Power Systems and Industrial Equipment

Society increasingly faces a global environment problem and needs electric power that is clean, reliable and economical. Toshiba is developing new technologies for power generation facilities and services. Toshiba has developed an environmentally-friendly system for thermal decomposition gasification/pyrolysis of waste. For today's rapidly aging society, narrower escalators take up a minimum of space in existing stairways. Toshiba is also providing operation management, electric power and vehicle control, as demonstrated by the package order received for the Taiwan Shinkansen. In this way Toshiba is answering the needs of society in a variety of different ways.

Completion at the Factory of the Pump-Turbine for Kazunogawa Pump-Storage Power Station Unit No.4 of The Tokyo Electric Power Co., Inc.

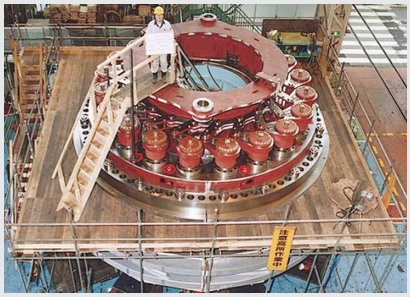
The pump turbine for Kazunogawa Pump-Storage Power Station Unit No.4 of The Tokyo Electric Power Co., Inc. was completed at the factory in July 2000.

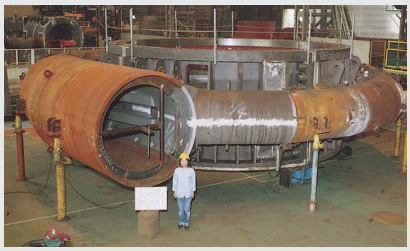
This represents not only the world's highest pumping head (782 m) in a single stage, Francis type, reversible pump-turbine, but it is also the world's largest output by an adjustable speed pump-turbine.

Toshiba is supplying two of the pump-storage units for Unit No.3 and No.4, including main transformer, generator-motors and frequency converters and control system for adjustable speed operation.

Turbine rating
- rated output: 412 MW
- maximum net head: 728 m
- revolving speed (adjustable): 480 to 520 min^{-1}

Pump rating
- maximum pumping head: 782 m
- pumping discharge at minimum head: 56.7 m^3/s
- revolving speed(adjustable): 480 to 520 min^{-1}





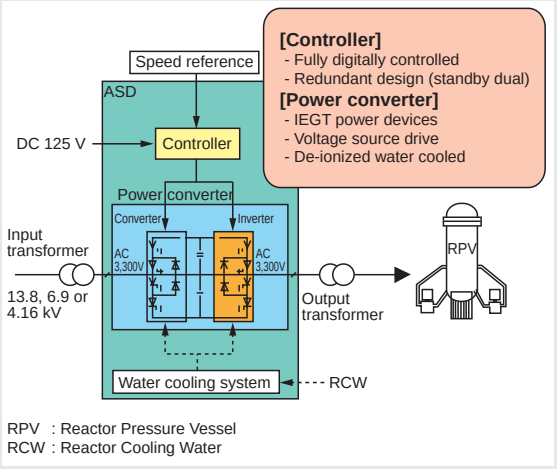
Shop assembly of pump-turbine for Kazunogawa Pumped-Storage Power Station Unit No.4 of The Tokyo Electric Power Co., Inc.

Application of Adjustable Speed Drive to Reactor Recirculation Pump in Boiling Water Reactor

The reactor recirculation system (RRS) pump of early generation boiling water reactors (BWRs) has been driven by a motor generator set with fluid coupler, with mechanically converted drive power. Many of these units have operated for more than 25 years and have been reaching replacement age.

For new nuclear power plants, Toshiba has been supplying adjustable speed electrical power drive systems (ASD), which can reduce house load due to its much higher efficiency than existing mechanical power supplies. To meet the replacement demand, Toshiba has launched on the global market a 3 level gate turn off thyristor (GTO) ASD, which complies with global standards.

Now Toshiba is developing an injection enhanced gate transistor (IEGT) ASD, which is a higher-efficiency, more space-saving system than that of existing ASDs. The IEGT is a new generation power device developed exclusively by Toshiba. The stand-by dual redundant system adopted in the controller, an exclusive Toshiba design, assures high reliability.



ASD system configuration overview

Thermal Power Plants

Tachibana Bay Unit No.1 A Toshiba/GE joint venture (JV) completed a CC4F-48" steam turbine generator (STG) unit for EPDC (Electric Power Development Co., Ltd.) Tachibana Bay Unit No.1 on July 27, 2000. The unit can generate 1,050 MW under steam conditions of 25 MPag/600 °C /610 °C.

9FA$^+$ Combined Cycle Plant The combined cycle thermal power plant, a new Toshiba product, was installed at the site. The newest single shaft combined cycle unit is composed of a 9FA$^+$ gas turbine, SCSF (Single Casing Single Flow) steam turbine and HRSG (Heat Recovery Steam Generator). It will achieve 50% thermal efficiency (HHV: Higher Heating Value) and will supply a total of 1,140 MW electric power generated by three single shaft units.

1,000 MW Tandem Compound Plant Toshiba has completed ex-work and has installed a 1,000 MW steam turbine generator (ST/G) for Chubu Electric Power Co., Inc. This turbine is a tandem compound 60 Hz having 1,000 MW-output capacity. The unit adopted 40-inch titanium blades for the last stage of the main turbine, and 24.1 MPa 566/593 °C steam conditions to attain high performance. Also, the generator is a tandem two-pole 60Hz 1,120 MVA unit, which is the world's largest capacity. Now, this coal fired ST/G is in trial operation before entering commercial operation in November 2001.

US Market To meet the great demand for new combined cycle power station construction in the US, Toshiba has standardized the design of ST/G's into three types. This has enabled advanced procurement of main parts and helped to achieve shorter delivery times. In 2000, Toshiba shipped 6 units (total 1,500 MW) and received orders for another 11 units (total 3,200 MW).

Steam turbine — generator under installation

Commissioning of Kii Channel HVDC Link

Thyristor valve for Kii Channel HVDC transmission system

The Kii Channel HVDC (High Voltage Direct Current transmission system) link is rated 1,400 MW, DC ±250 kV and is the largest HVDC link in Japan. It was commissioned on June 22, 2000. The Kii Channel HVDC Link was built to transmit power from Tachibana-wan PS (Power Station) on Shikoku Island to the Osaka area. The AC sides of converters are connected to the AC500 kV systems of Shikoku Electric Power Co., Inc. and The Kansai Electric Power Co., Inc.

Toshiba supplied HVDC main equipment such as thyristor converter, converter transformer, smoothing reactors, DC-GIS (Gas Insulated Switchgear), lightning arrestors and the control and protection system.

The system voltage and capacity is to be doubled to DC ±500 kV and to 2,800 MW in the future. For that reason, some of the DC main circuit equipment, smoothing reactor, DC-GIS and others are designed for DC 500 kV operation.

The thyristor converter is rated 700 MW and employs state of the art technologies such as the world's largest 8 kV-3,500 A direct light triggered thyristor and others to achieve large capacity, compact form factor, low loss and excellent earthquake resistance characteristics.

The control and protection system consists of such newly developed control functions as the power modulation control for damping power oscillation, SSTI (SubSynchronous Tortional Interference) damping control, and so on, to improve the stability of the transmission system cooperating with the HVAC (High Voltage Alternating Current) system.

Decontamination of Radioactive Wastes by T-OZON Process in Hamaoka NPS of Chubu Electric Power Company

The T-OZON process is a newly-developed decontamination method designed to reduce radiation exposure of workers who must be in proximity to contaminated equipment. This process removes radioactive materials deposited on the structural material surface of nuclear reactors.

This process is characterized by two main features: (1) high decontamination efficiency due to combination of oxidation treatment by ozone and reduction treatment by oxalic acid, (2) small amount of secondary waste because chemicals are used that are easy to decompose.

The first application of the T-OZON process was carried out on the radioactive waste components (PLR (Primary Loop Recirculation system) pump internals) of Hamaoka NPS (Nuclear Power Station). The surface dose rate of subjects was reduced to not more than 1/300 by the T-OZON process. Further, the amount of secondary waste was reduced to 70% of that generated by conventional decontamination methods.

The T-OZON process is expected to be widely applied to decontamination not only for waste disposal but also for inspection of in-service equipment.

Before decontamination

After decontamination

PLR pump impeller

Verification Test of Pyrolysis Gasification Waste Treatment System

10 t/day pyrolysis gasification test facility

Toshiba has developed and verified a pyrolysis gasification melting system with 10 t/day treatment capacity of municipal waste. The verification test program was conducted under consultation of JWRF (Japan Waste Research Foundation), and the test results showed excellent performance in controlling the emission of harmful substances such as dioxins with levels dramatically lower than regulation values.

In this system, wastes are pyrolysed in a 550 degC heated rotating drum, then the pyrolysed gas is fed to a gas cracker and discomposed into lower molecular weight gas, i.e. cracked gas, in a 1,100 degC atmosphere. A wet scrubbing unit is equipped to remove harmful chemical substances from the cracked gas. The final clean fuel gas that is produced can be utilized for combustors and gas engines to generate power.

This system is suitable for both large- and small-scale plants, and it is expected to be ideal as a local energy supply system using municipal and industrial wastes collected in urban and rural area.

Toshiba is currently constructing a commercial pyrolysis gasification plant with 60 t/day treatment capacity of automobile shredder residue (ASR), and plans call for operation to start this October.

Contract of Taiwan High-Speed Railway System

Illustration of Taiwan high-speed railway

After severe competition from the Eurotrain group since 1997, Japan's first export of the High Speed Railway System has finally been achieved. (Total contract price is about 330 billion yen.)

The planned High Speed Railway System will provide a 1.5-hour connection for the 350 km distance from Taipei to Kaohsiung. (The highest speed is 300 km/h. The existing express train takes about four hours.)

Main reasons for awarding the contract included the record of the highly reliable Japanese High Speed Railway System (Shinkansen), which has had zero passenger death accidents during 37 years under circumstances and conditions similar to those of Taiwan (typhoons, earthquakes, high population density, etc.), and a distributed traction system that provides excellent train running stability under rainy conditions.

Toshiba Corporation is performing overall system integration of the electrical and mechanical systems with Mitsubishi Heavy Industries, Ltd. and Kawasaki Heavy Industries, Ltd. In addition, Toshiba is supplying electrical equipment for the train, substation, wayside equipment, train radio system, and operation control center.

Narrow Type Escalators

Narrow type escalator

These days, facilities in the transportation sector are being made increasingly barrier-free. Accordingly, the need is growing for elevators and escalators than can be installed in limited spaces such as existing stairways of railway stations.

In response to these requirements, Toshiba has launched "narrow type" escalators, with reduced width.

The main features are:

- To retain the same transport capacity as the former 1,200 types, step size has been kept the same.
- The width of the escalators was reduced by not more than 210 mm (approximately 13%).
- The required width of the pit was reduced by 190 mm (approximately 12%), compared with the former type for a floor height of 6.5 m or less.

The first product was installed at the Kobuchi station (Yokohama line) of East Japan Railway Co. in November 2000.