

## Hydroelectric Power Technologies Expanding to Global Markets

## Hydroelectric Power as Environmentally Friendly Energy

KAZAO Yukihiko

## Latest Trends in Hydroelectric Power Technologies

KAWASAKI Satoshi / IKEDA Chikamasa

Prevention of the problems of climate change and environmental degradation has become an overriding issue on a global scale, with each country focusing on reducing emissions of greenhouse gases. With this as a background, hydroelectric power has been reevaluated as an environment-conscious electric power generation system. The market for new hydroelectric power plants is expanding to non-member countries of the Organization for Economic Cooperation and Development (OECD), and the demand for maintenance and renewal of existing hydroelectric power plants is also growing to promote both effective utilization of water resources and environmental measures.

Toshiba has been developing a wide variety of hydroelectric power technologies that achieve high efficiency, high performance, and long operating life in harmony with the environment.

## Optimization Method with Advanced CFD Technology for Design of High-Performance Hydraulic Turbines

HYUGA Takeshi / ENOMOTO Yasuyuki / NAKAMURA Kazuyuki

In hydroelectric power generation using renewable natural water power, it is necessary to develop the optimal hydroelectric performance individually for each hydraulic turbine because of the difference in head and output of each hydroelectric power station in accordance with its location and the customer's requirements. As there are many design parameters for the optimization of hydroelectric performance including efficiency, cavitation performance, and hydroelectric stability, a long computation time is required to obtain the optimal turbine shape.

Toshiba has developed a unique optimization method for the design of high-performance hydraulic turbines that employs both high-accuracy analysis and computational fluid dynamics (CFD) analysis. We have obtained good results applying this method to hydroelectric power stations in the domestic and overseas markets.

## Technologies for Large-Scale and Long-Life Hydraulic Turbines for Global Market

NAKAGAWA Naritoshi / KUROKAWA Toshifumi / NAKAHARA Yuusuke

Toshiba has been developing various technologies for hydraulic turbines in response to expanding world demand for hydroelectric power. To meet the demand for large-scale hydraulic turbine in recent years, we have developed manufacturing technologies for large-scale welded turbine runners including an analysis method for estimating welding deformation based on the inherent strain method, and an accurate welding technology using a welding robot with a sensing system. We have also developed a ring gate and its control and protection system for application as turbine stop valves. Furthermore, we have developed hard coating technologies for turbine water-contact surfaces as a solution against the silt abrasion of turbine.

## Hydro Generator Technologies with High Performance and Functionality to Reduce Environmental Burden

KUBO Toru / ISHIZUKA Hiroaki / OHTA Hitoshi

In recent years, attention has been focused on hydroelectric power generation not only because of its excellent characteristics such as high-speed startup, but also due to its ability to improve the quality of power systems as a large-scale renewable energy source.

Toshiba has been contributing to the expansion of hydroelectric power as a renewable energy source for both the prevention of global warming and stable electricity supply, as a corporate citizen of planet Earth. We have supplied more than 1,400 hydraulic turbine generators and generator motors throughout the world, with a total capacity of 52,000 MVA, since we manufactured Japan's first utility hydro generator for the Keage Power Station in Kyoto in 1894.

## Advanced Monitoring and Control System Technologies for Hydroelectric Power Plants

KINOSHITA Kentaro / MOTOHASHI Hideyuki / NONAKA Kazuya

Toshiba has been supplying advanced control equipment ranging from monitoring and control systems for large-scale hydroelectric power plants to all-in-one type control equipment for low-capacity hydroelectric power plants in the domestic and overseas markets.

In the field of monitoring and control systems we have developed the latest supervisory control and data acquisition (SCADA) system, which has been verified using a plant simulator similar to actual operating conditions. With regard to all-in-one type control equipment, we are aiming to apply such systems to overseas hydroelectric power projects. In the field of primary control equipment, we have confirmed the effectiveness of our advanced control governor through actual operation in a hydroelectric power plant in cooperation with users, and are working toward its application in domestic and overseas pumped-storage plants.

## Refurbishment and Replacement of Hydroelectric Power Equipment

KAWASAKI Satoshi

In the field of hydroelectric power generation, which uses renewable energy without carbon dioxide (CO<sub>2</sub>) emissions, there is an increasing need for the refurbishment and replacement of equipment in aging hydroelectric power plants in addition to the construction of new plants. In these cases, higher performance, higher reliability, and minimal maintenance are required in order to achieve further reductions in CO<sub>2</sub> emissions.

To fulfill these requirements, Toshiba has been actively applying new technologies for the refurbishment and replacement of equipment in aging hydroelectric power plants in Japan. These technologies include an electric servomotor that requires no control oil, to promote environmental conservation; a brush seal that prevents oil vapor from being discharged by bearings, to save maintenance work; and an electromagnetic brake for power generators that eliminates the need for air compressors. We have also been engaged in the refurbishment and replacement of equipment in overseas hydroelectric power plants. In particular, we are promoting large-scale refurbishment in corporation with our local engineering and construction companies in North America.

## Technologies for Hydraulic Turbines and Generators for Chinese Market

TSUJI Masayoshi / LEI Tiejin / TANG Fengjiao

Toshiba has been supplying hydroelectric equipment to the Chinese market, the world's largest hydroelectric market, through Toshiba Hydro Power (Hangzhou) Co., Ltd. (THPC) in China. Up to now we have been supplying the Qingshuitang Hydropower Station with large-scale bulb turbines and generators, the Dayingjiang Hydropower Station with hydraulic turbines using a splitter runner, and each of the Shenxiguo, Gongguoqiao, and Dongqing hydropower stations with large-capacity generators.

To meet the future requirements of the Chinese market, we have introduced large-scale manufacturing facilities for hydroelectric equipment of 600 MW-class capacity at the THPC factory, and have been developing a manufacturing technology incorporating an automation system for large-scale runners.

## Feature Articles

## Uncooled Infrared Radiation Image Sensor

HONDA Hiroto / FUNAKI Hideyuki

Toshiba has developed a quarter video graphics array (QVGA) (320 x 240 pixels) uncooled infrared radiation image sensor that achieves a noise equivalent temperature difference (NETD) of 0.25 K. As this sensor can detect a person in the dark from the image of the temperature distribution by sensing far-infrared radiation emitted by the skin, it is applicable to many areas including pedestrian detection sensors for automobiles, human detection sensors, security sensors, and so on.

In order to increase the resolution, or the number of pixels, we have utilized a microelectromechanical systems (MEMS)-based process to reduce the pixel pitch from 32 μm to 22 μm, which realizes a QVGA image sensor of the same sensitivity and chip size, and decrease the read-out circuit noise to improve the NETD from 0.55 K to 0.25 K.

## Advanced FEC Processing Technology for IPTV Video Streaming

AIZU Hiroyuki / GONDO Shunichi / TSUJI Masashi

In order to provide high-quality streaming video images over the Internet Protocol television (IPTV) network, a forward error correction (FEC) technology is required to compensate for IP packet losses that occur due to inevitable IP network problems. It is necessary to develop software-based FEC processing technology for cost reduction and expandability to various types of equipment.

To maintain the packet recovery rate without additional hardware, Toshiba has developed an intermittent FEC processing technology that reduces side effects on other real-time processing operations such as image processing, and improved the FEC process to realize adaptation to incoming out-of-sequence packets.

NPEngine<sub>TM</sub> Ultrahigh-Speed Hardware-Based TCP/IP Processing Engine

TANAKA Shingo / YAMAURA Takahiro

With the wide dissemination of digital high-definition (HD) broadcasting in recent years, large-volume audio and video contents have been increasingly distributed over networks including the Internet. The Transmission Control Protocol/Internet Protocol (TCP/IP), a standard network protocol of the Internet, has been conventionally processed by a software-based engine running on the central processing unit (CPU) embedded in network devices. The increase in transmission bandwidth is therefore an important issue, with CPUs requiring a higher operating frequency and higher power consumption to handle large volumes of data traffic including video streams.

To overcome this problem, Toshiba has developed the NPEngine<sub>TM</sub> hardware-based network protocol processing engine dedicated to TCP/IP, incorporating several technologies including hybrid protocol processing, direct data transfer, and pipeline processing. Experiments on NPEngine<sub>TM</sub> confirmed that it achieves much better performance than existing software-based solutions.

## Information-Theoretic Authentication Scheme for Real-Time Communication

KATAYAMA Shigeki / FUKUSHIMA Kazuto / SEKIGUCHI Katsuhiko

With the increasing dependence on information networks in social infrastructures such as power systems, transportation systems, and so on, safeguarding the security of information is now a crucial issue. In particular, a new security-enhancement technology with real-time responses and long-term maintenance of protection from threats and attacks is required to protect the control systems of these social infrastructures.

Toshiba has developed an authentication method that effectively applies information-theoretic cryptography to such real-time communication systems. Our method features a novel scheme based on unconditionally secure authentication codes (A codes) having short authenticators (authentication tags) and a feasible number of keys. We have developed a data format for the scheme, and confirmed its effectiveness through experiments using a protection relay in an electric power system.

## "Unified Controller nv simulator" Realizing Virtual System Integration Tests

HIROMAE Kozo

Industrial controllers serve as the core components of control systems for manufacturing facilities and environment-related equipment in various fields including general industry, social infrastructure, and electric power systems. As the functions of control systems using these industrial controllers have recently become increasingly integrated and sophisticated, the engineering costs are on a rising trend.

As a solution to this issue, Toshiba has newly developed the "Unified Controller nv simulator". This engineering tool offers a simulation environment for each stage of testing from software debugging to system integration prior to actual equipment tests, thus contributing to improved efficiency of engineering.

## BGA Reinforcement Adhesive Realizing High-Quality Notebook PCs

SUGAI Takahiro / TAKIZAWA Minoru / FUNAYAMA Takahisa

With the increasing portability of notebook PCs, demand has been growing in recent years for even more durable print circuit boards (PCBs) on which ball grid array (BGA) packages are mounted in order to assure the solder joint reliability.

Toshiba has developed a reinforcement adhesive agent for BGAs mounted on a PCB with well-balanced quality, cost, productivity, and reparability by optimizing the material properties for high-quality notebook PCs, and has applied it to the dynabook<sub>TM</sub> SS RX2 and so on from 2009.

## GRE Series New Multifunctional Numerical Protection Relays for Distribution Networks

SUMIDA Yoshihisa / MAEHARA Hiroyuki / TSUCHIYA Takehiko

A protection relay is a device that detects lightning strike faults and short circuits in electric power transmission systems such as transmission lines and substation equipment within several tens of milliseconds, and issues a tripping signal to a circuit breaker to isolate the fault point from the normal network in order to maintain stability of the electric power system.

Toshiba launched the world's first numerical protection relay in 1980. Since then, we have been contributing to electric power system stability throughout the world by continuously developing protection relays, including the GR series introduced in 1999. We have now developed a new family of numerical protection relays called the GRE series mainly for application to distribution networks, featuring compact design and improved usability.

## Frontiers of Research &amp; Development

## Image Recognition Technology for Detection of Pedestrians in Moving Background