

Environmentally Conscious Products

Environmentally Conscious Products

With our 2010 Environmental Vision goals of "application of Design for Environment to products" and "provision of products that contribute to environmental protection," we intend to contribute to the formation of a sustainable society by offering products and technologies that help protect the environment.

Product Assessment

Gas Turbines & Machinery Company developed the KC Coupling

In FY2003, we made application of Design for Environment a Key policy, and carried out product assessment actively.

The Gas Turbines & Machinery Company executed product assessment for the high elasticity rubber coupling that is used for the power transmission shaft of marine and land engines. As a result, the Kawasaki compression type elastic coupling (KC coupling) was newly developed by using the experience gained from the Kawasaki shearing type elastic coupling (KE coupling). The KC coupling improves the

ranges of acceptable vibration torque and eccentricity. Furthermore, the outside diameter of the KC coupling is 10% to 20% smaller than that of the KE coupling and the weight of the KC coupling is 15% to 40% lighter than that of the KE coupling, so the KC coupling saves resources as an environmentally conscious product.



Newly developed KC coupling (Kawasaki compression type elastic coupling)

Implementation of Product Assessments in Past Years

FY	1999	2000	2001	2002	2003
Divisions with regulation/ Total divisions	7/14	10/14	11/14	10/13*	10/12*
Cases of product assessment	47	69	138	123	98

*The total has decreased from the previous year due to the integration of two divisions.

Life Cycle Assessment (LCA)

Rolling Stock, Construction Machinery & Crushing Plant Company has begun application of the LCA technique

Each division of Kawasaki has been attempting to introduce life cycle assessment (LCA) technique in order to assess environmental impacts.

In particular, the Rolling Stock, Construction Machinery & Crushing Plant Company has begun an effort aimed at establishing the LCA technique for rolling stock in order to apply LCA to development and production. In the first step, in order to collect basic data, the company has mainly analyzed the interrelation between environmental impacts and aspects at the stages from the preparation of raw materials to movement. As a result, it has become possible to assess the change in environmental impacts by varying the raw materials and other environmental aspects for a definite period. The company is going to

implement assessment of the interrelation between product performance and environmental impacts throughout the entire life cycle, including final disposal, so that the company can develop rolling stock products that are more environmentally conscious.

Railways are often considered to be a means of transportation that have less impact for the environment. By applying the LCA technique, we can offer even more environmentally conscious products, thus contributing to the improvement of the global environment.

Green Procurement

Following our "Basic Policy of Green Procurement," we have been expanding the scope of green procurement throughout Kawasaki.

In FY2003, we introduced the e-Procurement System, with which we began to monitor amounts purchased by green procurement as well as to expand the green procurement percentage. At the same time, in order to encourage each internal company to be responsible for increasing green procurement, we have been involved in establishing environmentally conscious requirements to be applied to green procurement guidelines for supplies as well as for specifications of products.

Basic Policy of Green Procurement

Implemented in 1999

- ① Environmental impact must be considered across the entire lifecycle of all products from resource mining to waste.
- ② In the selection of a supplier, if multiple suppliers are equal in terms of quality, price and delivery, a supplier who is most seriously committed in environmental conservation is given priority over other suppliers.
- ③ Environmental product information must be obtained from suppliers.

Consumer Products & Machinery Company has begun green procurement

The Consumer Products & Machinery Company has established "Green Procurement Guidelines" in which the company requires suppliers to comply with a total ban of substances prohibited by laws and regulations. Additionally, for lead, hexavalent chromium, mercury and cadmium, the company integrates its internet-based procurement system with the material data system developed by the four motorcycle manufacturers in Japan so that it can determine the contents of these substances in every motorcycle component, manufacture products with reduced environmental impact, and design recycling-ready products.



Internet-based procurement system—K-Lab Net (Kawasaki Collaboration Network)



Examples of Products that Contribute to Environmental Impact Reduction

Advanced Cogeneration System

● CO₂ emissions reduction of about 10,000 tons per year

Gas turbine cogeneration systems are ideally suited for saving energy and decreasing CO₂ emissions when used at locations where there are demands for both electricity and heat. Since we constructed our first unit in 1974, we have been developing gas turbines with our proprietary technology, and now we are considered to be one of the leaders in this field worldwide.

Our Gifu Works has installed a 6,000 kW class cogeneration system. This system supplies one quarter of the power consumed by the plant and approximately half of the amount of steam that was generated by a heavy oil-burning boiler. This system is designed to have a variable heat-electricity ratio, making it capable of flexible operation. During the winter season, when demand for steam is high, all the steam generated from the system is supplied to the plant, but during the summer season, when demand for electricity is high, a portion of the generated steam is injected into the gas turbine to convert the thermal energy into electricity. Thus, this system will help attain optimal energy saving, alleviating environmental impacts.

Introduction of this system will decrease the energy consumption of the plant by 7% and CO₂ emissions by 14%, which corresponds to a decrease of 9,800 tons of CO₂ per year.

We will further develop our gas turbine cogeneration system technology so that we can offer more environmentally conscious products that satisfy the needs of our customers.

● Gas turbine cogeneration system that has been installed at the Gifu Works



- Fuel: natural gas
- Generation output: 6,480 kW
- Steam generation: 12.6 t/h
- Run time: approx. 5,650 hrs/year

Improved Bow Form Greatly Improves Fuel Economy of LPG Carriers

● Reduces CO₂ emissions by about 30,000 tons/ship over 20 years.

Kawasaki Shipbuilding Corporation contributes to the improvement of the global environment through energy saving achieved by incorporating its unique bow form design **SEA-Arrow** (Sharp Entrance Angle bow as an Arrow) into medium-speed vessels such as LPG carriers. Unlike common bulbous bow forms, this bow form does not have a projecting bulb. This reduces the wave making resistance by half and helps decrease the needed main engine horsepower by 6 to 10%.

The decrease in required horsepower with the 80,000 m³ ship that was the first ship incorporating **SEA-Arrow**, which was delivered in June 2003, is approximately 6%, equivalent to a reduction of about 3 tons per day of C heavy oil burned by the main engine. Considering an average ship service life is about 20 years, the expected conservation of C heavy oil amounts to approximately 10,000 tons, which corresponds to a reduction of 30,000 tons of CO₂ emissions.

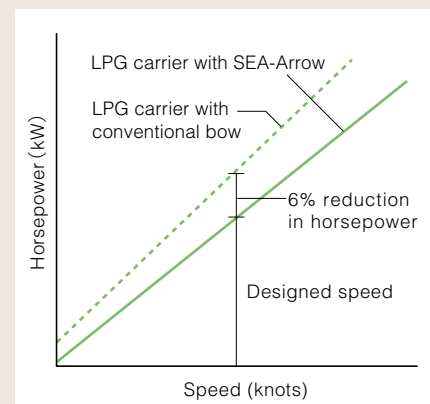
Currently, **SEA-Arrow** LPG carriers already delivered or ordered include one 80,000 m³ type and seven 59,200 m³ types. The expected reduction in CO₂ emissions over 20 years from each ship is approximately 30,000 tons, making the reduction for all eight ships as

much as 240,000 tons.

Furthermore, we will adopt **SEA-Arrow** in medium- and large-sized LPG carriers built from now on. In addition, Kawasaki Shipbuilding Corporation will continue to develop new technologies and build products with less environmental impacts.

In 2003, **SEA-Arrow** technology won The Japan Machinery Federation Presidential Prize (The Energy Conservation Division), one award in The Commendation System for Superior Energy-Conserving Machinery that is supported by the Ministry of Economy, Trade and Industry of Japan.

● Comparison of power curves



First ship with **SEA-Arrow**



Conventional bow form



SEA-Arrow bow form

Environmentally Conscious Products

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When developing and designing new products, we always attempt to reduce their environmental impacts by examining them from an environmental perspective. We handle a diverse spectrum of products and the nature of the environmental impacts of these products varies

greatly. For every product, however, we intend to find and execute possible improvements for protecting the environment, beginning with the easiest to achieve.

- ★...Technical Institute, Head Office
- ...Rolling Stock, Construction Machinery & Crushing Plant Company
- ...Aerospace Company
- ...Gas Turbines & Machinery Company
- ...Plant & Infrastructure Engineering Company
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- ...Kawasaki Shipbuilding Corporation
- ...Kawasaki Precision Machinery Ltd.

Energy Consumption Efficiency and Greenhouse Gas Emissions



● Blended winglets

Winglets are smaller wings on the wingtips of aircraft. Blended winglets incorporate unique curved surfaces that improve aerodynamic characteristics to increase fuel consumption efficiency and reduce noise. They are made of a carbon fiber composite material that we have independently developed.



● Electronically controlled marine diesel engine

The engine has achieved lower fuel/lube oil consumption as well as cleaner emission by means of full-electronic control of fuel injection and valve timing, and has realized the operation in much lower revolution than current mechanically controlled engines, resulting in better maneuverability of ship. This engine has already been contracted for car carriers and super-large container ships.

Energy Consumption Efficiency

【Example】

- Wheel loaders: A tire-slip preventing system has been adopted to improve fuel efficiency
- Supersonic Transport (SST) engines: Reduced fuel consumption, reduced noise and cleaner exhaust have been realized
- Incorporated fluidized bed for cement kilns has reduced energy consumption below that of rotary kilns
- Fuel efficiency improvement for motorcycles has been evaluated as a percentage through the product assessment
- A novel bow form "Sharp Entrance Angle bow as an Arrow"

(SEA-Arrow) was introduced that, by reducing wave-making resistance, improves the propulsion performance of vessels

- An energy-saving arrangement "Rudder Bulb System with Fins" (RBS-F) is added to the rudder that, by reducing the energy loss, improves the propulsion performance of vessels
- Improved hull form design realizes an efficient LNG carrier able to carry 10,000 m³ (about 7%) more LNG with almost the same fuel consumption as conventional LNG carriers

Greenhouse Gas Emissions

【Example】

- Wheel loaders: Reduced use of air conditioner refrigerant (CFC)
- Wheel loaders and road rollers: Instruction manuals and labels specify that recovery of air conditioner refrigerant (CFC) is mandatory

Waste Disposal and Recycling



● Introduction of returnable packing materials for Jet Ski engines

The packing of Jet Ski engines for overseas export has been converted from wood and cardboard to a returnable steel pallet.

Containers and Packaging

【Example】

- The wooden crates for tugboat propellers were replaced with steel racks to eliminate the use of wood materials
- The packing for hydraulic equipment components for overseas export has been converted to a returnable cage type

Product Service life

【Example】

- A truss type doweled composite slab has realized a highly durable slab for road bridges
- Model change intervals for motorcycles have been evaluated through the product assessment

Ratio of Use for Reusable and Recyclable Parts

【Example】

- Shield machines: Reuse system for internal components has been implemented
- Recoverability rate of motorcycles has been evaluated through the product assessment (Recoverability rate of 90% or more)

Product Disassembly Time

【Example】

- Wheel loaders and road rollers: Reduction in use of FRP components having built-in metal parts
- Reduced number of parts used in motorcycles

Recovery of Used Products, Containers & Packaging

【Example】

Material type is indicated by a symbol on resin components (● wheel loaders, road rollers ● back-up gas turbine generators ● motorcycles ■ hydraulic equipment) ● Back-up gas turbine generator: Standardization of resin materials is in progress



Hazardous Substances and Pollutants



● Reduced use of lead in motorcycles

We have been reducing the use of four substances with environmental impacts (lead, mercury, hexavalent chromium, cadmium). The Ninja ZX-10R and Z-750 marketed in FY2003 employ lead-free wheel balancers.



● Cleaner exhaust gas from wheel loaders and road rollers

Our wheel loaders and road rollers have powerful, cleaner engines. The NOx and particulate matters in exhaust gas have been greatly decreased. 14 out of the 15 models of wheel loaders that needed to comply with exhaust gas regulations, as well as all 13 models of road rollers, have cleared the latest emission regulations defined by the Ministry of Land, Infrastructure and Transport.



● Oil-free hydraulic water gate actuation system

We have developed an oil-free hydraulic actuation system that does not cause environmental pollution even if the hydraulic fluid leaks out. It was first introduced in the gate opening and closing system of the Hirado sluiceway gate.

【Example】

● Aircraft: Adoption of a low-polluting coating that does not contain lead ● Development of the Super Marine Gas Turbine (for the Super Eco-Ship): Dramatic decrease of pollutants in exhaust gas has been demonstrated ● Used atmospheric corrosion resisting steel members for bridge girders, thereby eliminating the need for painting or repainting ● Development of polyurethane foam material for heat insulation of the cargo tanks of LNG and LPG carriers

that uses alternative fluorocarbons (HCFCs) as foaming agents and does not deplete the ozone layer ● Ships: In order to decrease use of chlorinated coating, chlorine-free coating has superseded chlorinated rubber-based coating ● Ships: In order to decrease use of thinner, a solvent-free coating has been used on fresh water tanks ● Study of possible improvements for hydraulic pumps in order to use bio-degradable hydraulic fluid

Product Weight



● Back-up gas turbine generator made more compact

The suction system, which occupies more than 30% of the generator volume, has been reduced to approximately one half the previous size. More compact auxiliary equipment has also been introduced, so now all 19 models are available in a more compact size. Each product is also approximately 27% lighter compared with the model it supersedes.

【Example】

● A fluidized-bed system has been incorporated into a cement kiln. Compared with the previous rotary kiln system, the weight of this new configuration is much lighter ● Adoption of the hovering stage has enabled designs for unique multi-purpose domes (with baseball fields, soccer fields, etc.) to help promote resource conservation ● Weight decrease percentage of each motorcycle product is evaluated through the product assessment ● Industrial robots: Decreased robot product weight relative to its load-bearing capacity

Vibrations and Noise

● A World-class Low Noise Train

EMU (Electric Multiple Unit) for Hong Kong KCRC jointly developed by The Kinki Sharyo Co., Ltd. and Kawasaki, applying Kawasaki-developed "Statistical Energy Analysis Method", is one of the quietest commuter train in the World.



In addition to the noise simulation using an analytical model, sound reduction index test and mechanical excitation test was conducted using a mock-up in the reverberation chamber to work out a noise reduction plan. On the actual train, further sound source and sound propagation route investigation was also conducted. As a result, drastical noise level reduction was achieved compared to a conventional train, 10 dBA in the interior from 80 dBA to 70 dBA and 3 dBA at the exterior from 76 dBA to 73 dBA.

【Example】

● Helicopters: Rotor blade geometry and rotor wingtip form have been optimized to decrease helicopter noise in flight ● Back-up gas turbine generator: New package features an equipment noise level of 55 dB ● A noise reduction hangar for testing aero-engines significantly reduces the noise occurring from engine testing on the ground ● Subway system: Proposal of effective noise dampening arrangements through application of noise evaluation technology ● Estimated and reduced noise of steel viaduct for railway ● A soundproofing device is installed at the top of sound insulating walls to dampen road traffic noise effectively ● Development of an electro-hydraulic hybrid system (inverter motor-driven pump unit) featuring reduced noise and power consumption

Environmentally Conscious Products

Environmental Protection Products

Kawasaki is dedicated to continuing to make a wide range of products that help protect the environment by realizing efficient energy utilization, pollution prevention, waste disposal and recycling. In FY2003, we remained committed to environmental protection by

keeping pace with the current legal and regulatory trends in environmental protection and better understanding social needs by providing a diverse variety of new and proven products.

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Energy



● Combined cycle power plant (CCPP)

CCPP systems burn fuel to produce the gas that drives electricity-generating gas turbines and to recover waste heat for generating steam to drive steam turbines. Boasting higher efficiency, CCPP systems are common in the field of thermal power generation. This example installed in Brazil is a natural gas burning CCPP.

Conservation and Effective Utilization of Energy

【Product】

- Gas turbine cogeneration system
- Waste heat recovery boiler
- Cement plant waste heat power generation system
- Top-pressure recovery plant for blast furnace
- Ice storage cooling system
- District heating and cooling system
- Optimization and diagnosis of industrial energy system

【Research & Development】

- Ceramic gas turbine
- Fuel cell power system
- ★ Advanced battery



● Wind Turbine Generation System

The total output of our 32 already installed wind turbine generation systems amounts to 39,200 kW. In February 2004, Kawasaki delivered an offshore wind turbine generation system, the first example of its type in Japan, to Setana-cho, Hokkaido. In this example, two 600 kW power generator units were installed at a location situated 700 m from the coast.

Renewable Energy System

【Product】

- Photovoltaic system
- Geothermal generation system

【Research & Development】

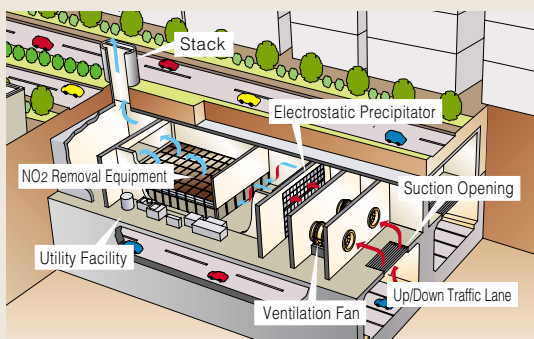
- ★ Black liquor gasification technology
- ★ Woody biomass power generation technology

New Energy System

【Research & Development】

- ★ Liquid-H₂ transport and storage technology

Air Pollution Control



● NO₂ removal system for road tunnel

This system uses an adsorbent to remove NO₂ and suspended particulate matter (SPM) from the gas released from stack. At present, a demonstration test prior to commercialization has been completed.



● Low NO_x heavy oil burning boiler (KACC)

This boiler consists of a high-temperature deoxidization combustion zone and a low-temperature oxidization combustion zone, and greatly decreases NO_x and dust in the exhaust gas. It can be used to burn low-grade heavy oil and certain powder fuels.

SO_x/NO_x Reduction, Dust Collection

【Product】

- De-SO_x/De-NO_x plant and dust collector for flue gas
- Low-NO_x gas turbine generation system
- Low NO_x coal burning boiler
- Ventilation filter for road tunnel
- Electrostatic precipitator for road tunnel

【Research & Development】

- De-NO_x technology for lower temperature flue gas
- ★ Motorcycle exhaust gas purifying catalyst

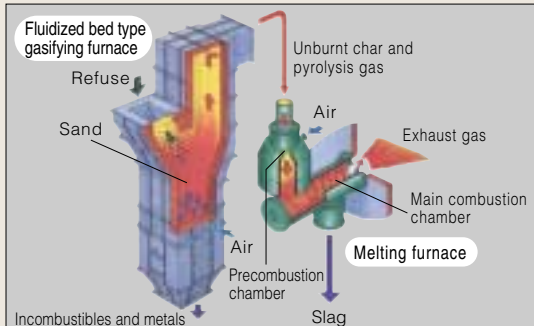
Air Pollution Control

【Product】

- ★ Photocatalytic coating business (For environmental protection)



Waste Treatment and Recycling



● Fluidized bed type gasifying-melting furnace

This system, which gasifies refuse in a fluidized bed type gasifying furnace and then melts ash in the melting furnace, has the advantage of melting ash by using the energy of the refuse itself and is intended to reduce the impact on the environment and operate economically. An actual plant built in Shiga Prefecture on Nov. 2002 achieved continuous operation for more than 3 months and was delivered to a customer in Apr. 2004.



● Refuse melting slag utilization system

With a magnetic separator, steel and iron are removed from the molten slag, and the grain size of the molten slag is adjusted with a crusher. Then, the slag is subjected to hot water treatment to convert the slag into a material resembling natural river sand. The so-treated slag will be used in various applications including aggregate for civil engineering and construction works.

Waste Incineration

[Product]

● High-performance refuse incineration system (Stoker-type furnace, Internal circulation fluidized bed-type furnace) ● Refuse gasifying-melting system (Shaft-type gasifying-melting furnace) ● High-efficiency refuse power generation system (Power generation from refuse combined with gas turbine, etc.) ● Waste-to-energy system (RDF power generation, Kraft recovery boiler, etc.) ● Flue gas treatment system for dioxin removal ● Dioxin thermal decomposition system for fly ash

[Research & Development]

● Monitoring technology for dioxin surrogates

Crushing and Sorting

[Product]

● Bulky waste crushing and recycling system
● Waste automobile/electrical appliance crushing and recycling system
● Construction waste crushing and recycling system
● Waste glass bottle/plastic sorting system

Recycling, Pollution Control

[Product]

● Incineration ash treatment system (Melting, Recycling) ● Refuse derived fuel (RDF) production system (Domestic waste, Industrial waste) ● Refuse paper and plastic fuel (RPF) production system ● Waste plastic rinsing and drying system (pretreatment before recycling)
● Food waste treatment system (Methane fermentation, Compost, Feed, etc.) ● Livestock waste treatment system (Methane fermentation, Compost, etc.) ● Coal fired boiler's ash recycling system (Road base material, etc.) ● Ultrasonic air filter cleaning system (Reusing air filter)

[Research & Development]

● Refuse incineration ash utilization technology ● Organic wastes treatment technology (Gasification, etc.) ★ Refuse gasification power generation technology ★ Removing technology of unburned carbon in coal ash ● PCB decomposition technology

Radioactive Waste Treatment

[Product]

● Radioactive waste treatment system

[Research & Development]

● Nuclear reactor decommissioning technology

Water and Soil Pollution Control



Sewage/Sludge Treatment

[Product]

● Sewage/Sludge treatment system ● Membrane type water treatment system (purification of leachates, etc.) ● Sewage sludge processing system (Transformation of sludge into fuel, fertilizer, etc.) ● On vehicle sludge drying system ● Turbid water filter

Water Pollution Control

[Research & Development]

● Purifying technology for closed water basin

Decontamination of Contaminated Soil

[Research & Development]

● Cleaning technology for dioxin polluted soil

● System for converting sludge into activated charcoal

Conventionally, sewage sludge has been incinerated and disposed of by landfill. We have developed a unique technology that converts sludge into activated charcoal that is recycled. The system produces activated charcoal rather than simply carbonating sludge, and is the first example of such a facility in Japan. A demonstration plant is being operated at wastewater treatment facilities in Fuji City, Shizuoka Prefecture and Nanao City, Ishikawa Prefecture and is attracting visitors from many municipalities around Japan.

Observation, Monitoring and Natural Environment Protection



Observation and Monitoring

● Offshore Monitoring Platform of Global Warming

To understand current climate change and to predict further change in the future caused by global warming, long-term and simultaneous observations of the biogeochemical cycle between the atmosphere and the ocean are needed. We are working to develop a cutting-edge offshore monitoring system and deploy a prototype

on the waters off the Northern Pacific Coast of Japan at the intersection of two ocean currents.

Natural Environment Protection

[Product] ● Beach Cleaner