Scope
Kawasaki Heavy Industries Quarterly Newsletter
No. 125 Autumn 2020
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Kawasaki
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Scope

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Special Feature

Ingeniously Designed to Protect Subsea Oil Fields: Kawasaki's AUV

カワる、
サキへ。
Changing forward

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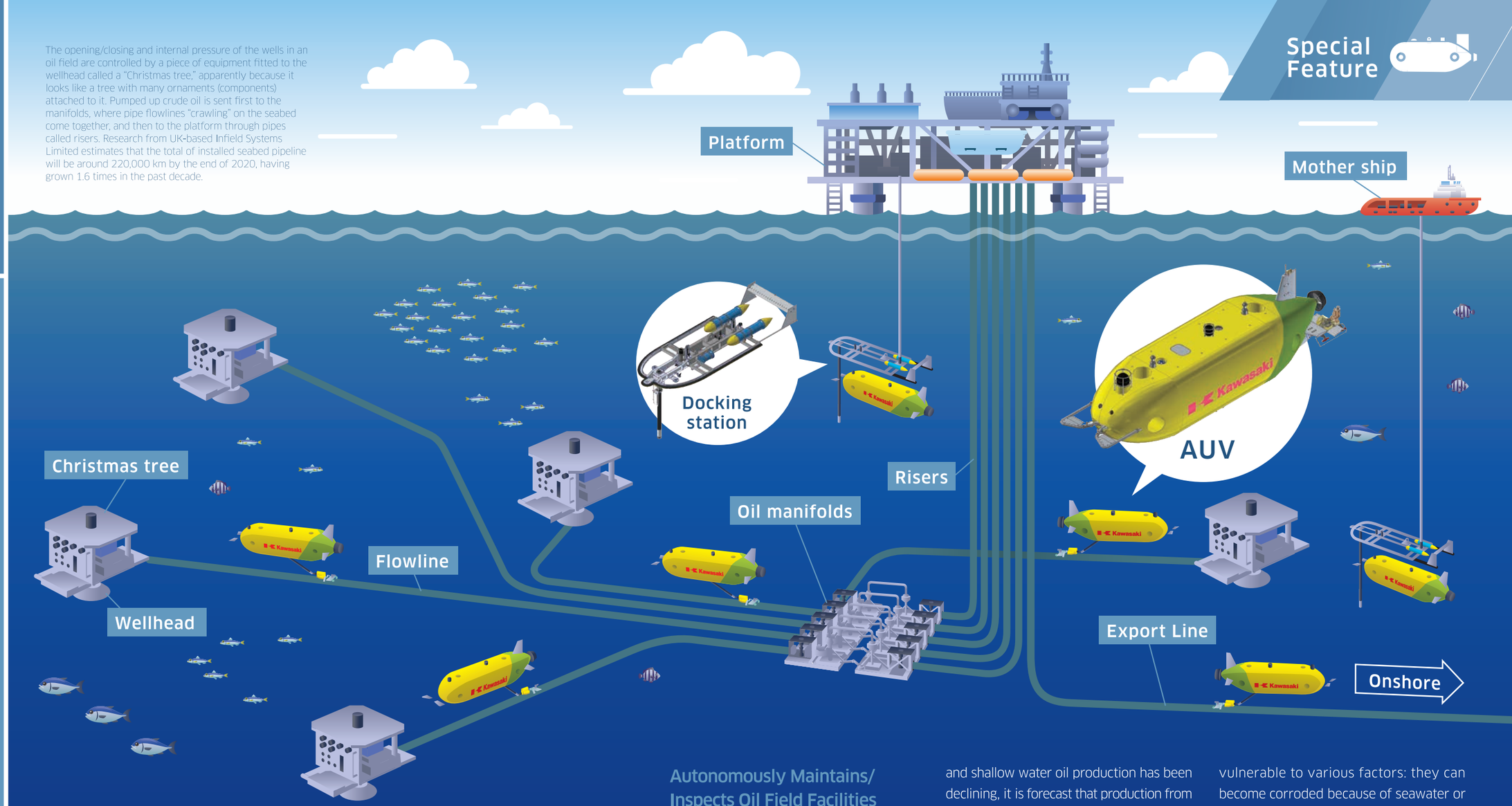
Contents

About the Cover
An AUV undergoing a demonstration test (Numazu City, Shizuoka Prefecture). For details, see *Special Feature* (this page).

The opening/closing and internal pressure of the wells in an oil field are controlled by a piece of equipment fitted to the wellhead called a "Christmas tree," apparently because it looks like a tree with many ornaments (components) attached to it. Pumped up crude oil is sent first to the manifolds, where pipe flowlines "crawling" on the seabed come together, and then to the platform through pipes called risers. Research from UK-based Infield Systems Limited estimates that the total of installed seabed pipeline will be around 220,000 km by the end of 2020, having grown 1.6 times in the past decade.



Ingeniously Designed to Protect Subsea Oil Fields: Kawasaki's AUV

As the development of subsea oil fields continues to grow, the efficiency with which the maintenance and inspection of pipelines can be done underwater or on the seabed is becoming a major challenge. Kawasaki has been a global pioneer in the development of autonomous underwater vehicles (AUVs) for these purposes, and to resolve the challenge, it plans the commercial launch of a new AUV in 2021, tasked with the mission of protecting this underwater energy source.

Autonomously Maintains/ Inspects Oil Field Facilities Located Deeper Than 400 m

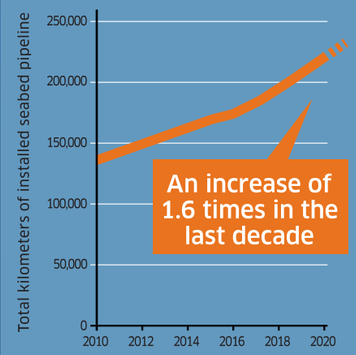
Of the world's primary energy, 30% is oil and 20% is natural gas. The International Energy Agency (IEA) forecasts that demand for oil will remain strong, and that even in the period up to 2040, 30% of primary energy will still be supplied by oil.

Recently, however, trends regarding the locations of oil fields have changed, and the volume of oil extracted from those in deeper waters has been increasing. According to the IEA, subsea oil fields produce 2.7 million barrels of oil daily, accounting for 30% of global oil production. The agency also estimates that proved reserves of subsea oil fields amount to 260 billion barrels, or 15% of total global reserves, but because onshore and shallow water oil production has been declining, it is forecast that production from fields located at a depth of 400 m or more will increase.

At an offshore oil field, what we see is a "drilling derrick on a platform standing upright in the sea" and most people would think that the derrick platform is standing over a single well, pumping up subsea oil after drilling the seabed from the derrick platform. In reality, although there are variations, subsea oil is sucked up at the seabed, and a more representational picture would be an octopus sticking its head out of the sea, with the ends of its tentacles clinging to the ocean floor.

Crude oil from wells scattered across the seabed is pumped up and delivered to a platform via pipelines in the sea or on the seabed. These pipes, however, are vulnerable to various factors: they can become corroded because of seawater or buried in the seabed, or they may become suspended in the sea if the bed below becomes eroded. Although regular

Demand for Pipeline Inspection



Source: Infield Systems Limited (based in the UK)

Under a platform standing in the ocean, multiple oil wells are scattered around.

maintenance and inspection are indispensable to sustaining subsea oil extraction, divers can operate only in relatively shallow water, up to 300 m deep, and it is a dangerous mission. Unmanned submersibles (robots), the most popular of which currently are remotely operated vehicles (ROVs), were developed to replace these divers.

Powered by cables connected to the mother ship, ROVs can be operated in real time. However, they can only be manipulated by skilled and dedicated operators, and the range of operations is limited to the area near the mother ship. Because these factors make the use of ROVs costly, AUVs are now regarded as an alternative “guardian of the subsea oil fields.”

AUVs do not require cables and, as the name indicates, perform tasks autonomously even in deep waters without the operational limits imposed by being tethered to a mother ship. The downside has been that the power supply on AUVs was limited, and that sophisticated control technology was required to enable them to perform complex tasks. Kawasaki broke through these technological challenges and developed an innovative commercial AUV for subsea oil field maintenance.

In June 2020, off the coast of Awaji Island in Hyogo Prefecture, the company successfully completed a demonstration test for the inspection of a subsea pipeline by an AUV with a robot arm. The great success of the test suggests that its commercialization is rapidly approaching.

Inspecting 20 km of Pipeline at a Maximum Depth of 3,000 m in a Single Dive

The AUV that Kawasaki plans to commercialize in 2021 is a streamlined vehicle with rounded ends, approximately 4 m long, 1.2 m wide, and 0.9 m high. It travels underwater at up to 4 kt (1kt = 1.852 km/h), and using a sensor, locates pipelines so the robot arm can come into contact with them. A sensor for inspection is attached to the tip of the arm, which collects various data from the pipes.

When fully charged, this AUV can operate underwater for about eight hours, performing inspections at a speed of around 1.5 kt, which means it is capable of inspecting more than 20 km of pipeline in a single dive. After a mission, it will dock at the docking station, which is suspended from the mother ship, and start recharging its batteries while transferring collected data to the ship. After four hours, recharging is complete and the AUV can return to its subsea mission. Compared to an ROV connected to the mother ship via cables, the AUV can operate without this constraint, giving both the AUV and the ship greater flexibly, which is one of its prominent advantages.

Although cruising-type AUVs developed by American and European companies for subsea exploration already exist, maintenance and inspection of pipelines by AUVs in offshore oil fields require completely different capabilities. It should be able to come close to the pipeline, track it automatically, inspect it, and collect the data effectively. These operations demand that the AUV clear the following major technological challenges: 1. A body that withstands enormous water pressure in deep seas, 2. Means to receive power, 3. Autonomous navigation controllability, and 4. Capability to accurately collect data for maintenance and management.

Kawasaki’s commercial AUV is designed to navigate at depths up to 3,000 m, which applies 30 megapascals (MPa) of pressure to the AUV or 3,000 t of load to a 1 m x 1 m area of the vehicle. To resolve these challenges, Kawasaki’s submersible technologies were utilized, which involved the use of water-pressure-resistant and anti-corrosion components.

Noriyuki Okaya
Manager
AUV Department, Kobe Shipyard
Ship & Offshore Structure Company

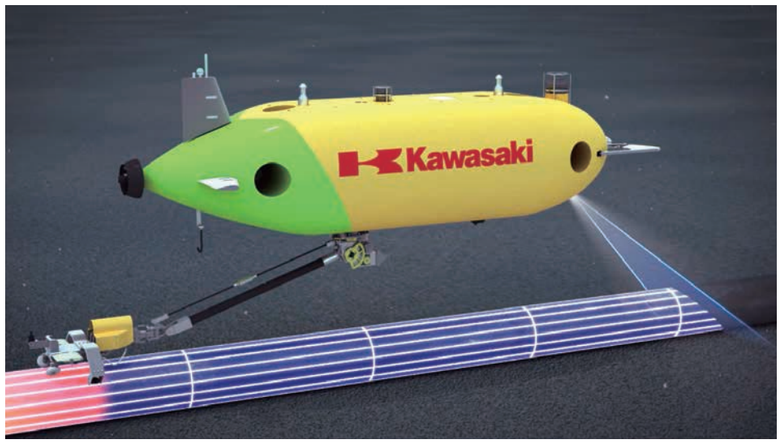
First-of-Its-Kind Docking Station Ensures Operator Safety

To supply power to the AUV, Kawasaki has developed a completely new docking station method. Commenting on the idea behind the development, Noriyuki Okaya, Manager of the AUV Department at Kawasaki’s Ship & Offshore Structure Company, says, “The most dangerous phases in the operation of an AUV are when it is launched into the water and when it is recovered. Underwater power charging and data transfer can reduce the danger and improve operational efficiency.”

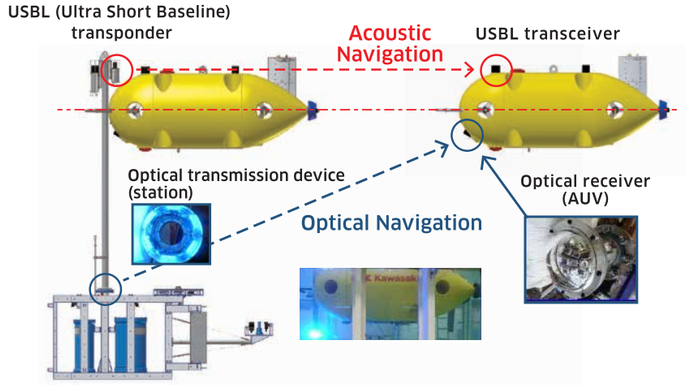
This is the procedure: When its battery requires recharging, the AUV locates the docking station using acoustic signals. As it approaches the station, it is navigated optically and the vehicle catches the pole of the docking station using an M-shaped connecting device found on one end of the AUV. The vehicle’s position is then fine-tuned using optical communication, the docking is completed, and power

Kawasaki’s Commercial AUV Specifications (Summary)

Length	4.0 m
Width/Width including fins	1.2 m/2.0 m
Height/Height including fins	0.9 m/1.5m
Weight	About 1.7 t
Speed	4 kt
Mission depth	3,000 m
Battery	Lithium-ion polymer batteries
Mission time	8 hours
Charging time	4 hours
Propulsion system	1 main thruster 2 horizontal thrusters 2 vertical thrusters
Navigational instruments	Inertial navigation system, sonar
Safety systems	Ballast release system Iridium communication device

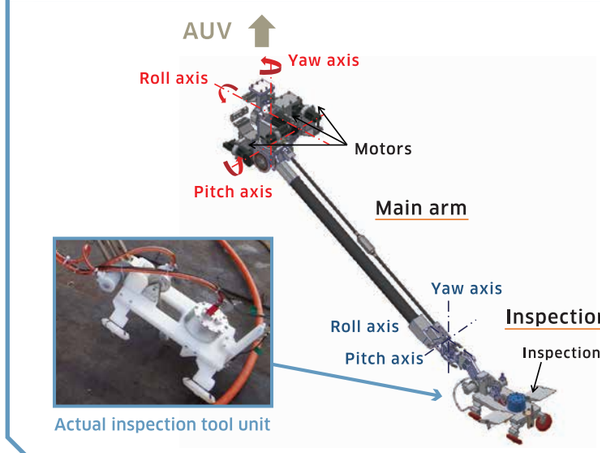


Automated Docking Technology

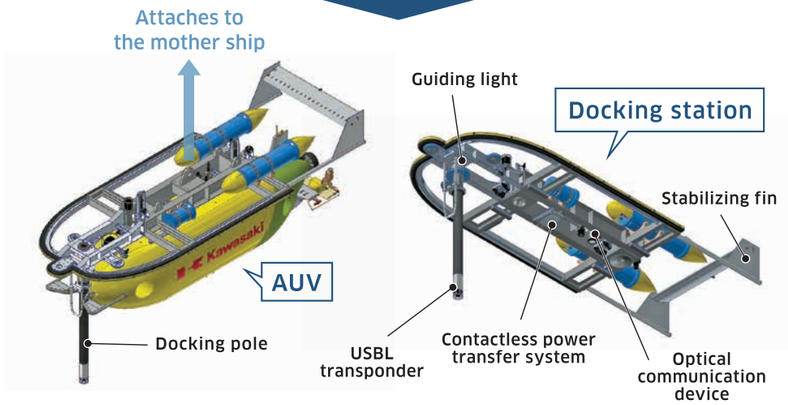


The above shows a docking station for the prototype AUV. Using both acoustic signals and optical communication, the AUV is connected to the docking station for battery charging and data transfer.

Robot Arm Technology for AUV



Commercialization of AUV for Pipeline Inspection



For the commercial AUV, we flipped the docking station, so that both the AUV and the station can be recovered together. Because this method involves no divers, operational safety has significantly improved.

recharging and data transfer begin. Charging is done using a contactless power transfer system, and data transfer is accomplished via optical communication.

The demonstration prototype AUV "sat" on the station to dock, but for the commercial version, Kawasaki completely reversed the concept so the station is suspended from the mother ship. Okaya adds, "By suspending the station from the ship, the AUV can be recovered or launched together with the station since the AUV is firmly tethered to the station. This is a more efficient and safer mechanism because it doesn't involve divers or boats to deploy or recover the AUV."

Accurate Inspection by Robot Arm — Another World's-First Achieved Through Technological Collaboration

Control technologies required for the vehicle's autonomous navigation were developed mainly by the Corporate Technology Division in Kawasaki. A method for automatically tracking pipelines was developed through a collaboration with Heriot-Watt University in Scotland, which is known for its excellent research on AUVs.

Kosuke Masuda
Assistant Manager
AUV Department, Kobe Shipyard
Ship & Offshore Structure Company

Another unique development in this system is the robot arm used for inspections, since an AUV equipped with a robot arm inspection device is a world's-first. The arm swiftly detects the condition of the pipes so maintenance work can begin as early as possible. This results in improved overall productivity and longer asset life.

For the commercial version, the arm is extended from the bottom of the AUV and has a wheeled base at the arm's tip which is packed with various sensors for inspection. The wheels of the base roll on the pipes as the base advances.

Kosuke Masuda, Assistant Manager of the AUV Department, who was in charge of developing the robot arm, explains, "Many of the AUVs developed by other companies inspect the pipeline from a distance, which makes it difficult to collect precise data. However, the robot arm can place the sensors close to the pipes and collect precise and accurate data."

When the AUV sways due to tidal currents, the arm absorbs the movement and continues to operate stably. Because the arm must function under the harsh conditions of 3,000 m below the surface, as mentioned earlier, its designing was far from easy.

Masuda adds, "We applied technologies developed through designing and constructing submersible vessels to the mechanism and structure of the arm dedicated to the AUV. We also received technical support from the Precision Machinery & Robot Company in Kawasaki to incorporate the accuracy and precision of industrial robots. Commercial AUVs are packed with Kawasaki's cutting-edge technologies."

Public Demonstration Praised by Oil Field Developers

Performance tests for commercial AUVs are currently being conducted in Okinawa and Awaji Island. Using the previous generation prototype, we conducted a public demonstration in Scotland in November 2017, to which local personnel associated with the subsea oil industry were invited.

According to the industry journal which immediately covered the event, the guests gave high ratings to the tests. Their comments included, "I was impressed by its high hovering performance during the time it was subjected to a 1 kt-class fast tidal current," "I found the system compact, considering that its contactless underwater power output was 5 kW-class," and "It's important for AUVs to have more applications, such as inspection systems. I'd like to talk to Kawasaki more specifically about them."

Okaya comments, "Speaking of the future of oil field maintenance, we expect that the roles of ROVs and AUVs will be more clearly divided: ROVs will be used for heavy-duty projects such as pipe replacements and AUVs will perform inspections and other less heavy-duty missions."

In 2021, the world will see the first commercial AUV tasked with the mission of protecting subsea oil fields and thereby supporting global energy use.

A pipeline inspection simulation test held in the sea off Okinawa.

Visit "Kawasaki Group Channel" on YouTube where you can find a video explaining the mechanisms of Kawasaki AUVs.

https://youtu.be/rrIl44oN63s

A Leader's Voice

Hiroshi Sakaue Senior Manager, AUV Department
Kobe Shipyard, Ship & Offshore Structure Company

Innovative Technology Quietly Supporting Global Energy Supply from the Ocean Floor

For decades, Kawasaki has been building Soryu-class submarine vessels, deep submergence rescue vehicles (DSRVs), and other submersibles. We have thereby accumulated a wealth of technologies for underwater operations over the years. Actually, before we completed the AUV *Marine Bird* in 2003, we had already established the basic technologies for automated docking and contactless supplying of energy.

For the development of this commercial AUV, and in continuation of our R&D efforts, we reverified component technology to resolve various challenges, including the supplying of energy, autonomous navigation control, and underwater communications. Fortunately, Japan enacted the "Basic Act on Ocean Policy" in 2007, to promote the protection of maritime rights, and decided to support the development of such technologies. As a result, our development program for the AUV was subsidized, allowing us to continue with our research on unresolved challenges.

This program supported our undertaking to develop not only automated docking and contactless power transfer technologies, but also measurements to be carried out by the robot arm and autonomous navigation control algorithms — both world's-first achievements. We intend to collaborate with our customers to upgrade the inspection unit at the tip of the robot arm. We also plan to utilize the robot arm for applications beyond the maintenance and inspection of subsea pipelines and would like to see it used with umbilicals for power transfer and control signal transmission, for offshore wind farm cables used for transferring power to onshore facilities, etc.

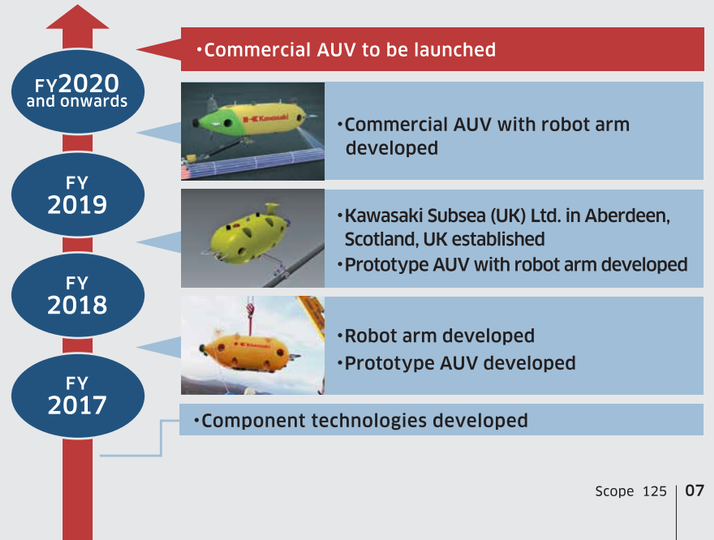
In 2019, we established Kawasaki Subsea (UK) Ltd. (KSUK) in Aberdeen, Scotland, UK, which is a hub city for North Sea oil firms, to focus not only on the sale of AUVs, but also on reinforcing our ability to collect information on customer needs regarding AUV features. Based on the knowledge gained, we plan to launch the first commercial AUV into global markets in 2021.

Because the world's demand for oil as an energy source is still strong, the trend to go deeper into the sea to extract oil will accelerate. This means that the length of subsea pipelines will be extended, and various types of control equipment will have to function under harsher operational conditions. I am proud that we can deliver AUVs to the world in order to support global energy demand — quietly, from the bottom of the sea.

Looking Forward to Tomorrow

Commercial AUV Achieves Higher Speed and Longer Mission Time than Demonstration Stage

Kawasaki developed a prototype AUV for demonstration tests in FY 2017 after verifying the technology for each component. Concurrently, the company was engaged in a separate project to develop the robot arm, which was completed and later attached to the prototype AUV for verification tests that began in FY 2018. The test results were used to improve the commercial version, resulting in a more streamlined shape, significantly faster navigational speed, and longer mission time — features which led to a drastic improvement in the inspection distance needed for commercial AUVs.



Kawasaki Heavy Industries: A Supporter of Hockey

Kawasaki does not have a corporate sports team at present, but is focusing on supporting sports promotion activities by acquiring naming rights for sports facilities and employing sports personnel.

Reach for Your Dreams!
Kawasaki Spirit

Keiko Miura

Senior Staff Officer, General Affairs Section, Human Resources & General Affairs Department, Planning Division, Aerospace Systems Company / Coach and Analyst, National Women's Field Hockey Team, "Sakura Japan"

Naming Rights to Facilities Such as Gifu Prefecture Green Stadium Acquired

A single coach, brimming with passion, changed a town. Zenjiro Yasuda, who participated in the Mexico Olympics as a member of Japan's men's field hockey team, graduated from university the year after the Olympics and became the field hockey club coach for Gifu Prefectural Female Commercial High School (now Kakamigahara High School) in his hometown. Since then, he has turned the school into a regular championship contender, winning the National High School Championship 20 times. As coach of the women's national field hockey team, he led to their participation in the Athens Olympics, a first for Japan. The sports press describes him as "a distinguished coach who has an outstanding record of accomplishments."

Gifu Prefecture and Kakamigahara City have also entrusted him with their dreams to turn the city into "Field Hockey Kingdom Kakamigahara." The symbols of this are Gifu Prefecture Green Stadium, a hockey complex boasting the best facilities in Asia, and Kakamigahara City Hockey Field, which were established on the same grounds. The facilities have three official competition pitches, and the Green Stadium has a main stand which can seat 1,630 people.

Kawasaki acquired the naming rights to both facilities as a result of a joint public offering in 2016. Since then, the facilities have gone under the name of Kawasaki Heavy Industries Hockey Stadium.

The stadium hosts games at the national and international level, and it is used as a national training center, which is home to the men's and women's Japanese national teams.

Actually, Kawasaki Heavy Industries Aerospace Systems Company (Gifu Works) is also located in this area, with the company on the opposite side of the hockey stadium and the Japan Air Self-Defense Force (JASDF) Gifu Base in between the two. The Gifu Works manufactures large aircraft, helicopters, and space-related equipment. Kawasaki decided to acquire the naming rights to the facilities as a unique way of acknowledging local employees' excellent work and of contributing to society.

Competition pitch at Kawasaki Heavy Industries Hockey Stadium.

Miura from General Affairs Is a "Sakura Japan" Coach

Keiko Miura, Senior Staff Officer in the General Affairs Section of the Aerospace Systems Company, was discovered by Coach Yasuda at Gifu Female Commercial High School, and was serving as captain of the Japan women's field hockey team when it was decided that they would take part in the Olympics for the first time, as well as during the Athens Games themselves. Having joined Kawasaki in 2015, she provides operational support in the General Affairs Section, gives lectures at elementary and junior high schools, and coaches junior high school field hockey clubs in the city as social contribution activities.

The Kendo grip she honed in junior high school and the powerful stroke she developed playing softball helped her in field hockey, and during her active career she made strong shots on par with male athletes in set-plays from the penalty corner. She is one of the key players who brought Japanese women's field hockey to the international level.

Miura is also currently a defense coach and analyst for the national women's field hockey team, "Sakura Japan." She uses her excellent computer skills during matches to segment images of the play in real time and analyze the movements of the players. She also sends the results to the bench.

Japan placed 14th in the international women's field hockey rankings announced in September 2019. However, Miura says, "There is no country we can't beat. We share ball possession 50-50 when playing against any team. If we give all that we have, to win each match, we will get results."

Coach Miura advises players in a match.

When asked once again why she chose field hockey, she says, "It's simply good fun. From field hockey I learned that if you have a goal and work hard, your dream will come true. Then being a coach taught me that I can contribute to people by giving them an environment where they can think for themselves and set their own goals." She always makes this point at lectures at elementary and junior high schools.

Do You Know the Rules of Field Hockey?

● 11 People Play on the Pitch

There are 11 people per team on the pitch during a match: 1 goalkeeper and 10 players. Players can be substituted at any time during the match, and any number of substitutions can be made, so the timing of player substitutions greatly affects the match. A player may run more than 13 km in one match, in a semi-crouched position. There are 18 registered players per team in an international match.

● 15 Minutes x 4 Quarters

A match is 60 minutes in total, with a 10-minute half-time after the 2nd quarter. If there is a tie, a shoot-out similar to a penalty shoot-out in a football match is played, in which five shooters from each team take part.

● No Offside

The previous offside rule has been abolished, which makes for a faster match.

● Harder than a Baseball

The ball is almost the same size as a baseball, but it is harder because the core, made of cork, is covered with resin. Recently, balls that are dimpled like golf balls have become popular, and top players can shoot at speeds of 150 - 170 km/h. It really hurts if you get hit.

● Flat Side of the Stick Only

The stick is a maximum of 737 g in weight and 105 cm in length. Sticks have a flat and a rounded side. Players can only hit the ball with the flat side. Players turn the stick to dribble the ball, which is more difficult than it seems.

● Artificial Grass Sprinkled with Water

Most matches are now held on artificial grass, so water is sprinkled on it to prevent friction burns when a player falls. Sprinkling water makes the play dynamic, speeding up the ball and drastically reducing mistakes. The games have become even more thrilling.

Reference: Japan Hockey Association website

Techno Box 24

Once-Through Boiler WILLHEAT

The WILLHEAT (3,000 kg/h) being introduced at this time will be released only in Japan. We are preparing for overseas sales.

Commentary by

Yoshitomo Tanaka (left)
Assistant Manager, Engineering Office
Research & Development Department
Kawasaki Thermal Engineering Co., Ltd.

Toshinori Murakami (right)
Senior Staff Officer
Sales & Service Control Office
Kawasaki Thermal Engineering Co., Ltd.

Customer-Centricity Drives Our Pursuit of Technological Innovation

In 2019, Kawasaki Thermal Engineering Co., Ltd. (KTE) developed and sold the once-through boiler WILLHEAT, proving to the world that significant technological advancement is still possible for boilers, which are considered products with mature technology whose performance indices are hard to improve even by 1%.

WILLHEAT now boasts a 99% efficiency rate (the percentage of the total absorption heating value of outlet steam in the total supply heating value), an increase from 98%, achieving the highest rate in the boiler industry. This accomplishment is attributable to a newly-designed economizer, which preheats feed water using waste heat, and the adoption of PID (proportional-integral-derivative) control, which controls the boiler's combustion and water feeding.

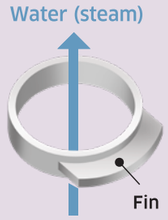
Many boilers have a turndown ratio* of 5:1 (i.e., 20%). The WILLHEAT, however, achieves an even higher ratio of 7:1, or the lowest combustion rate being about 14%. A boiler can be run at a lower cost if the combustion for steam production is continuous and the temperature of the boiler proper is maintained, compared to repeatedly cycling on and off. In that way, CO_2 generation can also be curbed, which makes the improved turndown ratio a significant benefit for industrial facilities using boilers.

KTE's proprietary "Steam-Water Separator" results in a greater than 99.5% steam dryness, which indicates a high quality of energy, since the higher the steam dryness, the greater the amount of heat energy. Therefore, achieving a higher steam dryness can significantly improve the production efficiency of industrial facilities using steam. This is one of the fruits of our ceaseless pursuit of user benefits, which culminates in technology that realizes a "greater than 1% performance improvement."

Kawasaki's Superior Technology

Boiler Combustion Control and Water Tube Fins

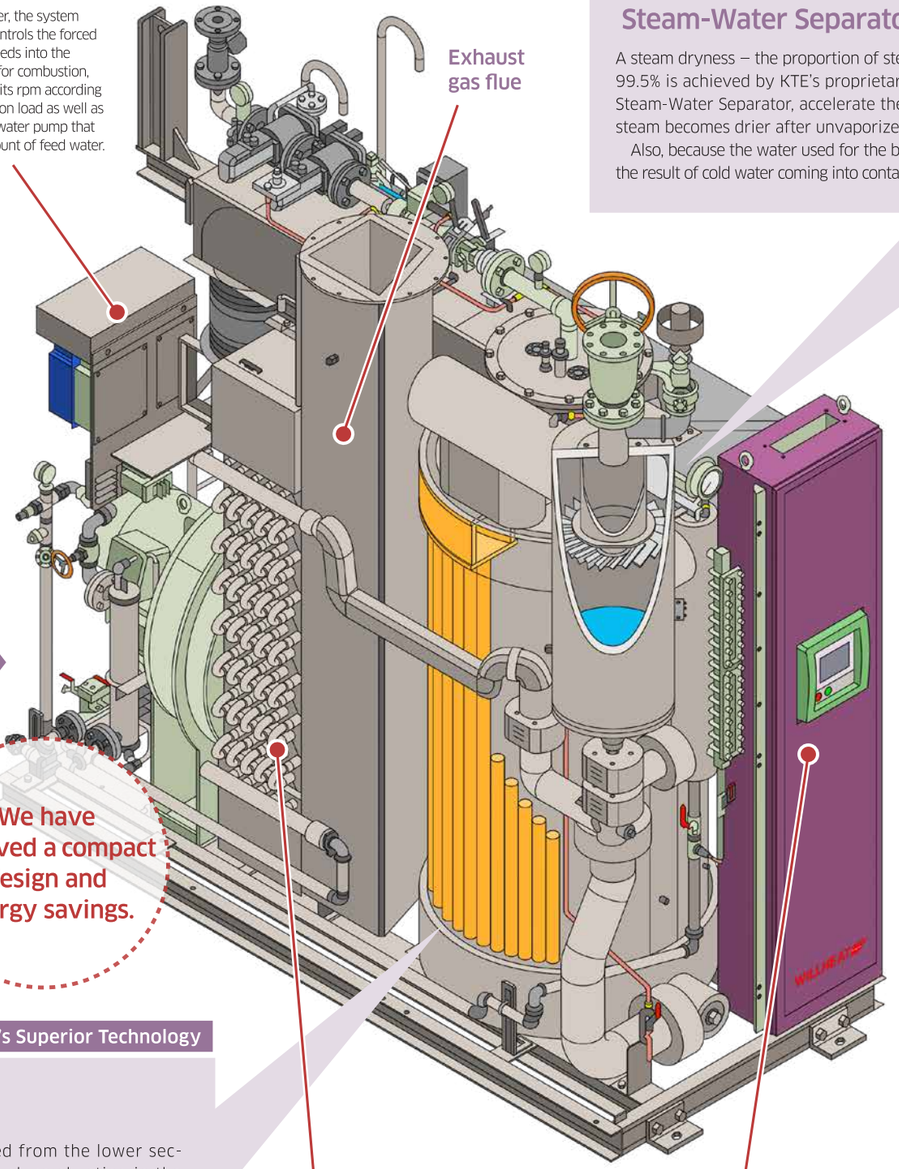
The boiler converts into steam the feed water fed from the lower section of the boiler, using the heat generated through combustion in the burner installed in the upper section of the boiler. During this process, PID control is at play, ensuring that the burner's flames are distributed properly so that no particular area is at an excessively high temperature and NOx emissions can be avoided as much as possible. PID control also optimizes the degree of heating during periods when less steam is required (i.e., when reduced amounts of water are fed into the system), which is KTE's unique tuning method for optimizing the "chemistry" between the burner and the boiler (furnace). The water tubes are equipped with fins of different shapes, optimized according to the location of each individual water tube, thereby facilitating the tuning.



* The turndown ratio refers to the ratio of the largest combustion amount and the least combustion amount.

Inverter-Equipped

Using an inverter, the system continuously controls the forced draft fan that feeds into the furnace the air for combustion, while changing its rpm according to the combustion load as well as controlling the water pump that adjusts the amount of feed water.



Economizer

The economizer is the main player in achieving 99% boiler efficiency, effectively recovering waste heat by creating a heat exchange between the feed water and the boiler's exhaust gas. A great deal of heat can be recovered if the area occupied by heat-transfer tubes (through which the feed water flows) is large. However, this approach increases the size of the boiler system, resulting in exhaust gas flowing in a larger area, slowing down flow speed and lowering thermal conductivity. To resolve this dilemma and achieve the best results, KTE has optimized the layout of the heat-transfer tubes and added fins to them. The rounded, protruding parts in the illustration are the heat-transfer tubes.

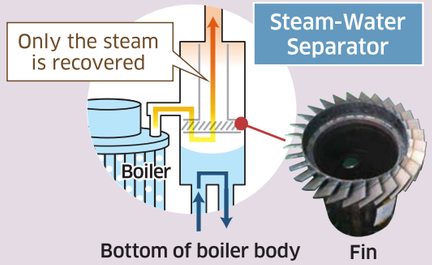
Control panel

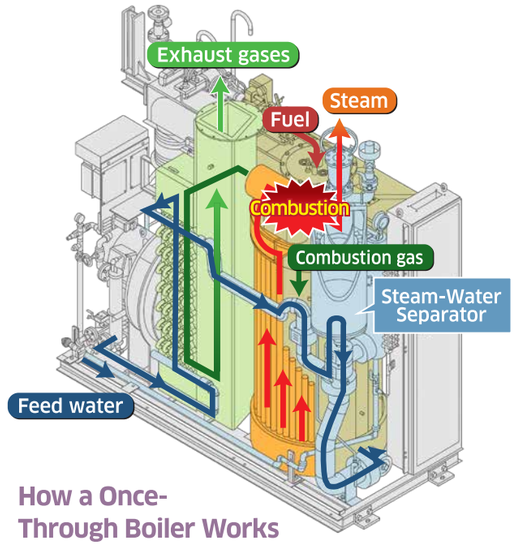
Kawasaki's Superior Technology

Steam-Water Separator

A steam dryness – the proportion of steam in "wet steam," a mixture of steam and water – of greater than 99.5% is achieved by KTE's proprietary Steam-Water Separator. The fins, which are turning inside the Steam-Water Separator, accelerate the centrifugal speed of the steam generated in the boiler, and the steam becomes drier after unvaporized hot water is removed by the inversion separator.

Also, because the water used for the boiler is preheated in the lower part of the separator, thermal shock – the result of cold water coming into contact with hot water inside the water tubes – can be avoided.





How a Once-Through Boiler Works

A once-through boiler is composed of water tubes, into which water is fed from one end and steam is output from the other end. Small type once-through boilers with compact configuration typically hold less water than normal sized versions and offer a shorter steam generation reaction time, as well as smaller footprints. The economizer preheats the feed water using waste heat, and this heated water is fed into the boiler's water tube, which produces steam following additional heating by residual heat inside the Steam-Water Separator. KTE's product portfolio includes both the compact "WILLHEAT" and the large-sized "Ifrit," which can produce 6 t of steam per hour.

Hydrogen Road

Use of New Boiler Fuel: Hydrogen

In March 2018, KTE launched a demonstration of a once-through boiler fired by hydrogen — the next-generation energy source. Tests on each element of the boiler have been completed successfully and experiments focused on commercialization are now being conducted. To resolve the challenge of NOx emissions resulting from hydrogen with a high flame temperature, KTE has changed the shape of the burner and taken other measures to improve prospects for commercialization.

You Gain from Both Victory and Defeat If You Enjoy the Fight

Mana Iwabuchi

Mana Iwabuchi is the ace striker of INAC Kobe Leonessa in the Japan Women's Football League, commonly known as the "Nadeshiko League," as well as the women's national football team "Nadeshiko Japan." She has been a leading force in improving the level of women's football in Japan. Her current focus is on achieving victory at next summer's Tokyo Olympic Games.

My Competitive Disposition Is the Energy for Growth

When she plays, the ball follows her foot movements, as if magnetically drawn to her. She skillfully dodges her opponents, securing a line of sight to the goal, and makes a powerful shot. The speed and accuracy of her dribbling skills have earned her the honorary nickname "Manadona," after football superstar Diego Maradona.

Iwabuchi, however, comments laughingly, "I've never been called by that nickname by someone close to me, so that's irrelevant to me." Whether the nickname is appropriate or not, she is undoubtedly the ace striker of INAC Kobe Leonessa and Nadeshiko Japan.

She is also a player who can brighten the mood of a team and bring it good luck. Since being registered in 2010 at age 16 as a member of the "A" National Team, she has played in 72 international "A" matches and scored 29 goals (as of March 31, 2020). Of 23 matches in which Iwabuchi successfully scored goals, the team saw 20 victories and only three defeats. This trend led fellow team members to expect that, "If Iwabuchi scores, we can win."

It is Iwabuchi's indomitable spirit and her sheer enjoyment of the sport which encourage such expectations. When she was a second grader in elementary school, she began kicking balls around, mimicking her brother who was always practicing at a football club in their hometown. Watching her play, the club's coach asked her to join them even though it was a boys' team, saying, "She's got a great aptitude for football."

Iwabuchi comments, "Back then, it was so much fun to play with the ball, and I wanted to win if the game was about winning or losing. I've never accepted being defeated by boys and always made all-out efforts to beat them, be it tag or a relay race."

Recalling those days, the coach says, "I always made her compete with boys one or two years older. That indomitable spirit that defies her seniors' skills and physical stamina was at the heart of her growth."

When Nadeshiko Japan was crowned world champion at the FIFA Women's World Cup in Germany, 18-year-old Iwabuchi was the team's youngest member. The following year, in 2012, she joined Germany's Bundesliga club TSG 1899 Hoffenheim and scored four goals in nine games, which contributed to the team's promotion to Division 1. In 2014, she transferred to Bayern München, which was crowned the Bundesliga champion for the first time in 39 years.

Injuries During My Years in Germany Showed Me Football's Importance in My Life

Despite her excellent performance, Iwabuchi suffered many injuries in her four-and-a-half-year career in Germany before returning home in 2017. She says, "Each time, I thought, 'Not again,' and felt it was a hassle [to continue], and that I'd quit playing football if I got injured again." The reason she continued was that her friends encouraged her, saying, "Let's play together again."

Iwabuchi adds, "If you take football away from me, I'm an empty person. My time [in Germany] taught me how heavy the weight of football is in my life. In the end, although I had to come home because of my injuries, I wasn't feeling negative."

She resumed her career in Japan by joining INAC Kobe Leonessa, wearing the number 10 — the team's ace striker's shirt. Currently, she is focused on competing in the Tokyo Olympics. "I'll think about what to do next after the Games are over." At the age of 27, Iwabuchi is now expected to deliver excellent captaincy.

"Nadeshiko Japan is still a team without much experience, so there is much to be gained from each game — win or lose. I think the most important thing is to play football in a way we enjoy. Of course, it's more fun if the game ends favorably. There were games that we lost but still enjoyed playing."

Iwabuchi adds, "One of the most enjoyable things about football is that the number of goals you can score is unlimited, so the number of things you want to try is infinite, too." These words indicate that she is determined to keep growing.

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Mana Iwabuchi

Born in Musashino City, Tokyo, in 1993. She began playing football when she was a second grader and made her debut in 2007 at age 14 in the Nadeshiko League after becoming a registered member of NTV Beleza. She was a member of the National Under-16, Under-17, and Under-19 teams, and in 2010, when she was 16, was registered as a member of the "A" National Team. She also played in the FIFA Women's World Cup in Germany and in Canada, as well as in the London Olympic Games. Beginning in 2012, she played for both TSG 1899 Hoffenheim and Bayern München before moving to INAC Kobe Leonessa in 2017.

Regulatory Approval Obtained for the “hinotori™ Surgical Robot System,” Japan's First Robotic Assisted Surgery System

Medicaroid Corporation, a joint venture between Kawasaki and Sysmex Corporation, obtained regulatory approval for the hinotori™ Surgical Robot System from the Ministry of Health, Labour and Welfare on August 7. This is the first regulatory approval of a Japanese manufacturer for a robotic assisted surgery system in Japan, and insurance coverage began on September 1.

hinotori™ consists of three units: (1) Operation Unit, (2) Surgeon Cockpit, and (3) Vision Unit. The robotic arms of the Operation Unit are designed to be as compact as human arms, which contributes to smoother operation because it reduces interference between the arms themselves, and between the arms and human assistants. The Surgeon Cockpit adopts an ergonomic design to fit the posture of the surgeon during surgery. It reduces the physical burden on the surgeon to reduce stress. In addition, the Vision Unit provides high-definition 3D images on the stereoscopic viewer in the Surgeon Cockpit, and supports smooth communication between the surgeon and the assistants.

The origin of this system's name, hinotori™, is the title of the classic manga (graphic novel) *Hinotori (Phoenix)* written by Osamu Tezuka as his greatest work. He is one of the most famous Japanese manga artists and had a medical license. Tezuka Productions approved the adoption of the name Hinotori for the surgery system, agreeing with the concept of Medicaroid's system: a robot to serve and support humans rather than to replace humans. Just as Osamu Tezuka illustrated the preciousness of life through his work Hinotori, Medicaroid will produce the hinotori™ Surgical Robot System to aid healthcare workers who are saving lives.

hinotori™ will first be used for urology surgery, such as prostatectomies and partial nephrectomies. Usage will be expanded in the future, and a training center will be established. The system will be launched in FY 2020, and sales are scheduled to start in earnest from FY 2021. In recent years, along with the progress of minimally invasive surgery that reduces the burden on the patient, there is a growing need for robotic assisted surgery. Japan is one of the world's leading powers in robotics, and although it has more than half the share of the world market for industrial robots, domestically produced surgical support robots have not appeared before. In response to this situation, Kawasaki and Sysmex established Medicaroid in 2013 for the development of medical robots.

In addition, Medicaroid is developing a robotic testing system to protect healthcare workers from infection during PCR tests for the coronavirus, and streamline the testing procedure.

Kawasaki Launches New Gas Engine with World-leading Electrical Efficiency

After completing endurance testing, Kawasaki has started sales of their KG-18-T gas engine, a newly developed product with a two-stage turbo-charging system and world-leading electrical efficiency in its class. It joins the Kawasaki Green Gas Engine lineup as a high-efficiency model.

The original model that the KG-18-T is based on has sold over 180 units, since it was introduced in 2011, and the latest model was developed to further boost performance. The new model has an output of 7,800 kW at 50 Hz and 7,500 kW at 60 Hz, and utilizes a newly developed two-stage turbo-charging system to achieve a 1.5% increase in power generating efficiency when compared with existing Kawasaki models, giving it a world-leading efficiency in its output class of 51.0%.*1 NOx emissions are kept to 200 ppm*2 or less, and it is designed to meet the environmental performance requirements demanded by many cities. Furthermore, it offers excellent fast startup, enabling maximum output within five minutes, contributing to optimal adjustments in response to grid fluctuations.

*1 Calculated using city gas in Japan (40.6 MJ/Nm³, methane number = 69)
*2 Converted at 0% O_2

Visit Our Website to see the New Movies

Kawasaki has posted short movies on its website with the corporate message “カワる、サキへ。* Changing Forward.”

Motorcycle Version

The movie focuses on Kawasaki's Ninja H2 motorcycle. During Bonneville Speed Week, the motor sports event that draws riders from all around the world, Kawasaki exploited the overwhelming power of the Ninja H2 to achieve a new world speed record. The movie captures this with plenty of realism to depict the value provided by the Ninja H2.

Special Site Changing forward ▶ https://global.kawasaki.com/en/stories/articles/vol47/#forward
Also Available on the YouTube Kawasaki Group Channel ▶ https://www.youtube.com/watch?v=7SVSerP5VCc

Rolling Stock Version

This movie focuses on the annual Model Railway event held at Kawasaki Good Times World, the company museum. The movie not only focuses on the pursuit of speed and comfort in the manufacturing of rolling stock, but also shows how rolling stock is connected to the dreams and excitement of children.

Special Site Changing forward ▶ https://global.kawasaki.com/en/stories/articles/vol47/#rail
Also Available on the YouTube Kawasaki Group Channel ▶ https://www.youtube.com/watch?v=3JcmQb7zB1I

* Reads, “KAWA-ru, SAKI-e”

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