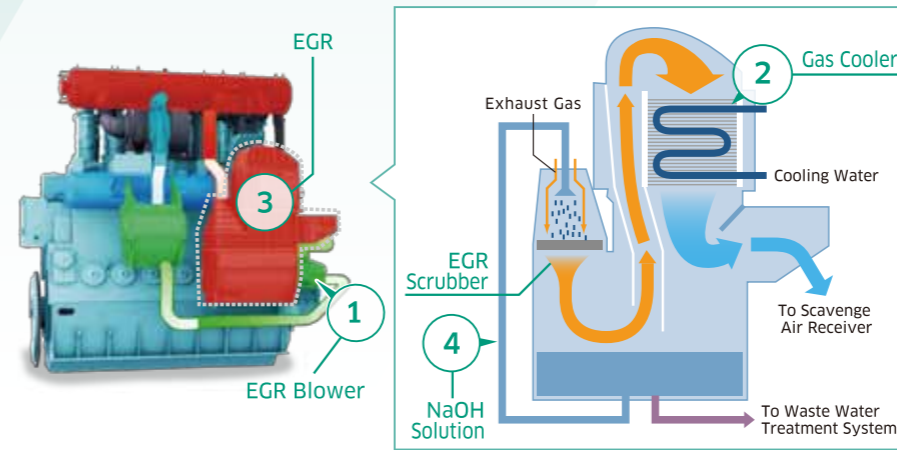


1

EGR (Exhaust Gas Recirculation)

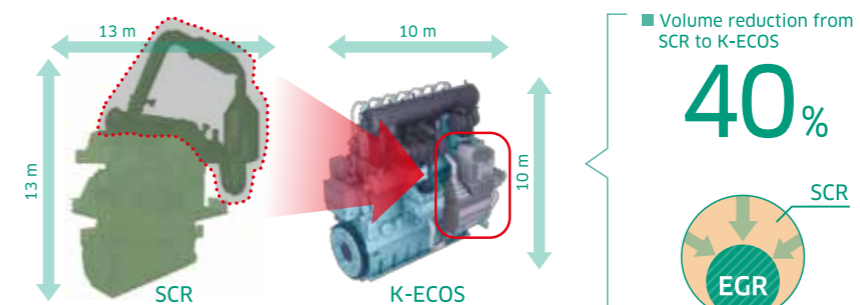
“Clean” and “Compact” EGR

EGR reduces a large amount of NOx emission by re-circulating a part of exhaust gas to engine. Kawasaki develops built-in “Compact” EGR.



Compact Design

Significant compact design is realized by introducing built-in type EGR. No additional installation of EGR is required.

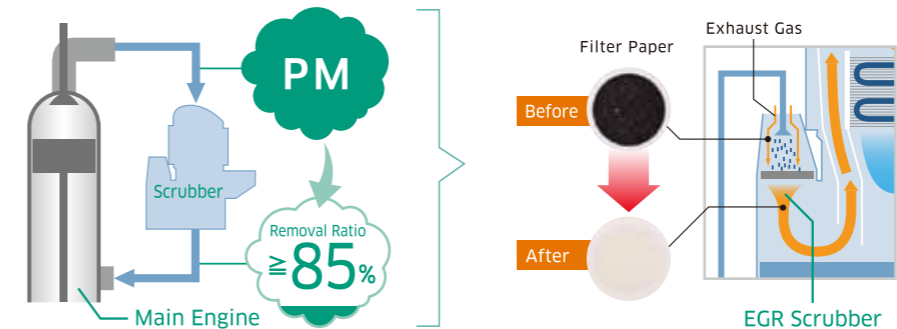


*According to in-company investigation, reduction might vary depending on engine type and Tier 3 solution.

“Clean” EGR Scrubber

Clean exhaust gas dedusted and desulfurized by EGR scrubber is re-circulated to engine.

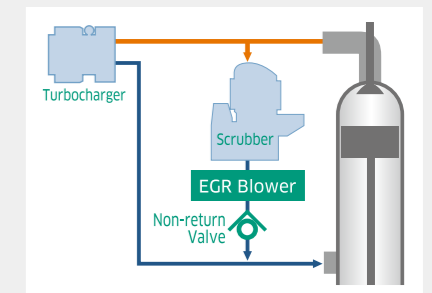
PM removal ratio *Measurement result before and after passage of EGR scrubber



1 Differentiation Technology

Highly Reliable EGR

EGR ratio is easily optimized by controlling EGR blower and non-return valve. High reliability is achieved by applying roots blower without surging.



2 Differentiation Technology

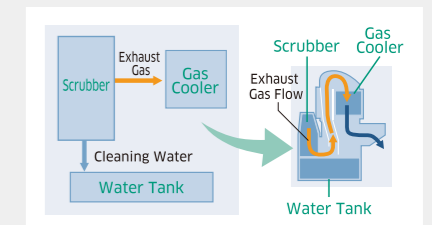
World-first Sea Water Cooled Gas Cooler

Kawasaki develops gas cooler applicable for normal sea water cooling system installed in many vessels.

3 Differentiation Technology

“Simple”, “Compact” EGR Unit

Significant miniaturized EGR system is achieved by integrating scrubber, gas cooler and water tank.



4 Differentiation Technology

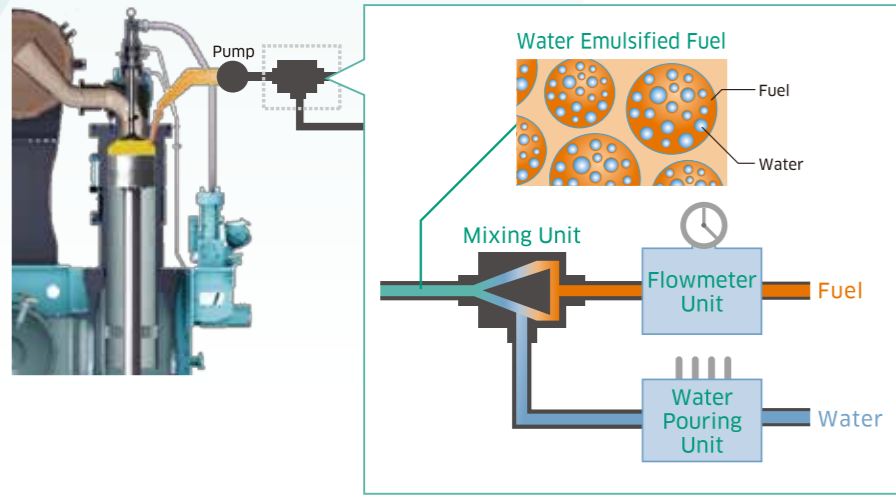
Low NaOH Consumption

NaOH consumption is significantly reduced by monitoring NaOH concentration in circulation line.

Water Emulsified Fuel

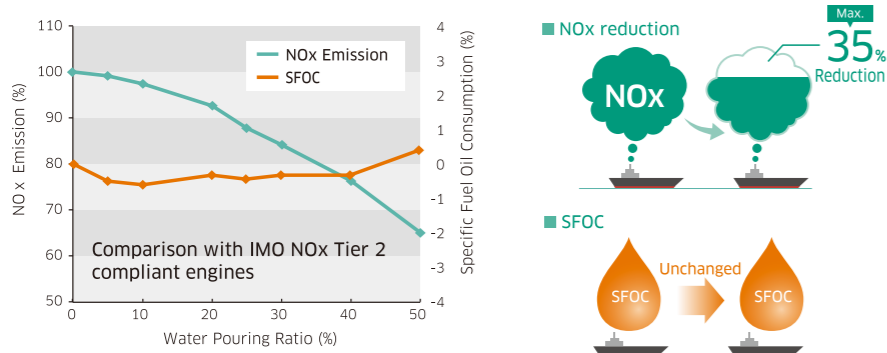
World-first*1 WEF*2 System in Practical Use

WEF reduces NOx emission by utilizing evaporative latent heat of water molecule. Kawasaki developed WEF system for commercial ships base on researches over years. *1 For Marine Engine *2 WEF: Water Emulsified Fuel



No Trade-off between SFOC and NOx Emission

WEF is epoch-making technology dissolving a trade-off between SFOC and NOx emission. IMO NOx Tier 3 regulation is cleared in combination with EGR and WEF.



"Space-saving" Unit Structure

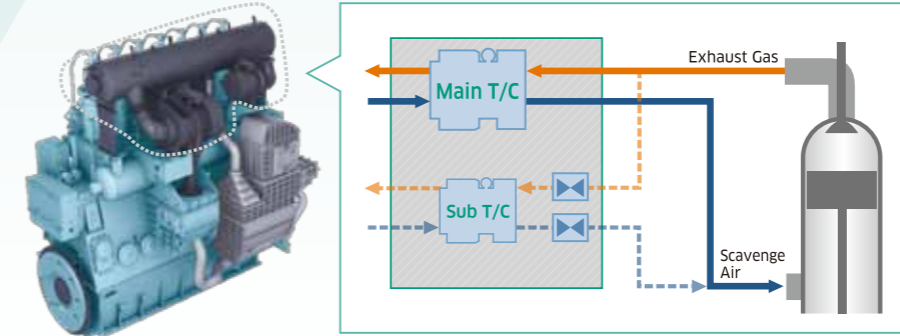
WEF components are made up into three units, "Mixer unit", "Measurement unit" and "Water Pouring unit". Unit structure contributes to space-saving and easy installation onboard.

Turbocharger Cut-out System

Application of Significant Fuel Saving System as Standard

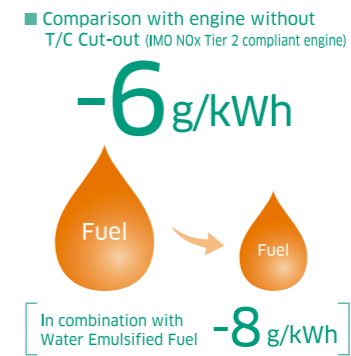
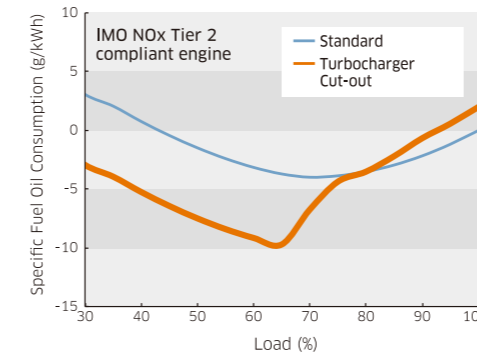
Turbocharger Cut-out system realizes a significant fuel saving by controlling two different size of turbochargers. World-first*1 sequential turbocharger control*2, which enables smooth changeover of turbocharger during engine operation, had been completed.

*1 For Two-stroke Diesel Engine installed on merchant vessel *2 Sequential turbocharger control is an optional supply.



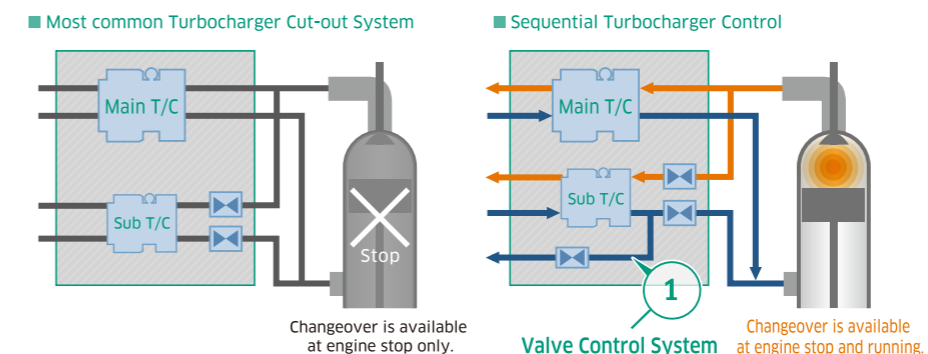
Fuel Saving

Significant fuel saving at part load is realized by bringing out the turbocharger efficiency to the maximum. Turbocharger Cut-out system is incorporated into all K-ECOS as standard.



"High Operability" Sequential Turbocharger Control

Sequential turbocharger control, enabling smooth run/stop changeover of turbocharger without stopping engine, has been developed successfully.

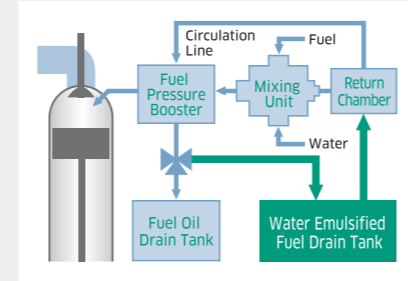


Kawasaki Advanced Technology

Differentiation Technology

Re-use of Water Emulsified Fuel Drain

Water emulsified fuel drain tank is installed in circulation line separately from existing fuel oil drain tank. The dedicated tank enables to re-use the drain without treatment.



Technical Verification

In-service Test Completed

Long term in-service test for more than 4 years had been completed, and made sure of no practical inconvenience on cylinder condition and WEF system.



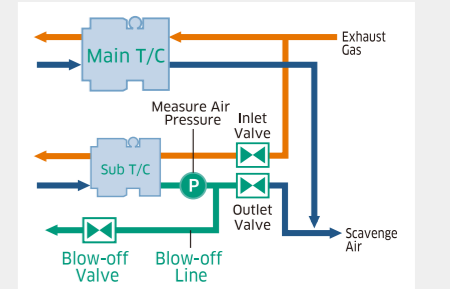
Cylinder condition after the use of Water Emulsified Fuel

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Differentiation Technology

Valve Control System

Blow-off valve controls air pressure after sub-turbocharger within speed dependent preset values not to cause surging at changeover. This valve system is a key hard for "sequential" turbocharger control.



Differentiation Technology

Safety Device for Turbocharger

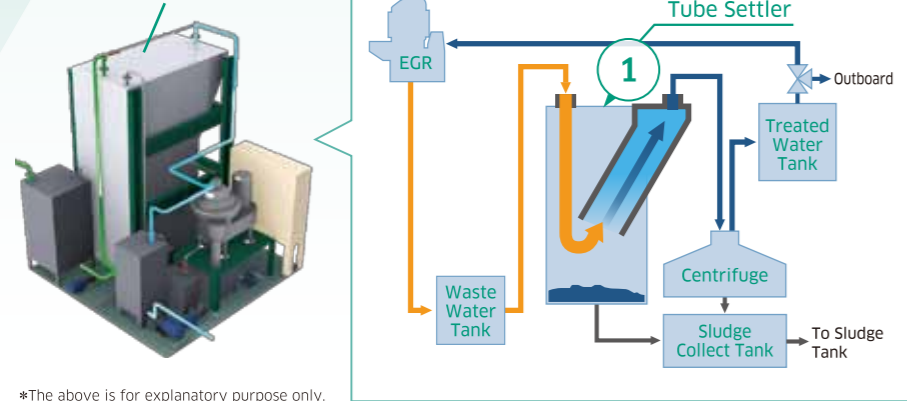
Fuel index limiters, varying corresponding to the number of turbochargers in operation, are incorporated and protects turbochargers from overspeeding.

Features 4 Waste Water Treatment System

“Space-saving” and “Energy-saving” Design

Waste Water from EGR scrubber is treated by a high-performance “Tube Settler” without power consumption. Treated water is re-used for EGR cleaning water, can be discharged outboard.

Waste Water Treatment Unit



*The above is for explanatory purpose only.

“Space-saving” Unit Structure

Unit structure contributes to space-saving and easy installation onboard.



Departure to the World

K-ECOS for K-LINE “DRIVE GREEN HIGHWAY”

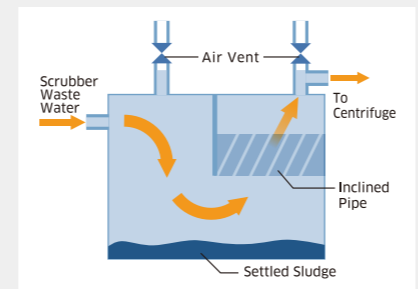
K-ECOS T3 is installed on “DRIVE GREEN HIGHWAY” delivered in 2016 February, a flag ship of K-LINE “DRIVE GREEN PROJECT”.



Kawasaki Advanced Technology

1 Differentiation Technology Energy-saving “Tube Settler”

“Tube Settler” has been developed for marine use based on those for land use such as disposal plants, does not need electricity and allows to choose a step smaller centrifuge.



FOR THE FUTURE with KAWASAKI TECHNOLOGY

Features 5 K-ECOS Control System

“High Safety” and “High Operability” by Easy Handling

All related components are monitored and controlled totally by K-ECOS Control System. Nonstop operation is achieved including sequential turbocharger control.

High Safety

Safety design is extremely reviewed by FMEA and HAZOP to cope with various changes of condition.

High Operability

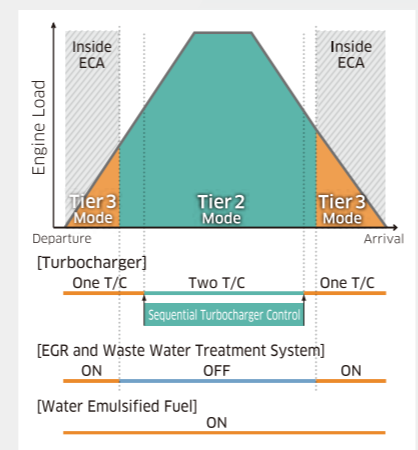
HMI of K-ECOS Control System is installed in Engine Control Room. Ship crew can change operation mode by one touch and monitor the related components integrally on screen.



Kawasaki Advanced Technology

Differentiation Technology Automatic Operation Mode Change

Run/stop of turbocharger can be carried out without engine stop. Operation mode can be changed automatically by K-ECOS Control System.



Value for the Future

Continuous Improvement for Environmental Performance

Kawasaki continues to pursue further improvement of environmental friendly technologies and safety control through in-field test plant and a full-scale test engine.

