TOSHIBA REVIEW

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Special Reports

Latest Technologies for Thermal Power Plant Systems

Best Available Technologies (BATs) for Realization of Thermal Power Plant Systems with Higher Efficiency
HAYASHI Masataka

Toshiba's Approach to Improvement of Efficiency and Environmental Performance of Thermal Power Plants
MOCHIDA Naotaka
Thermal power generation is playing a key role in energy solutions by supplying large amounts of electric power in response to rising demand in the global energy market. In view of the changes that have taken place in the social environment in recent years, there is a strong need for thermal power generation with higher economic efficiency, more flexible operability, and higher reliability.
To fulfill these diverse high-level requirements, Toshiba is continuing its efforts to develop technologies for improved efficiency and environmental performance and to deliver a broad range of systems and services, including a combined-cycle power generation system achieving the world's top-level gross efficiency of 62% (lower heat value basis), an advanced ultra-supercritical (A-USC) coal-fired power plant operating under the world's best steam condition, and a carbon dioxide capture and storage (CCS) facility with reduced lower energy consumption.

State-of-the-Art Technologies for High-Efficiency Combined-Cycle Power Generation Systems
HATTORI Yuta / HYOMORI Katsuhiro
Combined-cycle power generation is attracting attention as the cleanest form of thermal power generation with high thermal efficiency and cost-effectiveness.
Toshiba signed a memorandum of understanding with General Electric Company (GE) to form a global strategic alliance, under which the two companies will jointly develop combined-cycle power generation systems, in January 2013. We have embarked on this collaborative relationship to expand the global share of combined-cycle power generation by focusing on a high-efficiency combined-cycle power generation system integrating both GE's most advanced gas turbine technologies and Toshiba's latest high-efficiency steam turbine generators. As our first implementation of technical collaboration, we are developing power generating facilities for the Nishi-Nagoya Thermal Power Station Group No. 7 of Chubu Electric Power Co., Inc., which will achieve the world's top-level gross efficiency of 62% (lower heat value basis) utilizing GE's latest 7F-7 series gas turbine.

Life Extension Technologies for Gas Turbine Hot Parts Contributing to Reduction of Running Costs and Environmental Burden
YOSHIDA Kohei / SAKAI Yoshiaki / SAITO Daizo
With the diversification of power supplies in recent years, the number of combined-cycle power generation systems equipped with a gas turbine has been increasing due to the market demand for improvement of both energy efficiency and economic efficiency and the need for reduction of carbon dioxide emissions. As hot parts including combustion liners, buckets, and nozzles located in the hot gas flow path of a gas turbine are susceptible to various types of damage, it is necessary to constantly repair or replace them. Therefore, appropriate life extension technologies to allow gas turbine hot parts to remain in service for as long as possible are essential for the reduction of running costs and the environmental burden.
In response to these requirements, Toshiba has been developing life extension technologies for gas turbine hot parts and applying these technologies to actual products.

Approaches toward Realization of High-Efficiency Steam Turbines for Thermal Power Plants
IMAI Kenichi / TAKAHASHI Takeo
Thermal power generation systems, with their capability to respond flexibly to fluctuations in power demand, are crucial for the steady supply of electric power. In Japan, there has been a conspicuous increase in demand for thermal power generation since the Great East Japan Earthquake in 2011. With this as a background, improvement of the thermal efficiency of these power systems is an important issue from the viewpoint of securing low-carbon energy supplies.
Toshiba has been developing a variety of new technologies to realize high-efficiency steam turbines for thermal power plants through the reduction of internal losses and improvement of steam conditions, and has been applying these technologies to actual steam turbines. We are steadily reducing internal losses in steam turbines by employing state-of-the-art computational analyses and elucidating the actual conditions of such turbines using a steam turbine development facility. We are also developing a 700°C-class advanced ultra-supercritical (A-USC) steam turbine system aimed at achieving significantly higher efficiency than conventional systems.

Application of Carbon Dioxide Capture Technologies to Thermal Power Plants
EGAMI Norihide / SUZUKI Kensuke / IWASA Kiyohiko
Accompanying the ongoing expansion of thermal power plants, attention is being focused on the reduction of their carbon dioxide (CO_2) emissions by CO_2 capture and storage (CCS).
Toshiba is focusing on the development of CO_2 capture technologies toward the realization of large-scale CCS. Based on our accumulation of development experience in this field, we are committed to delivering solutions that can apply CCS to both existing and newly constructed thermal power plants. We have conducted studies on the application of CCS to a newly constructed ultra-supercritical (USC) coal-fired thermal power plant in Bulgaria and an existing coal-fired thermal power plant in Taiwan. These results have been shared with electric utilities for their review and are making a useful contribution to their consideration of CCS application options for their power plants. We are putting forward concrete proposals to power utilities around the world for the realization of large-scale CCS applying our proprietary CO_2 capture technologies.

High-Efficiency Technologies for Turbine Generators of Combined-Cycle Thermal Power Plants
OSHIMA Naohisa / IMAI Takehiko / UEDA Takashi
Accompanying the increase in demand for combined-cycle thermal power plants, there is a growing need for higher efficiency indirectly hydrogen-cooled turbine generators with an intermediate capacity in the 300 MVA class.
With the aim of realizing such turbine generators, Toshiba has developed an optimization design process that can automatically minimize the size of generator appropriate to the required efficiency. We have also developed a technology to improve cooling efficiency applying fluid analysis, a technology to reduce bearing friction loss by the use of lower loss elliptical bearings, and a technology to reduce stray load loss applying three-dimensional magnetic field analysis. As a result, a newly developed turbine generator applying these technologies has achieved approximately 0.2 % higher efficiency compared with conventional turbine generators.

TOSMAP-DS$_{TM}$/LX Next-Generation Controller for Thermal Power Plants to Achieve Efficient Operation and Low Environmental Burden
ISHIKAWA Tetsuro / TANI Akinori / NITTA Yoshiyuki
Demand is still growing for the construction of thermal power plants throughout the world centering on the Asian region. From the viewpoint of global environmental issues, however, it is necessary to further improve the operation of thermal power plants in order to achieve greater efficiency of their energy utilization and reduction of their environmental burden such as carbon dioxide emissions.
To fulfill these requirements in the global market, Toshiba has developed the TOSMAP-DS$_{TM}$/LX next-generation controller for thermal power plants, which realizes lower cost through the use of common computer technologies in combination with our proprietary technologies. Complex control theories can be easily incorporated into TOSMAP-DS$_{TM}$/LX to improve the overall efficiency of the thermal power plant, due to the expandability of its control application software. Furthermore, TOSMAP-DS$_{TM}$/LX is compatible with multiple field network interfaces, making it possible to accomplish both integrated control and monitoring and maintenance of the entire thermal power plant down to individual field components and devices.

Virtual Engineering Environment and Hardwareless Simulation System to Improve Operational Efficiency of Thermal Power Plants
MARUYAMA Masashi / SUDO Akiyoshi / OHTAKI Yuki
Enhancement of the operational efficiency of thermal power plants has become increasingly important since the Great East Japan Earthquake. As a consequence, it has become necessary to reduce production lead times and site installation periods at the time of equipment renewal such as supervisory monitoring and control system replacement.
Toshiba has developed an innovative production environment that encompasses each of the development processes from design and manufacturing to testing of equipment for thermal power plants, including supervisory monitoring and control systems, applying virtualization technologies. This production environment consists of both a virtual engineering environment that facilitates the streamlining of design processes, and a simulation system that realizes hardwareless tests. We have applied this environment to a supervisory monitoring and control system and confirmed that it achieves reductions in the production lead time and site installation period and contributes to the improvement of plant operational efficiency.

Innovative Thermal Power Generation System Applying Supercritical Carbon Dioxide Cycle
TAKAHASHI Takeo
Carbon dioxide (CO_2) emissions from thermal power plants are one of the primary causes of global warming. Demand has therefore been increasing for innovative technologies to reduce CO_2 emissions as a countermeasure against global warming from the medium- and long-term perspectives.
To meet this demand in the global market, Toshiba has been engaged in the development of an environmentally conscious thermal power generation system applying a supercritical CO_2 cycle in cooperation with three U.S. companies: NET Power, LLC; Chicago Bridge & Iron Company; and Exelon Corporation. The new system burns a mixture of fossil fuel and oxygen combined with CO_2 to produce a working fluid, mainly consisting of high-temperature and high-pressure CO_2 and water vapor, which is used to drive the turbine generator, and separates and collects CO_2 without the need for any carbon capture system.
Toshiba has been assigned the development of key equipment, including a high-temperature and high-pressure turbine and a combustor, for this thermal power generation system aimed at realizing a 250 MW-class commercial plant.

Feature Articles

Antenna in IC Package Using Bonding Wire for Millimeter-Wave Proximity High-Speed Wireless Communication
TSUTSUMI Yukako / HASHIMOTO Koh / KASAMI Hideo
Opportunities to handle large volumes of digital contents have recently been increasing due to the wide dissemination of smartphones and tablets. As a user-friendly interface for exchanging such data between digital devices, a high-speed wireless communication system including a millimeter-wave (MMW) proximity high-speed wireless communication system has become essential. Both a complementary metal-oxide semiconductor (CMOS) technology to realize low-cost MMW transceiver integrated circuits (ICs) in the high-volume manufacturing phase and a technology to produce low-cost antennas are key technologies that hold the key to the expansion of MMW wireless communication systems.
Toshiba has developed a technology to incorporate an antenna in an IC package using bonding wire for MMW proximity high-speed wireless communication systems. This technology provides a low-cost MMW transceiver solution because the antenna can be manufactured in the process of fabricating standard ball grid array (BGA) packages.

Quality Improvement Technology for Requirement Specifications Using Data Flow Diagrams
MURATA Yukari / YUMIKURA Yosuke / WADA Taiki
To successfully perform system development, the quality of the system requirement specifications is of critical importance. In particular, it is essential to completely eliminate ambiguities, omissions, and leaks in the requirement specifications. Formal methods using mathematical notation have recently been attracting attention as a means of describing requirement specifications. However, this approach requires a great deal of time and effort when applied to large-scale systems.
As a solution to this issue, Toshiba has developed a technology for improvement of the quality of requirement specifications based on natural language processing that analyzes the phrase structures of requirement specifications and automatically generates graphic expressions representing data flow diagrams (DFDs). Mechanical evaluation of the graphic expressions generated by this technology makes it possible to detect ambiguities, omissions, and leaks in the requirement specifications.

REGZA Z8X Series 4K Ultra HD LCD TVs Featuring Large Screens with High Picture Quality
WATANUKI Masanori
Toshiba launched its REGZA 55X3 and REGZA 55XS5 first-generation 4K ultra-high definition (Ultra HD: 3,840 x 2,160 pixels) liquid crystal display (LCD) TVs, equipped with a 55-inch 4K Ultra HD LCD having four times the resolution of Full HD LCDs, in December 2011 and June 2012, respectively.
In June 2013, we subsequently released the REGZA Z8X series second-generation 4K Ultra HD LCD TVs, the REGZA 84Z8X, 65Z8X, and 58Z8X models, with 84-, 65-, and 58-inch LCDs. In the REGZA Z8X series, a balance was achieved between larger screen size and further improvement of picture quality through the development of larger 4K Ultra HD LCDs and a new video processing engine called the "REGZA ENGINE CEVO 4K." These models, which were designed for the global market from the initial stage of development, have been launched in North America as the L9300 series and in Europe as the L9363 series, and will also be launched in the Asian market.

Open Logic Arithmetic Function Implemented in Water and Sewage Monitoring and Control Server
ADACHI Yoshifusa / CHOH Tatsuki / YOKOYAMA Suguru
In water and sewage monitoring and control systems, arithmetic functions are generally performed by process control stations (PCSs) at local facilities in real time. High-value-added functions including special operations based on the trends in continuous and historical data can be incorporated into a system by installing special servers and terminals. However, with the exception of a few facilities operated by large-scale local governments, these special operations have not been extensively introduced.
In response to these circumstances, Toshiba has developed an open logic arithmetic function as an optional feature of its TOSWACS$_{TM}$-V water and sewage monitoring and control system. The open logic function enables users to dynamically change the settings of alarms, to perform arithmetic functions using past data, and to easily realize supporting functions without the need for additional servers and terminals.

FR2100SS model 500 Rackmount Industrial Computer
SUWABE Satoru / AZUMA Takao / ANAN Kazuhiro
Industrial computers are applied to a wide range of systems in the social infrastructure field including various types of monitoring and control systems.
The FR2100SS model 500 is Toshiba's latest rackmount industrial computer, achieving both space-saving by the use of a 2U (87 mm) rackmount chassis and high-speed, large-capacity data processing performance due to its third-generation Intel® Core™ i7 processor, high-speed serial interfaces including universal serial bus (USB) 3.0, PCI Express® 3.0, and Gigabit Ethernet, and high-performance onboard graphics functions. This model will contribute to the stable operation of social infrastructure systems with its features of long-term product supply and maintenance as well as high reliability, improved environmental robustness, and easy maintainability.

Frontiers of Research & Development

Brilliance Restoration Technology for TVs