Kawasaki's Technology for Large-Volume, Long-Term Liquefied Hydrogen Storage

A special tank for large volume storage and a long term supply of liquefied hydrogen (LH2) is absolutely essential in realizing a hydrogen-based society. One of the issues in storing large volumes of LH2 is that of suppressing the boiling off of cryogenic hydrogen (-253°C). Kawasaki has resolved this issue through its advanced thermal insulation technology, resulting in Japan’s largest spherical LH2 storage tanks, each with a 540 m³ capacity. Since 1994, they have been used for fuel storage for space rockets at Tanegashima Space Center, which is operated by Japan Aerospace Exploration Agency. This technology is being applied to the development of a larger 2,500 m³ storage unit, corresponding in volume to the amount needed to fill the tanks of 30,000 fuel cell vehicles.* Kawasaki is working to develop the technological foundation of a hydrogen energy supply chain—production, transportation, storage, and use. We believe that by handling hydrogen in a manner that is safe, stable, and affordable, we will be able to enhance the quality of life. The road to that future is what we call the Kawasaki Hydrogen Road.

* This estimate is based on the fact that the amount needed to fill a fuel cell vehicle tank is 5 kg (0.07 m³).
Main Players in the Modal Shift in Transportation: Kawasaki’s Locomotives & Freight Cars

In recent years, various social challenges, including environmental concerns and a shortage of truck drivers, have been accelerating a modal shift in freight transport. Due to these factors, rail has been gaining increasing societal attention. As a leading manufacturer of locomotives and freight cars, Kawasaki is making a steady contribution to promoting this modal shift.

Operational improvements

Today, companies are increasingly focused on upgrading their logistics strategies in an attempt to reduce inventory and achieve cost reductions. Another factor behind heightened interest in the transformation of logistics is a serious systemic shortage in the workforce of the trucking industry, which once accounted for 90% of the volume of domestic freight transport. To cope with the shortage, the Japanese government and the transport industry have been promoting a shift from road transport to other means—a modal shift—and rail is top of the list as an absorber of this shift. Japan Freight Railway Company (“JR Freight”), with its nationwide network, happens to be Japan’s sole rail freight entity. Yasutoshi Ohashi, head of Railway Business Headquarters of JR Freight comments, “Transport volume has been steadily increasing. Two of the driving factors are the enactment in November 2016 of the Paris Agreement on climate change and shippers’ increased use of rail in order to reduce their environmental footprint.” Ohashi says that JR Freight has been receiving business inquiries even from medium-range transport sector competitors, namely trucking companies and airlines.

Rail offers a unique set of benefits, which includes an impressive volume of goods (the equivalent of 65 10-ton trucks) being transported by a single train, which is also cost-effective, eco-friendly, as freight trains emit only one-ninth of the amount of carbon dioxide as do trucks, and one of the world’s top punctuality ratings, achieving an arrival/departure punctuality score of 94%, while traveling the equivalent of five times around the world on a daily basis. Customers rate the company’s services highly, saying that with JR Freight, the receipt and dispatch of goods is easy, and because the company offers containers of various sizes, different packaging styles can be accommodated, which helps improve loading efficiency.

The modal shift to rail is becoming an irreversible trend, compelling companies normally competing with each other to share freight space, and forcing mass retailers to reconsider their transportation strategies, in order to utilize rail freight transport. The modal shift has also contributed to a sustainable logistics system in Japan, with JR Freight serving as a major player in this shift. In conjunction with JR Freight, Kawasaki has been developing and manufacturing locomotives and freight cars, including the EF210 and the EF510 (electric locomotives), which operate on the Tokaido Main Line and Sanyo Main Line, Japan’s main railway arteries; the M250 (express container train); and the DF200 (diesel-electric locomotive), which serves in a very cold region of Hokkaido Prefecture.

Kawasaki also manufactures freight cars. It also provides transport services for 1,883 privately-owned freight cars (as of April 1, 2016). In conjunction with JR Freight, Kawasaki has been developing and manufacturing locomotives and freight cars, including the EF210 and the EF510 (electric locomotives), which operate on the Tokaido Main Line and Sanyo Main Line, Japan’s main railway arteries; the M250 (express container train); and the DF200 (diesel-electric locomotive), which serves in a very cold region of Hokkaido Prefecture. In terms of bogies (trucks), locomotives manufactured by other companies all use Kawasaki-made units.

SUPPORTING CUSTOMERS’ LOGISTICS STRATEGIES THAT BRING ABOUT OPERATIONAL IMPROVEMENTS

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Kawasaki also manufactures freight cars, the latest model of the Koki 107 freight car for example, accommodates both compressed air and electric braking systems. Kawasaki is undeniably a leading developer and manufacturer of locomotives and freight cars in Japan.

Creating world-class locomotives and freight cars

Naoto Yamamoto, who oversees the locomotives and freight trains, says, “The specifications and standards we expect manufacturers to meet are extremely high.” This is because, as a freight operator, ensuring safe and stable operations is a must. Another reason for these high-level requirements is dictated by JR Freight’s operational style, as it is renting the nation’s network of passenger rail lines for its operation. High-speed capabilities and minimal malfunctions are prerequisites. Some countries outside Japan have axle load limits exceeding 20 tons. Yamamoto comments, “There are countries in the world other than Japan which operate locomotives that haul freight cars with goods weighing up to 1,300 tons, and freight cars that can withstand such extreme weight, given all the constraints and technological challenges arising from narrow gauge lines, a topology full of slopes and curves, and a variety of weather conditions. Japanese locomotives and freight cars are world-class.”

Tetsuya Kawahigashi, who is engaged in the development and design of locomotives and freight cars at Kawasaki’s Rolling Stock Company, says, “We aspire to maximize the overall capabilities of locomotives and create the highest quality of freight cars.”

In developing the EF210 locomotive, Kawasaki introduced the concept of “50-minute-rated output,” which means that output is at a maximum in a set period of time, but is usually represented in terms of an hour. The EF210’s one-hour-rated output is 3,395 kW. However, the EF210 achieves a 30-minute-rated output of 3,540 kW, which is higher than its one-hour-rated output. This improvement enables Kawasaki locomotives to climb steep gradients without the support of auxiliary locomotives, thereby eliminating the need to switch locomotives and making freight transport more flexible in dealing with various operating environments. A variety of technologies support this enhancement, such as VVVF (variable voltage and variable frequency) inverter control and a three-phase AC induction motor, resulting in a significant upgrade in overall performance.

A locomotive bogie is another product that must be fail-proof, and it is therefore packed with advanced mechanical technology to ensure high rigidity, durability, and gear performance. Yamamoto notes that all bogies used for new locomotives at JR Freight are manufactured by Kawasaki because, “They are definitely the epitome of technological expertise backed by time-tested development know-how.”

Manufacturing focused on enhancing customers’ transport services

With respect to development of new container cars, ingenious ideas are being introduced, including an underframe concept (a slight convexity in the center of the underframe) to absorb the weight of the containers and improve the overall stability of the cars. Unlike box-shaped passenger cars, container cars are structured more “two-dimensionally,” and became less stable without containers, because the container weighs less. A stabilizer is also providing technological consideration to the stability of container cars being operated with less than full payload. The volume of transport service significantly expands when maritime shipping containers can be transferred from ship to rail without unloading and reloading the containers. However, because such container cars are tall, when loaded onto container cars, they exceed height regulations. This has been hindering their wider application in the transport network. Yamamoto comments, “Development of container cars with lower floors is very much needed, but there are many technological challenges to resolve, such as redesigning their overall structure. We are currently summoning all our expertise to develop this new design.”

Speaking on Kawasaki’s approach to accommodating such customer needs, Kawahigashi says, “Locomotives and freight cars that rarely break down and require only simple and infrequent maintenance can render reliable performance for long periods of time. Such high-quality conveyances promote the expansion of customers’ transport services, and that’s why we make the current system even more robust.”

Welding the underframe

An underframe is the main platform for the cargo, and welding is the most sophisticated technique derived from Kawasaki’s long-accumulated know-how.

Manufacturing the bogie

Wheels, axles, and other basic parts used in making bogies are acquired from steel manufacturers.

Measuring the camber

Distortion resulting from welding of the bogie platform is measured and then the platform is heated to shape it into a perfect arch, a sophisticated technique derived from Kawasaki’s long-accumulated know-how.

Outfitting the bogie

Braking systems and pipes are installed to complete the bogie. This is a process to which utmost attention is paid, as it directly affects safety performance.

Outfitting the underframe

Metal connectors for securing containers, couplings, hand brakes, etc., are installed.

Completion

The underframe is then mounted on the bogie, completing the car, which has a load weight of 407 tons, a dead weight of 36.8 tons, and is capable of traveling at 120 km/h.
full understanding of customer requirements a high priority. Metakazu Yoshizawa, who is in charge of Kawasaki’s sales activities for JR Freight, says, “Building locomotives and freight cars that last for 30 or 40 years and remain efficient in harsh operating environments has been achieved only through the ongoing, united efforts between JR Freight and Kawasaki. I’d like to make the value of such partnerships more widely known.” Commenting on Kawasaki’s role in supporting railway transport as social infrastructure, Yoshizawa says, “We are committed to building a solid relationship of trust with our customers and dedicating ourselves to ensuring that our work is of the highest caliber. As a manufacturer offering an extensive lineup of transport products—from locomotives, freight cars, and shinkansen cars, to transportation systems covering land, sea, and air—I think it is our duty to utilize our extensive line-up of products and services in an integrated manner.

A Customer’s Voice

Taking Modal Shift to the Next Level

High Expectations for Kawasaki as Our Key Partner

By Yasutoshi Ohashi
Senior Managing Director, Chief Safety Management Officer, Railway Business Headquarters, Japan Freight Railway Company

We consider expediting modal shift to be a vital initiative for companies to pursue in addressing environmental and energy issues, beyond considerations for private gain. To that end, JR Freight has developed a 31-foot container loadable onto 10-ton trucks, increased the frequency of operations on high-volume transport lines, and formulated strategies to promote the use of rail transport by customers desiring to transform their logistics by finding more efficient ways to transport low- to medium-volume goods. We also improved cargo collection systems, constructed a large transport hub at the Tokyo Freight Terminal Station, and took various other measures to enhance our services.

What our customers expect of us is to see their cargo transported safely, without fail, expeditiously, and inexpensively. The development of new models of locomotives and freight cars is one of our key initiatives to meet those expectations. Our freight trains have already achieved their maximum speed of 110 km/h on main lines, thanks to our collaborative efforts with Kawasaki.

Of course, there are yet many challenges to resolve, including improvement of high-speed locomotives, development of AC/DC dual-current locomotives that can operate nationwide in a unified, standard manner, and safer and more driver-friendly locomotives utilizing IT. Therefore, we expect much from Kawasaki. Kawasaki is always innovative in designing new freight trains and, at the same time, honest in dealing with problems when they arise and conscientious in the way they remedy them. Such an approach provides strong support for our business.

In the future, JR Freight will be collaborating with Kawasaki in building an overseas freight transport network. We would like Kawasaki, as our key partner, to work with us in developing locomotives and freight cars that best meet local requirements.

Offering a Variety of Services Using a Widespread Network

With the addition of the following three services as primary offerings, Japan Freight Railway Company has been expanding its portfolio of rail transport services, including international freight services, by collaborating with overseas shipping and freight transport entities.

- Maritime shipping container direct transport service
  A rail transport service for 20-foot and 40-foot ISO import/export containers, using the Tokohoku Express trains operating daily between Tokyo and Manazuru, as well as other freight trains.

- “Sea & Rail” service
  A door-to-door, integrated transport service connecting rail lines and high-speed ferries in order to transport 12-foot JR Freight containers, linking Busan and Seoul in Korea and Suzhou in China with Japanese cities nationwide. This service aims to achieve “transport that is faster than by sea and cheaper than by air.”

- Cross docking services
  At freight sheds located next to Tokyo Station, Yokohama Station, and stations serving other major ports, cargo from ships is unloaded and immediately reloaded onto 20-foot rail containers. This cross-docking enables customers to import bulk goods using maritime shipping containers and reloaded them into 12-foot containers for nationwide distribution, achieving streamlined logistics.

Please contact personnel at the number below, if you are interested in JR Freight’s new international freight services.

Japan Freight Railway Company
Sales Department, Global Logistics Division, Headquarters: Daisuke Yamaji, Tomofumi Sato, Tatsuo Uenuma
Sales Department, Warehouse & Trade Firm Division, Headquarters: Masaya Narita, Manabu Hatta
Telephone: +81-3-5367-7399
URL: www.jfreight.co.jp/angl/index.html
Developing Engines for an Era of Mass Air Transport

A staggering number of commercial aircraft travel the skies in our current era of mass air transport, and Kawasaki has played an essential role in the development of the engines that power these planes.

Kawasaki has refined its techniques and technologies over the years through numerous international joint development projects, and the Company is now widely considered to be an essential partner in the development of new engines for civil aircraft.

In 1971, research and development for aircraft jet engines was begun under the initiative of the Agency of Industrial Science and Technology—forerunner to the current National Institute of Advanced Industrial Science and Technology—under the then Japanese Ministry of International Trade and Industry. The FJ71D engine, developed with the participation of Kawasaki and others, was installed on the short takeoff and landing (STOL) aircraft Asuka, earning praise from around the world for its performance. This effort led to an international joint research project in 1983 to develop the V2500 engine for 150-seat aircraft, and later Kawasaki participated as an RRSP* in international joint development projects with American company Pratt & Whitney (P&W) and British company Rolls-Royce Limited.

Later, Kawasaki went on to join other projects, helping to create the Trent 1000 engine for the Boeing 787 aircraft, the Trent XW9 for the Airbus A350 XWB, the PW1100G-JM for the Airbus A320neo, the PW1500G and PW1900G for regional jet aircraft, and the Trent 7000 for the Airbus A330neo. Kawasaki has played an important role in developing engines for many of the world’s major aircraft that travel the skies today.

In the area of production technologies for engine parts, the Company has achieved a flexible manufacturing system (FMS) that integrates production and control systems throughout all phases of the production process. Kawasaki’s FMS was developed jointly by the Jet Engine Division and Factory Automation and Robotics Division, and embodies the essence of the “All Kawasaki” approach.

1983

V2500 International Joint Development Project

The V2500 was realized through a joint development project involving organizations from five countries, including Japan, the United States and several in Europe. Kawasaki took part as a member of Japan’s project representative organization, the Japanese Aero Engines Corporation (JAEC), handling the design and production of fan casing, the low-pressure compressor (LPC), accessories and equipment piping parts. This engine has been installed on the Airbus A320 among other aircraft.

1985

PW4000 Kawasaki’s First Project as an RRSP

Kawasaki took part as an RRSP for the first time in this joint development and production project with P&W, creating the casing, shafts, seal rings (to minimize leakage of air, high-temperature gas and so forth), vanes (stator vanes) and other parts. The PW4000 has been installed on the Boeing 747, 767 and 777, the Airbus A320, A310 and A330, and other aircraft.

2004

Trent 1000 RRSP for IPC Module Development

Kawasaki joined as an RRSP in this joint development and production project with Rolls-Royce, this time taking part in the project from the design phase onward as a developer of the engine’s intermediate pressure compressor (IPC) module. The IPC module is an important section of the engine located between the fan and the high-pressure compressor (HPC), where it further compresses by seven times the pressurized air sent in via the fan. In addition to helping with design, production and assembly, Kawasaki participated in a portion of the engine testing operations carried out as part of the development program. The Trent 1000 is used on Boeing 787 aircraft.

2011

PW1100G-JM Joint Development of the V2500’s Successor

Kawasaki is responsible for the development, production and maintenance of the fan, low-pressure compressor (LPC) and other primary components for this engine, which is used in the A320neo, Airbus SAS’s cutting-edge passenger jet. The PW1100G-JM is a geared turbofan engine utilizing an advanced gear system that rotates the fan at slower speeds than the LPC and low-pressure turbines. The advantages of employing leading-edge materials and component technologies include greater combustion efficiency, reduced exhaust gas emissions and quieter operation.
Aeration blowers are installed at sewage treatment plants to supply air to biological reaction tanks, where organic matter contained in wastewater is decomposed. Aeration blowers are one of the key facilities in sewage treatment, and they come in various types, including turbo blowers and positive displacement blowers. The existing types of blowers are all mature machinery, so major changes to their basic structure had been made until the Kawasaki MAG Turbo introduced a technological innovation. After the first MAG Turbo was delivered to a sewage treatment plant in Ctri City, Japan, in 2006, the number of units installed at sewage treatment plants around the country grew steadily and soon reached 130. The MAG Turbo now commands an overwhelming share of single-stage blowers (turbo) sold as a senior staff officer at Kawasaki, says, “When customers see the MAG Turbo for the first time, they are truly amazed.”

The reason for the high evaluation is its compact size, energy efficiency, and excellent maintainability requiring almost no maintenance. The high-speed motor featuring magnetic bearings is fitted with an impeller and driven by an inverter. Unlike conventional-type blowers, the MAG Turbo does not require a lubricant and other auxiliary facilities due to the lack of mechanical contact. It is a compact package, including even the overall control system, and is optimized as a total system. One sewage treatment plant has estimated that the MAG Turbo reduced its annual operating cost by 12% compared to its previous blower, which had the same capacity. With the MAG Turbo, it is also possible to install the blower and control equipment separately, offering greater flexibility in installation.

The air volume that a blower is required to provide varies with the season, weather, day of the week, and time of day. To allow for this variation, sewage treatment plants have a number of blowers, including spare units, and they operate different numbers of blowers and adjust the airflow according to the required air volume. The MAG Turbo, which is compact, energy efficient, and easy to maintain, is attracting increasing attention and reputation precisely for this reason. Although blowers are not high-profile equipment, they bring major benefits by being environmentally friendly and helping make our lives safer and more comfortable.

**Kawasaki MAG Turbo**

Single-Stage Sewage Aeration Blower with High-Speed Motor & Magnetic Bearing

**Numerous Outstanding Features Achieved Through Technological Innovation**

Magnetic bearings

The MAG Turbo’s high-speed motor is levitated by the magnetic force: the force exerted by the magnets trying to attract the rotor in either direction of the electromagnets. The bearings consist of two radial magnetic bearings and one thrust magnetic bearing. The magnetic bearings minimize mechanical loss, and therefore power consumption is reduced. Since there is no need for a lubricant, related equipment and maintenance are also not required, considerably reducing the maintenance requirement for the overall unit.

High-speed motor

The high-speed motor contains a rotor that rotates at a high speed. It is integrated with magnetic bearings. The rotation speed is variable in manual control, which optimizes the speed according to the inlet condition.

Magnetic bearing controller

The controller is located on the blower side, which makes it possible to install the controller separately. This means that the controller can also be used for conventional blowers. The controller is the key to the MAG Turbo’s high efficiency; its main function is to supply air to the biological reaction tank.

We developed an ideal shape that facilitates the flow of air

The MAG Turbo consists of a blower, magnetic bearing controller, inverter (alters the frequency and voltage of supplied power to control the rotation speed of the high-speed motor), and other components. Each component is compact and has a small footprint. Another major characteristic is that the blower and control equipment can be installed separately, providing the flexibility to accommodate various installation conditions.

Various layout options: a compact design for installation in any space

Magnetic bearings

- **Position sensors**
- **Control signal**
- **Supplies air**
- **Outlet**
- **Blower**
- **Inlet**
- **Inlet guide vanes**
- **Outlet guide vanes**

The impeller is attached to the shaft end of the high-speed motor rotor. The impeller is driven at a high speed to compress the air entering through the inlet. The design of the impeller’s shape and outlet has always been one of the most advanced technical challenges. In recent years, Kawasaki has brought together its aerodynamic technology and successfully developed a new type of high-efficiency impeller called HYSET, which achieved even greater efficiency.

**Commentary**

**Takahiro Aota**
Senior Staff Officer (left)
Blower Engineering Section, Aero-Dynamic Machinery Department
Machinery Division, Kawasaki Heavy Industries, Ltd.

**Yuki Kinoshita**
Assistant Manager (right)
Blower Engineering Section, Aero-Dynamic Machinery Department
Machinery Division, Kawasaki Heavy Industries, Ltd.
Sasaki Norio

Scope 111

Don’t Scold Them for Mistakes

management theory, however, continues to inspire not only leaders in the world of sports but also top executives, as its applicability to business strategies is extremely effective.

Norio Sasaki

Give Them Credit for Tackling Challenges, Don’t Scold Them for Mistakes

Nori Sasaki is a former head coach of the Japan Women’s National Football Team (a.k.a., Nadeshiko Japan), renowned for leading the team to win the World Cup Championship in 2011. He resigned in March 2016, despite the public’s hope for continuation. His organizational management theory, however, continues to inspire not only leaders in the world of sports but also top executives, as its applicability to business strategies is extremely effective.

Sasaki Norio

Interviews with

Today’s Pioneers

Potential for Growth

Weaknesses to Draw Out

Sawa to play ‘volante’ (defensive mid/fielder) in order to gain possession of the ball, so that we could push the defense line up to make the space for executing strategies. It was a ‘triangular’ approach, involving preparation, practice, and review, using an audio-visual aid.

For my first 18 months as head coach, I hammered into them basic theories and principles in order to establish a foundation for executing strategies. It was a ‘triangular’ approach, involving preparation, practice, and review, using an audio-visual aid. I would say that, at this stage, the team’s staff took the initiative 80% of the time and the members, the remaining 20%.

During this time, Sasaki was careful not to scold the players all the time for their mistakes, so that they would not cringe. He also made sure not to discourage those who were motivated to boldly take on challenges, by leading their pro-active attempts even if they failed.

The next step was to encourage the members to think individually but to discuss things as a team. ‘So, I let the members lead meetings and figure out for themselves what their challenges were and how to resolve them. We provided doors and support, but by this time, the members were taking the initiative 60% of the time and the staff, the remaining 40%.’

This transition motivated the members to start communicating with each other voluntarily, which led to the inception of collective intelligence within the team. ‘We are all engaged in both defense and offense. Collective intelligence allowed them to connect with each other and perform social football.’

All these years, Sasaki never lost his cool, thoroughly performed analyses, and provided extensive and logical explanations to his team. He also patiently waited for the members to grow. He respected his staff and listened to them. He also took time to study medicine, so as to understand the physical and psychological differences between men and women. These may be on every leader’s to-do list, but it is never easy to put into practice. Sasaki talks about his experience somewhat nonchalantly, but ‘Hari-san’ — as everybody calls him — is a gentle and patient man, equipped with exceptional coaching skills and the tenacity to make painstaking efforts. Otherwise, the winning organization with such prowess — which people describe as ‘Nadeshiko power’ — would never have been born.

Where Sasaki will next demonstrate his coaching capability is yet not known. Moreover, he is certainly a brilliant leader from whom we can expect great achievements that are well worth noting.

Norio Sasaki

Born in 1958, in Shimonoseki City, Yamaguchi Prefecture, Japan. He played as a midfielder for several teams. After retiring as a player, he became head coach of Omiya Ardija in 1998, and then served for nine years as head coach of Japan Women’s National Football Team, beginning in 2007, after becoming one of the team’s coaches in 2006. His career is highlighted with great achievements. Nadeshiko Japan finished as one of the top four teams at the 2008 Summer Olympics in Beijing, were the victors at the EAFF Women’s Championship in 2008 and 2010, were champions of the FIFA Women’s World Cup Germany 2011, Silver Medalists in the 2012 Summer Olympics in London, and runner-up in the FIFA Women’s World Cup Canada 2015. In 2011, Sasaki became the first Asian recipient of the FIFA World Coach of the Year for Women’s Football award.
In January, Kawasaki announced that they had delivered the 100th unit of the CH-47J/ JA transport helicopter to the 1st Helicopter Brigade of the Japan Ground Self-Defense Force (JGSDF). Kawasaki produces the helicopter for the JSDF and the Japan Air Self-Defense Force (JASDF).

In January, Kawasaki announced the production of the CH-47JA under the license from the Boeing Company in the United States in 1984. Since FY 1986, Kawasaki has delivered a total of 69 units of both the CH-47J and the CH-47JA in an upgraded version of the CH-47 equipped with a larger fuel tank to enable greater flight range to the JGSDF.

100th Unit of CH-47J/JA Transport Helicopter Delivered

Kawasaki announced recently that the Faculty of Medicine of Chulalongkorn University (MDCU) in Thailand had performed a cell therapy of knee cartilage using mesenchymal stem cells cultured by AUTO CULTURE, an automated cell processing system developed by Kawasaki. Kawasaki and MDCU have been collaborating in a joint research project to automate the process of culturing mesenchymal stem cells using AUTO CULTURE. This is the world’s first clinical study using cells cultured by robot automation.

In clinical applications of regenerative medicine, cells are collected from the patient, cultured, then transplanted to the affected area. Cell culturing and processing facilities (DPF) where cells for clinical application are cultured, require the utmost of cleanrooms and highly skilled culturing technicians are required. These requirements make it extremely expensive to construct and maintain DPFs, with the added burden of having to train technicians. These obstacles are impeding the widespread use of regenerative medicine. AUTO CULTURE resolves these issues through robotic culturing inside a system maintained at an extremely high level of cleanliness; thus contributing to the safe and low-cost clinical application of regenerative medicine.

Based on technologies cultivated through this project in Thailand, Kawasaki is currently developing a more efficient version of AUTO CULTURE, which is scheduled to be launched in a few years.

Cells Cultured by Automation Used for Groundbreaking Clinical Study

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Kawasaki Heavy Industries Quarterly Newsletter

Scope

Kawasaki Heavy Industries Quarterly Newsletter

30,000 Units

Kawasaki Heavy Industries, Ltd.

Kawasaki’s Technology for Large-Volume, Long-Term Liquefied Hydrogen Storage

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One of the issues in storing large volumes of LH2 is that of suppressing the boiling off of cryogenic hydrogen (-253°C).

Kawasaki has resolved this issue through its advanced thermal insulation technology, resulting in Japan’s largest spherical LH2 storage tanks, each with a 540 m³ capacity.

Since 1994, they have been used for fuel storage for space rockets at Tanegashima Space Center, which is operated by Japan Aerospace Exploration Agency.

This technology is being applied to the development of a larger 2,500 m³ storage unit, corresponding in volume to the amount needed to fill the tanks of 30,000 fuel cell vehicles.

Kawasaki is working to develop the technological foundation of a hydrogen energy supply chain—production, transportation, storage, and use.

We believe that by handling hydrogen in a manner that is safe, stable, and affordable, we will be able to enhance the quality of life.

The road to that future is what we call the Kawasaki Hydrogen Road.

Special Feature

Main Players in the Modal Shift in Transportation:
Kawasaki’s Locomotives & Freight Cars