Scope

Kawasaki Heavy Industries Quarterly Newsletter

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Kawasaki

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About the Cover
Kawasaki's F Series Robots are small to medium sized all-purpose industrial robots, designed for material handling, arc welding and sealing operations. The FA10N shown on the cover is used for arc welding.

KAWASAKI HEAVY INDUSTRIES, LTD.

Scope

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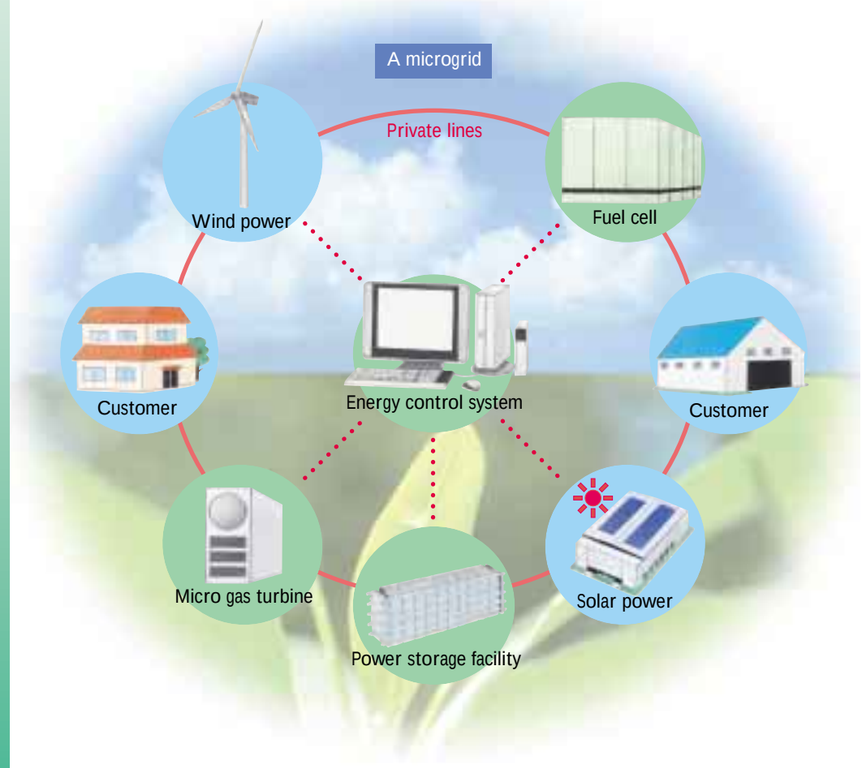
Powering the Future with the Microgrid

Mounting environmental and energy security issues have fueled an urgent need for distributed power sources. One source that may fulfill that need is the microgrid. It's a new localized energy supply system that combines natural energy, biomass power generation, fuel cells, power storage facilities and others to ensure a stable energy supply that will balance variable power output and demand. Join us for an in-depth look into the microgrid.

Harnessing Nature for Local Electric Energy Production and Consumption

The microgrid is a combination of various types of distributed energy systems that generates and supplies power. The typical microgrid consists of a power supply system that makes use of wind and solar power, fuel cells, micro gas turbines, batteries or other power storage facilities as well as a complete energy control system. A small scale power network can be constructed within a limited area with a system controlling the supply to cope with any changes in power demand. The eventual goal is to create a system of local production and local consumption that is totally independent from conventional power supply systems. There also exists the potential to operate a network of several connected microgrids. Microgrid technology has garnered the spotlight in Japan over the last five years and is the focus of a growing number of public and private research projects including those under the wing of Japan's independent administrative corporation, the New Energy and Industrial Technology Development Organization (NEDO).



The Microgrid, An Answer to Our Energy Needs

There are two types of microgrid systems, one designed to meet the needs of urban areas and the other built for suburban areas. Experimental studies in Japan have mainly focused on the suburban microgrid model. Suburban microgrid systems make use of mainly natural energy sources such as wind and solar power.

There are a number of advantages to using a distributed energy system. Power is generated exactly where it is needed for lighting and heating, eliminating miles of power lines and cutting capital expenditure for power transmission facilities as well as dramatically reducing wasted power that is lost during the transmission process. Since power is generated in the same location that it is used, any exhaust heat produced during the power generation process can be utilized, thereby increasing energy efficiency. Risks from disaster are also reduced since the system can effectively prevent large communities from grinding to a halt. Using several new energy sources frees consumers of their dependency on conventional power sources and paves the way for increasing energy supply sources. The microgrid effectively leverages the advantages of distributed power systems to answer our energy needs.

Saving Power for a Rainy Day

The instability of natural energy remains a major issue. Wind power generation depends on how strong the wind blows and the sunlight needed for solar power generation varies from day to day and hour to hour. Lacking a stable power supply, these systems become easily overloaded, forcing their owner/operators to purchase power from the big commercial power companies. Variations in output when power companies purchase power from wind or solar power generators also remain a major issue.

Microgrid research is focusing on these issues in an attempt to find a viable solution. Power storage facilities have become useful in averaging out the fluctuations in wind and solar power generation. Power is stored in these facilities during times when large amounts of power are being generated and then discharged during times of low power generation, leading to a reliable power supply system. These power storage facilities are also useful in coping with sudden surges in power demand and are essential to the microgrid.

Kawasaki produces a large range of equipment and facilities used in the microgrid system

Gigacell Batteries Built to Fit the Microgrid

Power storage facilities are the key to microgrid construction. Kawasaki has been working on a special project to develop a large scale nickel-metal hydride battery called the Gigacell. Compared with NaS batteries and redox flow batteries, which can only be charged and discharged slowly, the Gigacell has a low internal resistance that allows it to be charged and discharged at high speeds. Layering of the flat board type electrodes means the battery can easily be designed for large capacities. In the Gigacell ten of the smallest unit cells (0.23 kWh) in the series form one stack. Stacks can be arranged in modules, in series or parallel depending on load requirements, so that battery units can be tailor-made to suit the capacity required. These features make the Gigacell the optimum microgrid battery.

Gigacells have a smaller volume but weigh less than other batteries with a similar capacity. There are no toxic materials such as lead or cadmium contained in a Gigacell. On top of that, the battery materials and electrodes are not welded together, making them easier to recover and recycle. Put all that together and you have one very environmentally friendly battery.

Large nickel-metal hydride battery Gigacell

Urban Microgrid Utilizing the Gigacell

Shimizu Corporation constructed a microgrid system at its Institute of Technology in Tokyo. It consists of a main power generator boasting 350-kW and 90-kW gas turbine engines, a 10 kW solar battery, a nickel-metal hydride battery (the Kawasaki Gigacell) with an output of 50 kW per 8 hours, and an electric double layer capacitor (condenser) with an output of 100 kW. Energy efficiency has been boosted by making use of the exhaust heat produced from the power generator. This is the first case of the Gigacell being implemented in a microgrid system.

There is an immense difference between daytime and nighttime power requirements at the Institute. The operation of large experimental facilities during the day can cause the center's power load to suddenly jump. If it were a conventional in-house power generation system, the system would not be able to cope with the sudden change and the load would be passed on to the electric system, e.g. the power company. The microgrid and its range of facilities including the Gigacell, automatically adjusts for variations in load using a state-of-the-art control system. Unlike conventional in-house power generation systems that generate power up to a certain level and rely on the electrical system for any variations in load, this system can respond automatically to any load variation. This is welcome news for power companies that currently have to deal with sudden load changes.

** Gigacell is a registered trademark of Kawasaki.*

First Solar Power Generation System Using Gigacell

Yachiyo Shoin Junior High and High School in Yachiyo City, Chiba Prefecture had Kawasaki design and install a solar power generation system with a solar battery capacity of 70 kW on the roof of its Gymnasium No. 2. It has been using the system since 2000. The school had another 100 kW system installed on the roof of its Gymnasium No. 1 and began operating it this summer. A combined total of 170 kW of power, makes the system one of the largest solar power generators installed at an educational institute in Japan.

Kawasaki Plant Systems, Ltd. undertook the design and installation of the system, which employs power storage facilities such as the nickel-metal hydride battery Gigacell. It is the first solar power generation system in Japan to feature a nickel-metal hydride battery with a peak-cut function that enables quick charging and discharging.

The schools reach their peak power usage during their cultural festivals held in autumn every year. A contract exists with their power company to cope with the extra load during peak times, meaning the basic charge is more expensive. During this autumn's cultural festival, the electrical power stored in the Gigacell (50 kW per 1.5 hours) was able to provide enough power to cope with the peak usage, keeping the amount of power bought from the power company down to a minimum.

The 100 kW solar power generation system that began operating this summer is fully automated. Combining solar power and stored electrical power, it is designed to automatically power the teacher's room and security guard's office when there is an electricity failure due to a disaster or similar occurrences. The two solar power generators installed on campus produce a combined total of 160,000 kWh yearly. It has reduced thermal power CO_2 emissions by 106 tons, making the system very effective from an environmental perspective.

* *This system is part of NEDO's Solar Power New Technology Field Test Operations and was constructed as a joint research project between NEDO and Yachiyo Shoin.*

Solar battery modules installed on Yachiyo Shoin Gymnasium No. 1

Gigacell installed in the basement of Gymnasium No. 1

Electrical control board displaying the generating status of the solar power system

Solar battery modules installed on Gymnasium No. 2

Wind and Solar Power Facilities with Proven Track Records

Kawasaki holds a stake in Vestech Japan Co., Ltd., the sole Japanese agent for the world's leading manufacturer of windmills, Vestas (Denmark), and is involved in every facet of operations from engineering to afterservicing of wind power generators. The wind power generators include a pitch control design that allows for maximum use of wind for high power output in wind speeds of 4 m/sec to 25 m/sec and also feature a slip control feature to control fluctuations in power output due to sudden changes in wind conditions for a reliable supply of power.

Since Japan's geographic size limits the area available for land-based facilities, it has turned seaward to tap the wind's energy potential. Completed in 2004, the Setana ocean wind power generation facility in Setana-cho, Hokkaido, known as "Kazamidori," is home to two 600 kW generators. It is the first large scale ocean based wind power generation facility in Japan. The Summit Wind Power Sakata Power Generator with eight 200 kW units operated by Yamagata Prefecture's Summit Wind Power Sakata, has also been built along Japan's shoreline.

A good example of solar power generation is the rooftop solar power generation system (with a solar cell capacity of 85 kW) atop the World Trade Center Building Annex in Tokyo. The system consisting of hybrid solar cells configured in the shape of a pyramid and a gas turbine cogeneration system installed inside the pyramid is Japan's first hybrid energy supply system. Another is the photovoltaic or solar power generation system at Yachiyo Shoin Junior/Senior High School in Chiba Prefecture. The 152 kW solar power generation system at the Isobe Water Purification Plant, operated by the Public Enterprise Bureau of Mie Prefecture, is a perfect example of how to kill two birds with one stone. The system has been installed to cover sedimentation basins at the water treatment plant, effectively blocking out sunlight to prevent the growth of algae and production of potentially dangerous trihalomethane.

World Trade Center Building Annex solar power generation system

Setana ocean wind power generators, "Kazamidori"

Development of Various Woody Biomass Power Systems

The environmental impact of CO_2 emissions from burnt woody biomass is offset by the fact that the trees used as fuel initially absorbed the same amount of CO_2 through the process of plant photosynthesis. Using the heat energy produced from the combustion process for power generation eliminates the need to burn fossil fuels at other power plants which in turn takes a big bite out of CO_2 gas emissions.

Kawasaki has racked up a long list of achievements with its direct combustion system. The results of its efforts can be seen at the Power Plant in the Woods, a steam turbine power generation system with an output of 600 kW that has been installed at the Tounou Hinoki Product Circulation Cooperative in Gifu Prefecture. A similar model is the woody biomass power plant, a steam turbine power generator with an output of 230 kW, installed at the Shizuoka Sawing Cooperative in Shizuoka City. Another success story is the woody biomass gas power generation and heat supply system that Sekisui House, Ltd. installed in their Azai Plant in Nagahama City, Shiga Prefecture. It employs a fixed bed gasifier developed by Kawasaki to turn solid saw waste into purified synthetic gas through thermal decomposition. The gas is then used to fuel the system's gas engine for 175 kW of power output. Exhaust heat produced by the gas engine is converted by a heat exchanger into heated air for the plant and heated water for the office. The system can produce 1,750 kWh of electricity per day from 2.2 tons of saw waste. (See p9 for details.)

Development of a pressurized fluidized bed gasification/gas turbine power generator for woody gas power generation systems is also under way. This system would offer the advantage of gasification at the relatively low temperature of 650°C. At that temperature, synthetic gases containing combustible gases and tar could be safely and efficiently burned with Kawasaki's gas turbine. A research and development facility with a power output of 150 kW is now being constructed in Kochi Prefecture.

Power Plant in the Woods, Tounou Hinoki Product Circulation Cooperative

Woody biomass gasification power plant, heat supply system, Sekisui House, Azai Plant

The F Series Robots: World's First Modular Length-Adjustable Arm

Slimmer and Faster Than Ever

An industrial robot's arm is just like a human arm: it rotates, flexes, swivels, moves up and down as well as left and right to do most any task. The joint axes between each moving section are driven via reduction gears which decrease motor output, allowing for optimal torque. The robot's movements are directed via a controller. The F Series robots employ a six axis manipulator to mimic human arm movement. Since its release by Kawasaki Heavy Industries in 1998, the F Series has received high praise across a wide range of industries. These small to medium sized robots, designed for material handling, arc welding, and sealing operations, boast three distinct features that include:

1. Significantly reduced operating time

High-powered miniature motors and high-efficiency speed-reduction gears all housed within a lightweight arm allow for better operation and acceleration speed to cut operating time dramatically.

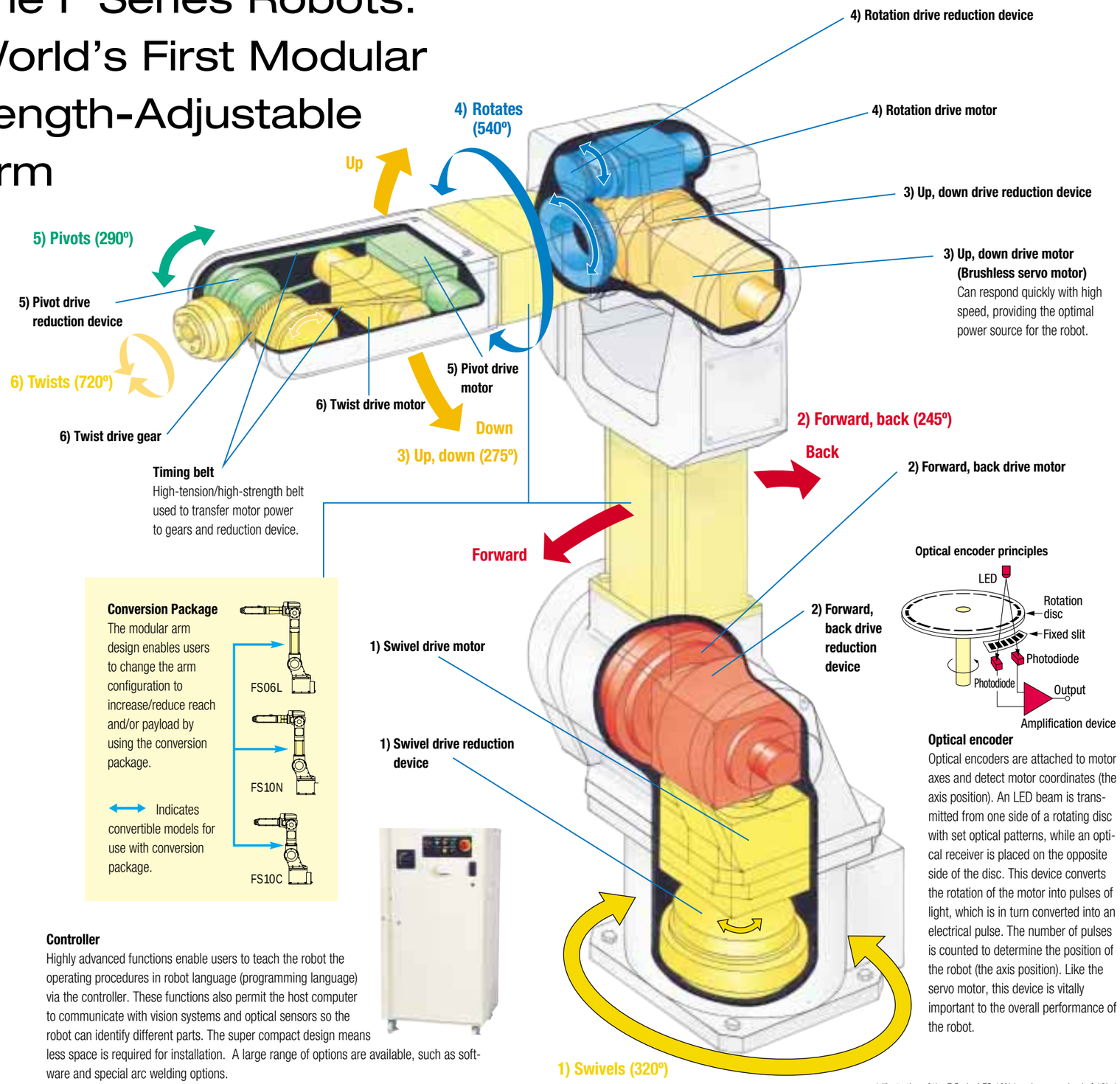
2. Smaller footprint and compact work cell

A more compact wrist section, slimmer arm and streamlined symmetrical design provide the F-Series robot with a very small footprint ideal for use in a compact work cell.

3. Arm reaches and payloads that can be easily configured, even after installation

In an industry first, the F Series' conversion package allows customers to easily configure the modular arm's reach (arm length) and payload after installation.

The wide choice of configurations (a total of 18 models) that combine these three features makes the F Series triple extraordinary! The extra large line up enables users to find the exact arm type to suit their operating system. Its extra fast speed cuts operating time while its extra slim space-saving design makes for a compact work cell. These robots have received high marks where it counts most, especially for their unique features, ease of use and seamless integration with the surrounding operating environment.



Conversion Package

The modular arm design enables users to change the arm configuration to increase/reduce reach and/or payload by using the conversion package.

⟷ Indicates convertible models for use with conversion package.

Controller

Highly advanced functions enable users to teach the robot the operating procedures in robot language (programming language) via the controller. These functions also permit the host computer to communicate with vision systems and optical sensors so the robot can identify different parts. The super compact design means less space is required for installation. A large range of options are available, such as software and special arc welding options.

Optical encoder

Optical encoders are attached to motor axes and detect motor coordinates (the axis position). An LED beam is transmitted from one side of a rotating disc with set optical patterns, while an optical receiver is placed on the opposite side of the disc. This device converts the rotation of the motor into pulses of light, which is in turn converted into an electrical pulse. The number of pulses is counted to determine the position of the robot (the axis position). Like the servo motor, this device is vitally important to the overall performance of the robot.

** Illustration of the F Series' FS 10N (maximum payload of 10kg).*

Basic F Series Lineup
(excluding the FS 10N seen in the illustration)


FS06N


FS20N


FS30N


FS45N


FS60L

In the Business of Making Asbestos Safe

Kawasaki Plant Systems, Ltd. recently launched an asbestos treatment system business employing PEM (Plasma Enhanced Melter) technologies.

These technologies have a proven track record for efficiently treating toxic waste and recyclable resources. With a PEM at its core, the Kawasaki system can melt asbestos down into a totally harmless substance. The thoroughly tested system, includes a high-temperature pyrolysis process that detoxifies, white and blue asbestos, as well as nondispersable asbestos like slate board. A hyaloid (glass-like) byproduct generated during the process was found to be completely recyclable. Atmospheric monitoring performed during the tests confirmed that air quality around the facility met levels of environmental safety.

Asbestos waste is inserted from the top of the PEM and melted in a plasma arc furnace at a temperatures ranging from 3,000º to 5,000º C. The asbestos is then recovered as molten glass, and metals in the asbestos (infused materials) are recovered as molten metal on the bottom of the furnace. Organic waste such as plastics is decomposed into its component elements by pyrolysis. The flow rate of exhaust gases in the process is lower than in conventional combustion methods and does not allow untreated asbestos to leave the PEM System, as other methods do.

Kawasaki is marketing the PEM System, which has a capacity to process 2 to 30 tons/day (750 to 9,000 tons/year), to local governments and the industrial waste treatment industry. The company is committed to doing all it can to fulfill the national environmental initiative launched by the Ministry of the Environment to eliminate asbestos.

Hydraulic Equipment Made in China

Kawasaki Precision Machinery (China) Ltd., a subsidiary of Kawasaki Precision Machinery, Ltd. (KPM) recently began production of its renowned hydraulic pumps for excavators.

KPM (China) was established in December of 2005 in Suzhou with a staff of 15. It plans to start off by manufacturing 100 pumps per month and bring production up to 700 units per month with 30 employees by 2008.

KPM had been supplying hydraulic components to the Chinese market from its main facility in Kobe. The new local presence and knockdown production will enable it to respond more promptly to rising orders in the rapidly growing market.

China's expansive urban and rural development projects, coupled with strong economic growth, have made its hydraulic excavator market the world's largest. Continued growth in the mid and long term will be stimulated further by the 2008 Beijing Olympic Games and the 2010 Shanghai World Expo as well as ongoing infrastructure improvements in irrigation, gas, electricity and transportation networks.

Overview of KPM (China)
Company name: Kawasaki Precision Machinery (China) Ltd.
Address: Yangshan Industrial Park, 9 Guanshan Rd., New District, Suzhou, People's Republic of China
President: Hiroshi Morita
Establishment date: December 26, 2005
Capital: ¥500 million (wholly owned by KPM)
Businesses: Manufacturing and sales of hydraulic components for construction machinery
Floor space: 3,150 m²
Number of employees: 15

Kawasaki Delivers First Woody Biomass Gasification Cogeneration System

Kawasaki recently delivered its first woody biomass gasification cogeneration system to Sekisui House's Azai factory in Shiga Prefecture. The system utilizes Kawasaki's advanced gasification technology to turn wood waste from timber production at the factory into electricity. It will be used in a joint bioenergy demonstration project conducted by Sekisui House and the New Energy and Industrial Technology Development Organization (NEDO).

The system's gas engine generates electricity from refined CO and H_2 gases that are produced during the processing of solid wood waste in Kawasaki's low-tar pyrolysis gasification furnace. The exhaust heat from the engine is recovered by a heat exchanger and used to provide heat for the Sekisui facility's wood driers and offices. The cogeneration system can supply 1,750 kWh of power per day (10 hours) from 2.2 tons of wood waste to provide 30 percent of the factory's electric power needs.

Kawasaki's small-scale woody biomass gasification system, available in both 70 kW and 175 kW models, has been simplified by minimizing the gas refining components to reduce maintenance requirements. Startup takes only 30 minutes, making daily start-and-stop operations feasible.

This woody biomass gasification system is a clear demonstration of Kawasaki's commitment to creating a sustainable society through the development and deployment of technologies and systems that reduce emissions and make efficient use of our limited natural resources.

100th Turbine for LNG Carrier a World's First

Kawasaki recently wrapped up work on its 100th marine steam turbine designed for an LNG carrier, making it the world's largest producer of these machines. The milestone UA-400 turbine would then be mounted on a 145,000 m³ LNG carrier.

Kawasaki started off producing marine steam turbines in a joint venture with the Curtis Co. (U.S.A.) in 1907. When their agreement was terminated in 1925, Kawasaki began developing its own proprietary steam turbines.

Steam turbines are used to power LNG carriers because they can take full advantage of the evaporating LNG load. Kawasaki built and installed Japan's first LNG carrier, the Golar Spirit, in 1976. Since then, the company has produced more of these turbines than any other manufacturer.

Kawasaki continues to set the bar as LNG demand increases worldwide. It supplied 24 turbines for LNG carriers during FY 2005 ended March 31, 2006 alone. The company is constantly searching for innovations in the development and production of reliable, efficient marine steam turbines to fulfill diverse market needs

Making Sailing Dreams Come True

LNG Dream

Asian Progress IV

In September, Kawasaki Shipbuilding delivered the *LNG Dream* to Lloyds TSB Equipment Leasing (No. 7). The carrier, identified as Kawasaki Hull No. 1545, is scheduled to transport LNG from Western Australia for Osaka Gas Co., Ltd. It will be operated by NYK Bulkship (Europe) Ltd., a Nippon Yusen Kaisha (NYK Line) Group company.

The vessel, which can hold a total of 145,254 m^3 of LNG, has four individual Moss spherical tanks that employ Kawasaki's propriety panel system. The system enables ultra-efficient thermal insulation and achieves a boil-off rate of 0.15 % per day.

Kawasaki Shipbuilding took to the *seas again in the same month to deliver the Asian Progress IV,* a very large crude (oil) carrier (VLCC), to Primo Shipping S.A. at its Sakaide Shipyard. The 315,000 DWT, double-hull tanker makes it the 1,574th vessel built by the company.

Powered by a Kawasaki-MAN B&W 7S80MC-C diesel engine, the vessel features the latest tanker developments, including one of the largest cargo capacities that can pass through the Malacca Straits and enter primary oil tanker berths in Japan. The 333 m long carrier is equipped with Kawasaki's rudder bulb system with fins (RBS-F) and high-performance propellers for energy-efficient operations..

New York's Metro-North Inks Electric Passenger Car Deal

In August, the New York Metropolitan Transportation Authority's Metro-North Railroad (MNR) signed a deal for 300 AC/DC electric passenger cars from Kawasaki Rail Car, Inc. (KRC). The cars will be the first multicurrent electric models to go into service on the MNR. A prototype car was delivered in May 2009 and production cars are slated for delivery in 2011.

The contract includes an optional order for up to 80 cars, with delivery to be completed by 2013. It's part of the MTA's five-year Capital Program to replace existing cars and improve services. Kawasaki's electric cars will serve commuters on the 116 km northeastern corridor between Grand Central Station in Manhattan and New Haven Station, Connecticut. The stainless-steel cars will be the longest and widest of their kind, with the ability to operate under three types of power, 12,500 VAC, 25,000 VAC and 650 VDC.

Kawasaki's rolling stock plant in Lincoln, Nebraska will manufacture the car bodies, install the equipment and complete final assembly, while KRC's Yonkers, New York plant will be responsible for procurement, delivery and warranty service.

First IPC Module Shipped for Trent 1000 Engines

This August Kawasaki completed assembly of its first intermediate pressure compressor (IPC) module for the Trent 1000, Rolls-Royce's state-of-the-art passenger plane engine. The first module was shipped to Rolls-Royce's Derby facility.

Kawasaki has been participating in the development and production of the Trent 1000 as a risk and revenue sharing partner. It is responsible for the production and assembly of the IPC module, and played a key role in its design and development in conjunction with Rolls-Royce. In October 2005, it began shipping IPC drums and other components. After completing the entire process, from parts production to assembly, Kawasaki has shipped its finished modules.

The IPC module is a critical engine component. It is comprised of an IPC rotor, which includes an IPC drum with eight titanium alloy discs welded together by an electron beam, rotors and stators, an IPC case and front-bearing housing.

Rolls-Royce will install the IPC module in the flying testbed engine of a Boeing 747 and put it to the test during the first quarter of 2007. The Trent 1000, the latest in the jet engine series, is designed for passenger aircraft with 53,000 to 75,000 pounds of thrust. It will be installed on the 250-to-300-seat Boeing 787

Dreamliner, scheduled to begin service in 2008. Rolls-Royce has already received orders for the engine from All Nippon Airways (ANA), Air New Zealand, Northwest Airlines, LOT Polish Airlines, Icelandair, and leasing companies such as ILFC, LCAL and Pegasus Aviation Finance for Blue Panorama Airlines.

World's Most Efficient 8 MW Gas Engine

Kawasaki has developed the world's most efficient 8 MW-class gas engine. It is the first in its class to achieve 48% electric generation efficiency as well as excellent environmental performance, with extremely low NOx emissions of 120 ppm at 0% O_2. The engine is applicable to a wide range of markets, with models offering outputs from 5 to 7.8 MW and a cylinder diameter of 300 mm in four available cylinder combinations of: 12, 14, 16 or 18.

The engine features a larger stroke/bore ratio than conventional models, and incorporates the Miller-cycle system, which improves anti-knocking and combustion performance to boost cycle efficiency. The addition of a prechamber spark ignition system does away with the need for additional liquid fuel for ignition and realizes economical and easy operations.

Kawasaki released its first marine diesel engine in 1919, and has continued to actively develop, design and manufacture an array of diesel engines as well as power generation systems. Kawasaki recently leveraged its expertise and experience, in launching a gas engine development project. It will continue testing and build a 7.5 MW demonstration power plant at one of its facilities by September 2007 before launching sales operations.

South Korea Digs Kawasaki's TBM

Recently Dong-A Geological Engineering Co., Ltd. tapped Kawasaki for its tunnel boring machine (TBM) to complete work on the KEPCO (Korea Electric Power Corp.) power cable tunnel project in Seoul. This is the third time the company has chosen Kawasaki, after ordering equipment for work on the Seoul Subway Line No. 9 project in 2003 and the Incheon International Airport High-Speed Railway project in 2005.

The TBM will be used to construct the 2.4 km KEPCO/Geoyo-Karak cable tunnel in Jamsil, Seoul, scheduled for completion in December 2009. By combining shield tunneling technology for soft ground and high water pressure with tunnel boring technology for hard rock and gravel layers, Kawasaki's TBM is able to excavate a wide range of soil and rock compositions.

Kawasaki has provided over 1,300 shield machines and TBMs to customers in Japan and other parts of the world, including six TBMs to Korea. In 2003 and 2004, it received orders for eight shield machines for subway construction work in Singapore. Kawasaki is widely recognized for its superior technology and experience in the field.


Kawasaki
Let the good times roll.
More Than Skin Deep
True Kawasaki Character Comes from Within
http://www.khi.co.jp/mcycle