

# TOSHIBA REVIEW

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## Special Reports 1

### Energy-Saving Railway System Technologies Enhancing People's Lives and Supporting Business Development

#### Technologies toward Realization of Eco- and Human-Friendly Railway Transportation Systems

KONDO Keiichiro

#### Business Development of Railway Transportation Systems Meeting Diversification of Market Needs

NAKAZAWA Yosuke / NITTA Kazuhiko

Accompanying the movement toward improvement of the environment as a countermeasure against global warming and to minimize the damage caused by natural disasters, attention has been increasingly focused in recent years on stable supplies of electric power, high energy efficiency, and energy saving. In the field of railway transportation systems, various types of products have been developed and introduced to solve these issues. In addition, there is an ongoing need for more stable and safe transportation and more comfortable and convenient trains and stations to improve services for passengers through the application of information and communication technologies (ICTs).

To fulfill these diverse customer requirements, Toshiba has been taking the initiative in constructing various new technologies to provide railway solutions and is making efforts to promote the development and expansion of railway transportation businesses.

#### High Energy-Saving Propulsion Systems for Rolling Stock

KADOOKA Shohei

Toshiba is committed to developing and delivering environmentally conscious products and services. In the field of railway systems, we are engaged in the development and application of various products offering high energy-saving performance. We have developed energy-saving propulsion systems for rolling stock comprising the following equipment: (1) totally enclosed induction motors (IMs) and permanent magnet synchronous motors (PMSMs) that achieve energy saving and low noise while requiring less maintenance work; and (2) inverters equipped with silicon carbide (SiC) devices, one of the next-generation power devices providing energy saving, compactness, and light weight. From the results of demonstration experiments and data obtained in actual commercial operations, we have confirmed that these systems achieve significant reductions in power consumption.

#### Power Electronics Technologies Underpinning Next-Generation Rolling Stock Systems

AOYAMA Ikuya

Accompanying the increase in demand for rolling stock with higher functionality and performance in recent years, there is a growing need for onboard equipment with larger capacity, higher efficiency, smaller size, lighter weight, and greater energy-saving capabilities.

Toshiba has been focusing on the development of power electronics technologies to fulfill these diverse requirements for next-generation railway systems. In particular, we have applied silicon carbide (SiC) devices, one of the next generation of power devices providing energy saving, compactness, and light weight, to power conversion equipment. We have enhanced these technologies and incorporated them into power electronics equipment that we are offering for rolling stock propulsion systems and auxiliary power supply systems.

#### Battery Energy Storage Systems for Rolling Stock Using SCIB™ Lithium-Ion Battery

HIROTA Kohsuke

Accompanying the expansion of storage battery applications to power systems and automobiles in recent years, attention has been focused on technologies for battery energy storage systems in the field of railway systems. The installation of a battery energy storage system on rolling stock can be expected to improve safety and energy-saving performance because it allows operation to continue even in the absence of an external power supply and makes effective use of regenerative energy. Toshiba has developed two onboard battery energy storage systems for rolling stock: (1) a battery energy storage system for emergency operation in the event of an abnormality such as a blackout, and (2) a battery energy storage system for train operations in sections without a catenary. These systems achieve high safety and long service life through the adoption of our SCIB™ lithium-ion battery as a storage device.

#### Integrated Train Information System to Efficiently Enhance Sophistication of Rolling Stock

YOSHIMATSU Takanori

Network functions have become increasingly sophisticated in the field of rolling stock in recent years. Up to now, when onboard systems such as a monitoring system and an information display system have been installed independently, the impact in the event of a failure has been relatively small due to overlapping of the functions and hardware components of each system.

However, a significant issue with this approach is the need for reductions in installation space and cost. Toshiba has developed an integrated train information system using the TEBus (Train Ethernet Bus) train communication network standard as a solution to this issue. This system, consisting of (1) monitoring devices providing equipment information monitoring, failure recording, and inspection and repair functions, and (2) guidance information service functions for passengers, makes it possible to efficiently enhance the sophistication of rolling stock.

#### ATO System for Improvement of Riding Comfort and Stopping Position Accuracy and EE Train Operation Control System for Highly Efficient Train Operations

HATTORI Yohei / SEKIGUCHI Takahiro / TAJIMA Masahiro

An automatic train operation (ATO) system is a technology aimed at realizing both energy saving and riding comfort in railway systems.

Toshiba has now developed an ATO system that offers improvements in energy saving, riding comfort, and stopping position accuracy while maintaining the correct running time between stations by automatically generating a running plan between stations according to the operating circumstances, taking into consideration the learned braking characteristics of each vehicle. We have also developed a transmitter and receiver for the ATO system, which allow communication between ground devices and on-vehicle devices in order to exchange stopping position information, using a software radio technology to flexibly respond to various configurations. To expand the range of applicability of this ATO system, we are engaged in the development of an energy-efficient (EE) train operation control system in which the central control unit can transmit an adjusted operation plan to each train based on the entire train information collected by the ATO systems in order to control the following train so as to minimize braking and stopping even in the event of a delay of the preceding train, thereby achieving a balance between stable train operation and energy saving.

#### EL120 DC Electric Locomotive for Nagoya Railroad Co., Ltd.

YAMADA Masahiro

In the railway system of Nagoya Railroad Co., Ltd. (known as Meitetsu), six electric locomotives, including four DEKI600 DC electric locomotives that were designed and manufactured by Toshiba in 1943, have been used for more than 70 years for track maintenance operations such as ballast sprinkling, rail transportation, and so on, as well as for the transfer of rolling stock.

To replace these aging electric locomotives, Toshiba developed the EL120 DC electric locomotive and delivered two locomotives to Meitetsu in FY2014. The EL120 was put into service in May 2015 after completing test runs.

#### Verification of Effects Obtained by Introduction of Traction Energy Storage System on Okinawa Urban Monorail Line

ITO Fusao / NOGI Masayuki / SUMIYA Akihiko

Electric railway systems, which are generally regarded as energy-efficient transportation systems, can be expected to achieve further improvement in energy-saving performance through the effective utilization of regenerative energy during deceleration. Particularly in monorail systems, in which regenerative braking is used in order to reduce brake shoe abrasion, there is a potential for high levels of energy saving by effectively utilizing the surplus energy thus generated. From the perspective of operation, the difficulty of safely evacuating passengers due to the unique characteristics of a monorail track is also an important issue in the event of a power failure.

In cooperation with Okinawa Urban Monorail, Inc., Toshiba has conducted verification tests using a traction energy storage system on the Okinawa Urban Monorail line with the aim of realizing energy saving and supplying emergency power in the event of a power failure. From the results obtained, we have confirmed that the traction energy storage system achieves a significant reduction in the power consumption of each substation, as well as stable operation even in the event of a power failure.

#### Electric Bus System for Practical Realization of Environmentally Conscious Urban Transportation Solutions

SUZUKI Katsuyoshi

In response to the worldwide movement toward the prevention of global warming in recent years, Toshiba has been engaged in the construction of urban transportation solutions incorporating the use of batteries for public transportation, aimed at realizing an environmentally conscious society.

As part of these efforts, we have developed an energy-saving electric bus system applying a frequent and superquick charging method, and confirmed the effectiveness of this approach through demonstration tests. In 2015, we put into practical use an electric bus system applying a quick charging method for route bus services within a relatively short distance. We are also developing an information system for the electric bus system to reduce costs and increase revenues in parallel. With the aim of offering comprehensive urban transportation solutions, we are moving forward with studies on future expandability to facilitate the introduction of and smooth transition to an efficient transportation system in stages.

#### Preventive Maintenance Ensuring Reliability of Electrical Equipment for Rolling Stock

HAGIWARA Junichi

Electrical equipment for rolling stock tends to be in operation for more than 20 years because rolling stock usually has a long service lifetime. Problems caused by the degradation of electronic parts mounted on such electrical equipment often occur about 10 years after the commencement of operations. Due to the close relationship between these problems and the operating time of each part, there is a possibility that multiple failures might occur at around the same time. This can disrupt transportation schedules and lead to adverse effects on society. The need has therefore arisen to extend the service lifetime of electrical equipment and sustain its reliability by replacing electronic parts before degradation takes place, based on preventive maintenance methods.

In cooperation with railway companies, Toshiba has been making efforts to support the stable operation of rolling stock through improvements in degradation investigations by means of actual products and the disassembly of sample parts, as well as design techniques to replace parts that are difficult to procure.

## Special Reports 2

### Technologies Creating Water Circulation Systems for Future Generations

#### Promotion of Study on Water Circulation Systems by Development of Watershed Environmental Information Platform

FURUMAI Hiroaki

#### Toshiba's Approaches to Water Circulation Systems and Solutions for Water and Environment

TONOZUKA Yoshikazu

Current megatrends in global issues related to the Earth's water cycle include expanding demand for energy and water due to the rapid growth of the global population, the resultant increases in global warming and the water-stressed population, and the deterioration of raw water quality with progressive urbanization. In Japan, attention has been increasingly focused on various climate change-related phenomena such as the more frequent occurrence of flood damage in urban areas year by year caused by localized torrential downpours. A comprehensive approach aimed at a healthy water cycle is therefore required in which effective countermeasures against these issues can be implemented by harmonizing artificial systems including water supply and sewerage systems with the water cycle in the natural world.

Toshiba is making continuous efforts to provide a wide variety of solutions that can adapt to rapid changes in the social and natural environments aimed at creating and sustaining healthy water circulation systems, based on its information and communication technologies (ICTs), water and wastewater treatment equipment, and operational control technologies.

#### TOSWACS™-V Monitoring and Control System Enhancing Water Supply and Sewerage Business Foundations

IDEMITSU Takeshi / MATSUDA Hiroaki / ARIMURA Ryoichi

Water supply and sewerage systems are important social infrastructures supporting people's lives and corporate activities. For the construction and maintenance of strong and sustainable water infrastructures, it is necessary to enhance the business foundations of the water supply and sewerage fields. The national government has therefore been promoting consolidation and reduction of facilities and broadening the range of management, as well as promoting cost reductions for medium- and long-term operation and maintenance and for the renewal of facilities.

In response to the changing needs of the water supply and sewerage businesses, Toshiba is supplying the TOSWACS™-V water supply and sewerage monitoring and control system applying information and communication technologies (ICTs) and plant control technologies. Through advancements in flexibility, expandability, and reliability and a wide range of operational applications, the TOSWACS™-V system is contributing to enhancement of the foundations of the water supply and sewerage businesses.

#### Stormwater Drainage Systems and Solutions Contributing to Reduction of Flood Risk

HIRAOKA Yukio / YAMANAKA Osamu

Precipitation including rainfall plays a key role in the Earth's water circulation system and is essential to human existence. On the other hand, localized torrential downpours due to global warming and heat island phenomena have been causing serious damage to people's daily lives in recent years. Flood control and urban drainage systems are therefore required to sustain a healthy water cycle, as defined by the Basic Act on the Water Cycle. In particular, urban drainage facilities and their proper operation and control are crucially important both to reduce flood risk and to protect people's lives and property from flood damage.

Against this background, Toshiba has been engaged in the development of a wide variety of water drainage systems and solutions contributing to the reduction of flood risk.

#### Solutions for Water Supply and Sewerage Systems Supporting Realization of Healthy Water Cycle

KOMINE Hideaki / FUKUDA Mii / KANEHIRA Mariko

Water supply and sewerage systems play a major part in maintaining the soundness of the water cycle as defined by the Basic Act on the Water Cycle. In order to ensure the soundness of the water cycle, demand has been rising for solutions not only to adapt to various changes in the natural and social environments, but also to solve the following issues: reduction of water quality risk using an energy-saving membrane bioreactor (MBR), conservation of the water environment using a coagulant injection control system, and effective use of sewer resources to generate electric power.

To efficiently solve these issues, Toshiba has supplied solutions making full use of control technologies acquired through the development of water supply and sewerage systems from the viewpoints of risk reduction, recovery, and reuse, and is contributing to the maintenance of a healthy water cycle.

#### Water Treatment Solutions with High Performance and High Efficiency for Reduction of Water Quality Risks and Water Environment Conservation

MAKISE Ryutaro / YAMAGATA Hideaki / OBA Yujiro

In the fields of water supply and sewerage and industrial water treatment, water treatment solutions that play a critical role in the reuse of wastewater for recycling and the effective use of water resources are required in order to reduce water quality risks and conserve the water environment. A significant issue in relation to the sedimentation tanks commonly used at water treatment facilities is the need for a spacious site to store large volumes of water when removing suspended solids (SS) from the water, due to the low speed of sedimentation of SS.

To further increase the speed of sedimentation so as to reduce the installation space, Toshiba has developed a high-speed sedimentation tank applying its proprietary structure capable of reducing fluctuation of the water flow velocity in the tank. The high-speed sedimentation tank achieves a treatment speed of 4 m/h, about four times that of our conventional sedimentation tanks. Demand has also risen for ozone treatment systems to reduce water quality risks accompanying the deterioration in quality of treated water. However, the large amount of power consumed during ozone generation is a serious issue. In order to solve this issue, we have developed the TGOGS™ high-efficiency ozone generator and introduced it in practical applications.

The TGOGS™ system achieves a reduction of approximately 20% in power consumption as well as reduced size due to downsizing of the diameter of the discharge tube.

#### Public-Private Partnerships in Water Supply and Sewerage Field Aimed at Enhancement of Business Efficiency and Technology Succession

MHYAO Keiichi / HOKARI Hiroyuki / YAMATO Ryota

With the growing diversity of requirements in the water supply and sewerage field in Japan, attention is being focused on improvement of the business operation base. Following the enforcement of the Basic Act on the Water Cycle in July 2014, opportunities for creating new business models have been increasing centering on the broadening of water supply works. The Panel on Measures for Strengthening of Water Supply Business, which is under the jurisdiction of the Ministry of Health, Labour and Welfare, released an interim report in January 2016 containing proposals for reinforcing the administrative foundations of this field including strengthening of the management base and optimization of business scale.

In line with these trends, the Toshiba Group has been promoting enhancement of business efficiency and technical succession by providing solutions for customers based on its information and communication technologies (ICTs) while taking the customer's actual conditions into consideration, through public-private partnerships (PPPs) in the water supply and sewerage field.

#### Zero Liquid Discharge (ZLD) System to Maximize Wastewater Reuse and Eliminate Liquid Waste

KOTO Yoshihiko / Hersh KSHETRY / T. Sivaram REDDY

Accompanying the increase in water pollution in developing countries due to their rapid industrial development, actions have been taken to strengthen laws and restrictions so as to ensure soundness of the water supply. The introduction of wastewater treatment systems aimed at zero liquid discharge (ZLD) has been promoted from the viewpoint of the reduction of water pollution risks and the reuse and recycling of wastewater. In order to achieve the widespread introduction of such ZLD systems, water and environmental solutions are required that take the water balance of a whole factory into consideration. The two major functions of a ZLD system are (1) a water purifying function to extract impurities from wastewater and produce recycled water, and (2) a water evaporation function to obtain dry salts from the highly concentrated brine produced as a byproduct of the water purifying function. However, scaling and fouling on the reverse osmosis (RO) membranes, the existence of a maximum feed pressure limit for RO membranes, and the concentration of high-solubility compounds in evaporators are critical issues in the operation of ZLD systems.

Addressing these issues include pretreatment processes, such as processes to remove hardness and alkaline components and a denitrification process, and RO membranes with an ultrahigh feed pressure limit. The Toshiba Group has now supplied a ZLD system incorporating some of these measures to an automobile factory in India.

## Feature Articles

#### Text-to-Speech Technology to Control Speaker Individuality with Intuitive Expressions

OHTANI Yamato / MORI Koichiro

With the expansion of the field of text-to-speech (TTS) applications, including e-book reading, speech advertisements, and entertainment, demand has recently arisen for TTS technologies capable of controlling and generating speaker individuality according to the characteristics of the contents.

In response to these diversifying needs, Toshiba has developed a novel TTS technology that can not only control speaker individuality with perception expressions that represent voice characteristics such as gender, age, brightness of voice, and so on, but also generate synthetic speech that creates a certain effect in accordance with impression expressions such as cuteness, refinement, and so on. This technology allows users to produce synthetic speech with the desired voice characteristics matching the contents.

#### Soldering Technology for BGA Packages on PCBs for High-Quality Thin and Lightweight Mobile Notebook PCs

SUGAI Takahiro / HIRAMOTO Shuji / HAYASHIYAMA Shinya

Highly reliable high-density soldering technologies to mount electronic parts on printed circuit boards (PCBs) are essential for the development of mobile notebook PCs, in which the soldering of joints plays a critical role in product quality. In particular, advancements in the density and multifunctionality of central processing units (CPUs), which employ a ball grid array (BGA) package and serve as a core component of a PCB, have now reached a stage where it has become difficult to ensure solderability and solder joint reliability with the pitch reduction of solder balls on the BGA package.

Toshiba has responded to this situation by developing a BGA package soldering technology that can be used for multi-pin BGA packages with a narrower pitch than ever before. We have applied this technology to the dynabook R82/T, a high-quality thin and lightweight 2-in-1 detachable Ultrabook™ PC.

## Frontiers of Research & Development

### Personalized Recommendation Method Capable of Finding Favorite TV Programs and Casts

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