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Special Reports

Technologies for Next-Generation Thermal Power Plants

Realization of Zero-Emission Thermal Power Plant
KAZAO Yukihiko

Prospects for Electric Power Supply and New Technologies for Future Thermal Power Plants
MIYAIKE Kiyoshi
With the growth in world energy demand and progress of global warming, the reduction of carbon dioxide (CO_2) emissions from thermal power plants is essential for the creation of a low-carbon society, in addition to the active use of nuclear power and renewable energy resources.In particular, the trends in future technologies for thermal power plants have an important effect on both energy supply and the environment. For thermal power generation, the realization of higher plant efficiency and carbon capture and storage (CCS) are required.
Toshiba is promoting the development of an advanced ultra-supercritical (A-USC) power plant system and technologies to capture CO_2 from coalfired power plants.

700°C-Class Advanced Ultra-Supercritical Steam Turbine
SUGA Takeo / TAKAHASHI Takeo / IMAI Kiyoshi
Enhancement of the thermal efficiency of coal-fired power plants is required for the reduction of carbon dioxide (CO_2) emissions. The most effective means of achieving this goal is to improve the steam condition of the plant.
Toshiba has been developing various new technologies for high-efficiency steam turbine plants, including a 700°C-class advanced ultra-supercritical (A-USC) steam turbine. These technologies will realize both higher thermal efficiency of coal-fired power plants and lower CO_2 emissions to prevent global warming.

High-Efficiency Steam Turbines and Turbogenerators
OKITA Nobuo / TAKAHASHI Toru / SATO Osamu
The power supply business has been encountering dramatic changes involving complex challenges, including global environmental issues such as the reduction of carbon dioxide emissions, diversification and conservation of available fuels due to limited reserves, and deregulation of the power supply market.
Based on its extensive experience and integrated technological capabilities, Toshiba is developing and manufacturing proven state-of-the-art high-efficiency steam turbines and turbogenerators achieving high reliability, high performance, and compact design that satisfy the needs of society for stable electricity supply and the solution of various challenges.

Japan□s First Environmentally Conscious H System^{TM} Combined-Cycle Thermal Power Plant
MATSUSHITA Takehiko / EGAMI Norihide / TAKASHIMA Michiharu
The H System^{TM} combined-cycle power plant utilizing a 1,500 °C-class gas turbine is expected to be the main environmentally conscious thermal power plant for the next generation, offering high efficiency and high power with low nitrogen oxide (NOx) emissions.
Toshiba has concluded an H SystemTM manufacturing partnership agreement with General Electric Company (GE), and has been working with GE on design, manufacturing, installation, and commissioning for Futtsu Thermal Power Station Group 4 of The Tokyo Electric Power Company, Inc. (TEPCO), which is the first H System^{TM} combined-cycle power station in Japan. The first vacuum up of the Unit 4-1 condenser was carried out in October 2007, and the first firing of the Unit 4-1 gas turbine was executed in November 2007. Unit 4-1 reached the rated output of 507 MW in February 2008,and started commercial operation in July 2008.

Life Extension Technologies for Gas Turbine Hot Parts
SAKAI Yoshiaki / SATO Iwataro / SAITO Daizo
The number of combined-cycle power plants utilizing a gas turbine has been increasing due to the market demand for the reduction of carbon dioxide emissions toward the achievement of a low-carbon society, and for the improvement of energy efficiency. Since the hot parts of a gas turbine are susceptible to damage such as thermal stress cracks and high-temperature oxidation, it is necessary to constantly repair or replace them. Appropriate gas turbine maintenance technologies, including diagnostic and repair technologies, are therefore required so that expensive hot parts can remain in service for as long as possible.
In response to these requirements, Toshiba has been making efforts to develop remaining life assessment and life extension technologies for the hot parts of gas turbines.

Geothermal Turbine Technologies Contributing to Spread of Renewable Energy
TANIGUCHI Akihiro
To reduce carbon dioxide (CO_2) emissions, which are a major cause of global warming, efforts toward energy conservation and improvement of energy efficiency are making progress. In addition, renewable energy systems such as geothermal power plants, which emit less CO_2, are coming into widespread use.
Since Toshiba□s introduction of a turbine and generator for Japan□s first geothermal power plant in 1966, we have been developing equipment for such plants accounting for about 30% of global geothermal energy capacity up to now. Applying various improvement technologies for geothermal turbines, including technologies for improving performance and reliability, we are making efforts to contribute to the prevention of global warming through the spread of geothermal power.

Carbon Dioxide Capture from Flue Gas of Thermal Power Plants
OHASHI Yukio / OGAWA Takashi / YAMANAKA Susumu
Almost a quarter of global emissions of carbon dioxide (CO_2) are released from thermal power plants. There is consequently an increasing need for the development of low-cost CO_2 capture technology.
Toshiba has been developing a chemical absorption method suitable for capturing CO_2 from large volumes of flue gas. We have now found new amine solvents with good performance, and have been evaluating them experimentally. We are making continuous efforts to decrease the energy required for CO_2 capture and inhibit degradation of the solvents, and are carrying out experiments with a bench plant using real coal combustion gas.

Feature Articles

Sportio CDMA2000 1xEV-DO Sports Cellular Phone
MATSUURA Takanori / TOKUDA Yoshinori / TOKUYAMA Yosui
In recent years, Japanese mobile phone service provider au□s WIN (We Innovate the Next) cellular phones have been supporting the CDMA2000 1xEV-DO (code division multiple access 2000 1x evolution data only) service, and the size of the radio circuit system has been increasing to accommodate the triple bands. A further factor increasing the size of cellular phones has been the demand for multiple functions and high performance approaching the level of PCs. On the other hand, demand for the miniaturization of cellular phones is also strong.
Toshiba has released the Sportio CDMA2000 1xEV-DO sports cellular phone, which realizes compact size by incorporating only essential functions. The Sportio also has a pedometer function using an acceleration sensor, making this model the first au sports cellular phone equipped with such technology.

1kW-Class Stationary Fuel Cell Utilizing Diversified Raw Fuels
IWASAKI Waichi / TANAKA Masatoshi / ISOBE Yasuyuki
Toshiba is aiming at the commercialization of a 1kW-class stationary fuel cell for the residential market in FY2009. We have been participating in the Large-Scale Stationary Fuel Cell Demonstration Project, which is being implemented by the New Energy and Industrial Technology Development Organization (NEDO), since FY2005. As a result of large-scale continuous data acquisition, we have attained the level of commercialization in terms of performance and durability using city gas (natural gas: NG) and liquefied petroleum gas (LPG) as raw fuels.
Furthermore, in FY2006 we succeeded in the operation of a 1 kW-class stationary fuel cell using commercially available kerosene, which is widely preferred as an inexpensive and easy-to-use fuel due to the infrastructure installed in cold regions of Japan.

Electrical Equipment of Dual-Voltage (25kV AC/3 kV DC) Electric Locomotives for Transnet in Republic of South Africa
HIRAHARA Akira / KANAI Toshinobu / KISHI Shu
With the increase in global demand for mineral resources in recent years, even the Republic of South Africa, a leading mineral resource producing country, has experienced an urgent need to enhance transport capacity from mines to shipping ports.
Toshiba received an order from Transnet in the Republic of South Africa for the electrical equipment of Class 19E dual-voltage (25kV AC/3 kV DC) electric locomotives for coal transport. The Class 19E electric locomotives offer high efficiency due to their ability to operate on both 25kV AC and 3kV DC sections of the railway network, and high reliability as they are provided with redundancy of the main equipment. They are also environmentally conscious, as the first electric locomotive system operating on the country□s AC railway sections to incorporate regenerative braking.

Large-Capacity Core-Type Main Transformer for Overseas Electric Locomotives
MAYA Takeyoshi / TAKEOKA Takaaki / MIYANISHI Tsutomu
Due to the global expansion of freight transport demand in recent years, it is essential to realize both the enhancement of traction ability and higher running speeds for AC electric locomotives in order to improve transport efficiency. This has resulted in the size of AC electric locomotives becoming larger, which in turn requires the main transformer of the locomotive system to have a larger capacity.
Toshiba has developed a core-type main transformer for large AC electric locomotives. This new transformer makes it possible to meet the various specifications and requirements of railway track conditions, operating conditions, and so on. Space-saving is achieved by the smaller size and lighter weight of the transformer, and the tank is sealed with nitrogen gas to prevent oil degradation, thus offering easy maintenance.

Project for Replacement of 275 kV Transmission Line Protection Panels for Inalum in Indonesia
KASUGA Ken / UCHIYAMA Masanao / SUKEGAWA Yukio
Toshiba completed the renewal of transmission line protection panels for the Indonesia Asahan Aluminum, PT (Inalum) hydroelectric power station, located in the lower reaches of the Asahan River in Northern Sumatra, Indonesia, in January 2008. This project was a part of rehabilitation projects for hydroelectric power generation and transmission equipment and aluminum smelting facilities.
Although there was a severe condition that the supply of power for aluminum smelting had to be continued during the work, we were able to implement the project in accordance with the requirements by making detailed arrangements. We will continue to promote replacement projects in the global market based on our record of successful results.

High-Speed Technology of p-Type MOSFET
SAITOH Masumi / KOBAYASHI Shigeki
The gate length of metal-oxide-semiconductor field-effect transistors (MOSFETs) in large-scale integrations (LSIs) has been continuously shrinking to achieve improvements in the operation speed of LSIs. In recent years, however, the performance of MOSFETs has been somewhat degraded by these reductions in gate length, because the substrate impurity concentration becomes extremely high to suppress the adverse effects of the shrinkage in MOSFET size.
Toshiba has newly found that carrier mobility, which determines the performance of MOSFETs, is greatly improved even under high substrate impurity concentration by fabricating a p-type MOSFET (pMOSFET) on a silicon Si(110) substrate instead of the conventional Si(100) substrate. By further introducing strain into the channel of the MOSFET, high-performance MOSFETs can be fabricated that offer promise as future technology nodes.

Frontiers of Research & Development

Intelligent Remote Maintenance System