

First Contract for Overseas Nuclear Plants and Advanced Plant Construction Technology

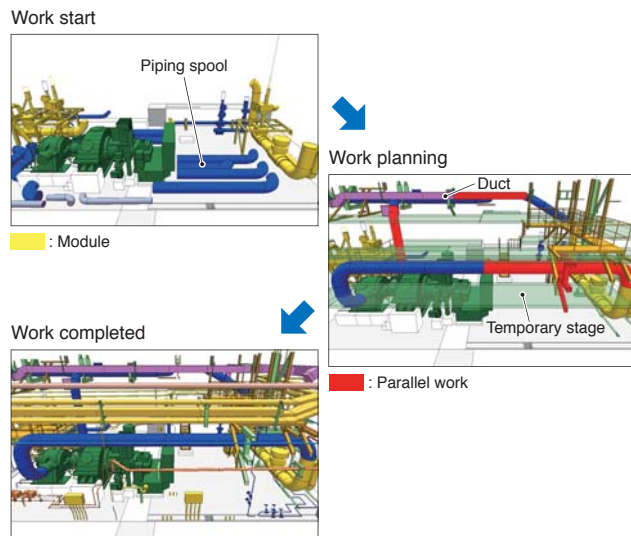
In February 2009, Toshiba became the first Japanese company to win a contract, through Toshiba America Nuclear Energy Corporation (TANE), for two overseas nuclear power plants including their construction work. They are the South Texas Project Units No. 3 and 4 (STP-3/4), the first advanced boiling water reactors (ABWRs) in the United States.

In July 2009, Toshiba underwent an audit by the U.S. Nuclear Regulatory Commission, and was qualified as a supplier for U.S. ABWRs. Toshiba then established an engineering office of TANE in Charlotte, North Carolina, to promote nuclear business operations in the U.S. Toshiba and TANE are now accelerating engineering work for STP-3/4.

In addition, Toshiba is simulating the on-site construction using a six-dimensional computer-aided design (6DCAD™) system, which links materials, processes, and human resources with three-dimensional (3D) CAD data.

Consequently, Toshiba has established a construction scheme that will help reduce the amount of on-site construction by increasing modular processes and shorten work periods through parallel work.

Toshiba is providing advanced plant construction technology to domestic and overseas customers by leveraging its state-of-the-art information technology including the 6DCAD™ system.



Construction simulation using 6DCAD™ for reactor feedwater pump area in Ohma Nuclear Power Plant of Electric Power Development Co., Ltd.

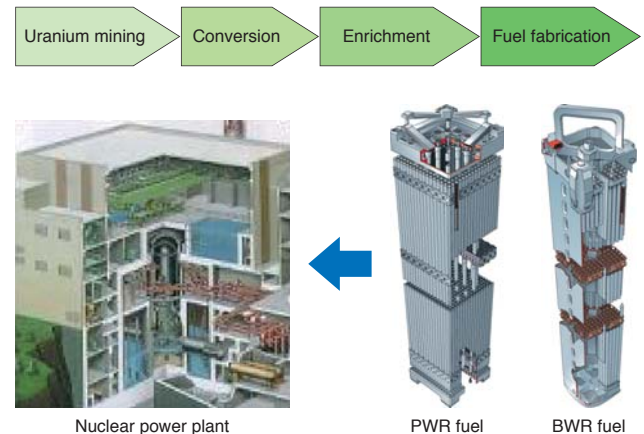
Meeting the Challenge of Providing Stable Nuclear Fuel Supplies

The assurance of long-term nuclear fuel supplies is critical to the construction and operation of nuclear power plants.

In 2007, Toshiba signed a memorandum of understanding (MOU) on promoting cooperation in the nuclear power industry with NAC Kazatomprom of Kazakhstan, which has the world's second-largest reserves of uranium; Toshiba thereupon became a participant in the Kharassan Uranium Mine Project.

In 2009, Toshiba signed an MOU on studies of business concepts or commercial plans in connection with enriched uranium products with Technabexport (TENEX) of Russia.

It is our belief that the stable supply of nuclear fuels, from uranium mining to fuel fabrication, will contribute to Japan's energy security. Toshiba continues to strengthen and stabilize its nuclear fuel supply capability to meet customer needs.



PWR: pressurized water reactor
BWR: boiling water reactor

Flow of nuclear fuel supply to nuclear power plant

Full-Scale Prototype of ITER Toroidal Field Coil

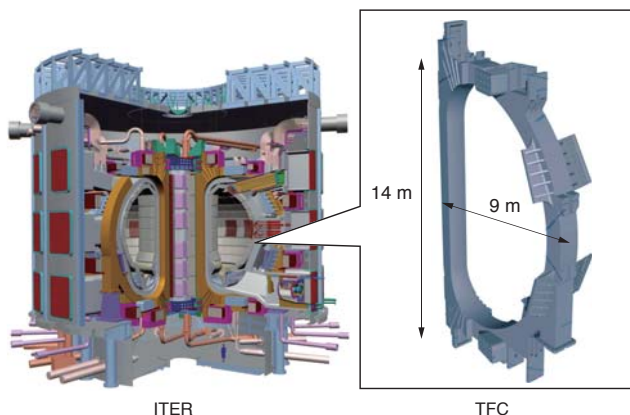
The International Thermonuclear Experimental Reactor (ITER) project has entered the construction phase with a target of starting operation in 2018.

The toroidal field coils (TFCs) are superconducting magnetic coils with a maximum field of 12 T to confine high-temperature and high-density plasma in a vessel.

These TFCs have a large structure, with a height of 14 m and a mass of 300 tons, and must be precision manufactured with a tolerance of not more than 0.1% to obtain an accurate magnetic field profile. To meet these requirements, it is necessary to verify the feasibility of the coil winding, large-scale machining, and welding technologies.

Toshiba has received an order for a full-scale prototype TFC from the Japan Atomic Energy Agency. Design and manufacturing technologies for one of the world's largest superconducting coils will be established through the fabrication of this prototype based on our forced-flow-cooled superconducting coil technology, which is expected to contribute to the ITER project.

T: tesla



(figure courtesy of the ITER Organization, the Japan Atomic Energy Agency (JAEA))

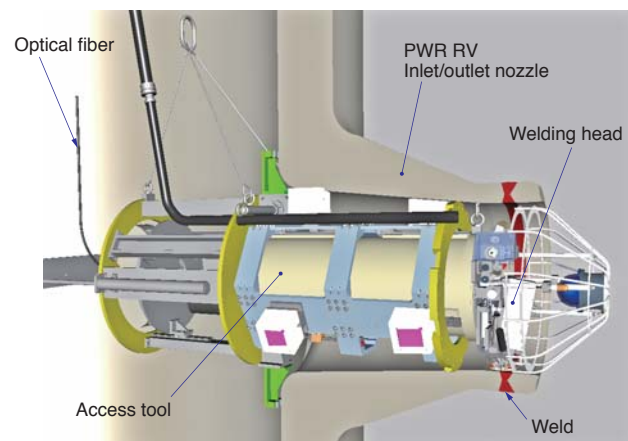
ITER and TFC

Underwater Laser Beam Welding Equipment for Pressurized Water Reactor Nozzles

Pressurized water reactors (PWRs) are filled with water to provide shielding from radiation during regular outages. To repair stress corrosion cracking (SCC) at the inlet/outlet nozzles of a reactor vessel (RV) or apply weld cladding to their interior for preventive maintenance purposes, it has been necessary up to now to seal up and drain the work areas.

Toshiba has developed underwater laser beam welding equipment for use in PWRs, which eliminates the need for water drainage.

A small laser welding head injects argon gas into gaps at the inlet/outlet nozzles to displace water and dry out the surfaces. The new welding system does not need any special structure for sealing and drainage, and can continually perform welding while injecting argon gas and moving the welding head. This welding system can work in tandem with underwater inspection and excavation systems, reducing the repair period to less than half. We will utilize this system at nuclear power plants both in Japan and abroad.



Underwater laser beam welding equipment for PWR inlet/outlet nozzles

Full-Scope Simulator for Human Factors Engineering



Full-scope simulator for HFE

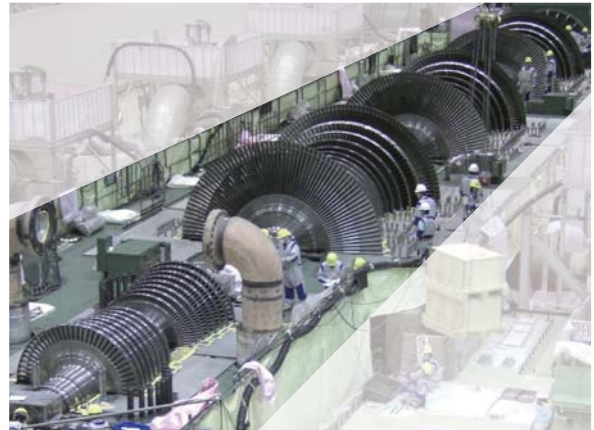
Thousand of displays, alarms, and switches for operation and monitoring are in the main control room (MCR) of a nuclear power plant, which is designed, based on human factors engineering (HFE), considering the physical size, angles of view, and cognitive characteristics of plant operators.

Quantitative evaluation of operators' visual perception, workload, and other parameters based on HFE, and proof of the adequacy of MCR design by means of a third-party evaluation, have recently become increasingly important.

Toshiba has developed a full-scope simulator in-house that allows us to evaluate human factors, while changing display colors, symbols, operator response times, etc. in an environment equivalent to that of an actual MCR.

We will leverage this simulator to design the MCR for planned plants and to improve the MCR at existing plants around the world.

Replacement of Large Turbine Systems of TEPCO Fukushima Daiichi Nuclear Power Station Unit 6



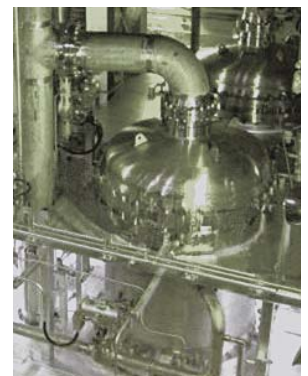
Replacement high-efficiency steam turbine

Toshiba has replaced the steam turbine of Unit 6 (electrical output: 1 100 MWe) at the Fukushima Daiichi Nuclear Power Station of The Tokyo Electric Power Company, Inc. (TEPCO), achieving a 5% increase in its rated electrical output. We also retrofitted the hollow-fiber-based condensate prefilters, reducing impurity levels at their outlets to approximately 1/1 000.

The heat energy utilization of the new steam turbine has been improved by using three-dimensionally shaped blades and lengthening the last-stage blades by approximately 200 mm. The existing casing was reused to minimize waste disposal. The reduced impurity levels at the prefilter outlets have led to a reduction in waste generated by the downstream demineralizer system.

Additionally, the prefilters are expected to reduce the 10-year radiation exposure of personnel to half the previous level.

We completed the above work and routine inspection within only 94 days. We will continue to promote the benefits derived from the enhancement of steam turbines and condensate prefilters for nuclear power facilities both in Japan and abroad.

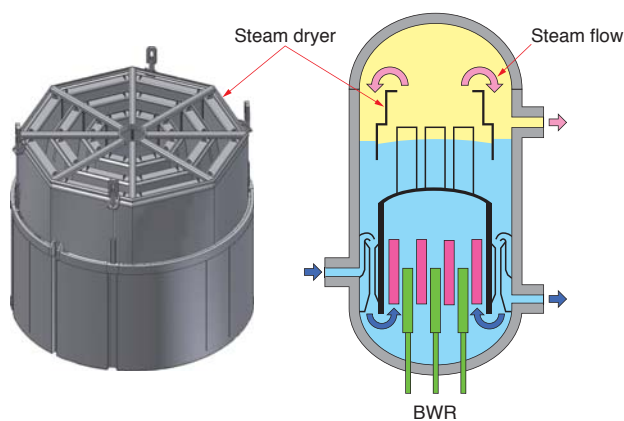


Retrofitted condensate prefilters

Replacement Steam Dryer for U.S. Nuclear Power Plant

Owing to our years of experience in the manufacture of reactor internals, Toshiba has won an order for a replacement steam dryer for a nuclear power plant in the United States. This steam dryer realizes a steam flow of approximately 120% and is currently being manufactured for delivery in 2011.

The steam dryer separates moisture from steam generated inside the reactor pressure vessel. It is a stainless steel structure measuring approximately 5 m in diameter and 5 m in height. In Europe and the U.S., efforts are being made to uprate the electrical power of reactors by significantly increasing the steam flow. The structural strengths of existing steam dryers are being evaluated based on increased steam flow conditions, and they are being replaced if they are found to lack adequate strength.



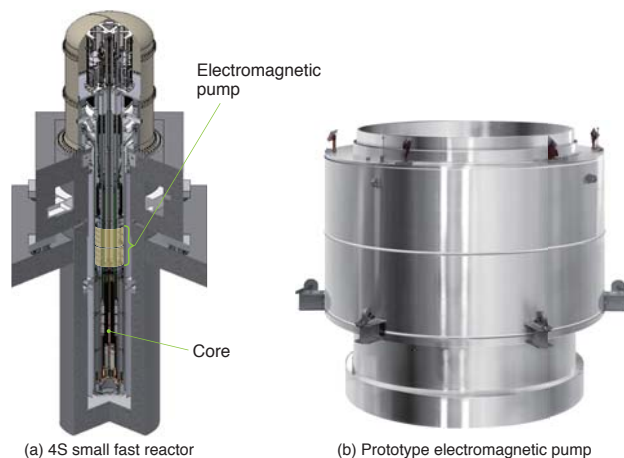
Replacement steam dryer for U.S. nuclear power plant

Prototype Electromagnetic Pump for 4S Small Fast Reactor

Toshiba and the Central Research Institute of Electric Power Industry (CRIEPI) are developing a sodium-cooled small fast reactor named 4S (Super-Safe, Small and Simple), which can generate electric power of 10 MW to 50 MW without refueling for up to 30 years.

The electromagnetic pump used as the primary coolant circulation pump is to be installed within the reactor using Toshiba's proprietary radiation-proof, high-temperature isolation technology. This pump features enhanced maintainability since it has no moving parts. To validate its applicability to the 4S reactor, Toshiba has designed and manufactured a full-scale, large-diameter prototype, and has verified the design propriety of this prototype at its high-temperature liquid sodium circulation facility.

Toshiba will proceed with long-term soundness testing with a view to practical use in fast reactors. Part of this project has been subsidized by the Ministry of Economy, Trade and Industry (METI).



Fabricated prototype electromagnetic pump and location in 4S reactor vessel

Alpha Clearance Monitor Using Ionized Air Transport Technology

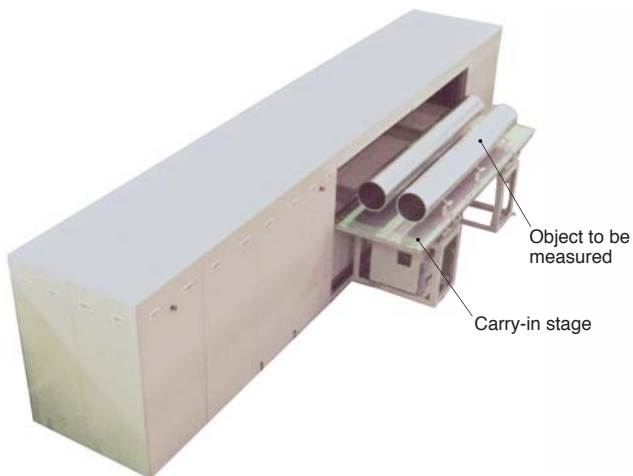
Toshiba has developed an alpha clearance monitor that allows quick, easy, and accurate measurement of the low-level radioactivity of alpha-emitting nuclides such as uranium.

Previously, such alpha radioactivity measurements were time-consuming because a conventional alpha survey meter had to be placed in close proximity to the entire surface of the object concerned in order to directly measure the alpha radioactivity. Moreover, tubular or complex-shaped objects had to be segmented for measurement due to the short range of alpha particles.

We have established a new technology for determining the radioactivity of alpha-emitting nuclides by detecting ionized air molecules produced by alpha particles, thereby eliminating the need for a surface survey.

The alpha clearance monitor based on this new ionized air transport technology can discriminate objects as being lower than the clearance level within 100 s, even in the case of tubular or complex-shaped objects without pretreatment.

This monitor is expected to be used for the clearance level discrimination of objects contaminated with uranium or other alpha-emitting nuclides.



Alpha clearance monitor using ionized air transport technology

Neutron Imaging Technology Using Neutron Color Image Intensifier

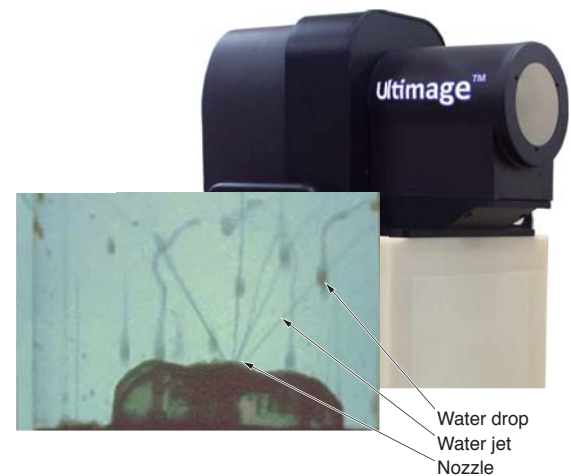
Toshiba has launched the Ultimage™, the world's first(*) highly sensitive inspection system based on a neutron color image intensifier (I.I.) for viewing through heavy metals such as iron and lead.

Without the need for any complicated adjustments according to the condition of the objects to be imaged, the Ultimage™ can visualize the motion of fluids such as water and fuels inside metal containers, which have not been able to be visualized by X-rays, with a time resolution of 1/500 s.

The Ultimage™ is already being utilized by automobile manufacturers and university laboratories for evaluation of the basic hydraulic properties of hydrogen gas inside fuel cells, fuels, and lubricants in combustion engines.

In addition to automobile engines, application of the Ultimage™ is expected to expand to a wide range of fields such as aircraft engines and rocket engines.

(*) As of May 2009 (as researched by Toshiba)



Neutron color I.I. and visualization of water jet in metal piping

Commercial Operation of Senboku Natural Gas Power Plant Units 3 and 4 of Osaka Gas Co., Ltd.



Overview of Senboku Natural Gas Power Plant of Osaka Gas Co., Ltd.



Power train of Unit 4



HRSG of Unit 3

The Senboku Natural Gas Power Plant of Osaka Gas Co., Ltd. is a combined-cycle power plant with a total power output of 1 109 MW. Toshiba was in charge of the design, engineering, manufacturing, construction, erection, and commissioning of Units 3 and 4 (277.5 MW each), and technical coordination of the overall power plant.

Units 3 and 4 started commercial operation in November 2009 and October 2009, respectively, as originally scheduled.

This project was our first domestic engineering, procurement, and construction (EPC) project for a combined-cycle power plant. The Senboku Natural Gas Power Plant is a highly efficient, environmentally friendly liquefied natural gas (LNG)-fired power plant equipped with the latest General Electric Company 7FA+e model 1 300°C-class gas turbines, and steam turbine and generators supplied by us.

The power station layout is highly optimized so that a large number of facilities, including the gas turbines, steam turbines, generators and auxiliaries, heat recovery steam generators (HRSGs), stacks, cooling towers, demineralized water systems, wastewater treatment systems, fuel gas supply systems, a firefighting system, and water tanks, are compactly arranged in a limited space. One of the most outstanding characteristics of this project is that the HRSGs were assembled on-site utilizing parts and components manufactured overseas. Another key feature is that the gas turbine inlet-air cooling system is capable of recovering and maximizing generator output in summer by cooling the gas turbine inlet air with cooling water supplied by a chiller unit.

Shipment of Large-Capacity, Indirectly Hydrogen-Cooled Generator with High Efficiency



670 MVA indirectly hydrogen-cooled turbine-driven generator undergoing shop test

Toshiba manufactured the world's largest capacity^(*) indirectly hydrogen-cooled generator (670 MVA), which accomplished a high efficiency of 99.1% in its shop test, and shipped it for use as the primary generator at Maizuru Power Station Unit No. 2 of The Kansai Electric Power Company, Inc. in February 2009.

Although large-capacity generators have generally been of the water-cooled type, we have developed and applied various technologies for the improvement of cooling performance such as high-thermal-conductivity insulation, and succeeded in enlarging the capacity of an indirectly hydrogen-cooled generator where hydrogen gas is used for cooling of the stator coil as well as the rotor coil.

(*) As of October 2009 (as researched by Toshiba)

Shipping of Generators for Porce III Hydroelectric Power Plant in Colombia



Section of generator stator for Porce III Hydroelectric Power Plant, Colombia

Four hydroelectric generators (218 MV-13.8 kV) for the Porce III Hydroelectric Project were delivered to Empresas Públicas de Medellín (EPM) in Colombia in June 2009.

Toshiba is a leading company in the hydroelectric generator market in Colombia, having supplied 35 hydroelectric generators for seven power stations. The first unit of the Porce III Hydroelectric Power Plant is currently under construction and is expected to start commercial operation in December 2010, with all four units planned to be in commercial operation by mid-2011.

Hydroelectric power is the leading source of electric power in Colombia, accounting for a share of around 80%^(*) of the country's total electricity generation in 2007. The Porce III Hydroelectric Power Plant will become one of Colombia's major power sources and will contribute to power system stability in that country.

(*) Source: *Hydropower & Dams World Atlas*, 2009

Completion of Thermal Power Online Data Management System for Kyushu Electric Power Company, Inc.

A thermal power online data management system delivered by Toshiba to Kyushu Electric Power Company, Inc. entered service in March 2009.

This system networks 51 thermal power plants together including geothermal power plants and internal combustion power plants. Individual systems were previously utilized for each power plant, and the new online system integrates those individual systems into a host computer system to make data management available on an enterprise level. This integration improves the usability of the system and contributes to reductions in the cost of operation and maintenance.

The system gathers and archives operating data, performance data, data on the conditions of facilities, and other information of all power plants in the network. Management of plant operations, performance/deterioration assessments, and engineering for operation and maintenance based on the accumulated data and their analysis are thereby centralized in the headquarters of Kyushu Electric Power Company. This system can gather more than 2 million process data in real time and archive all data for secure storage. The data are secured, archived for long-term storage, and can be quickly retrieved thanks to our original data compression and data retrieval methods.

The system is operating efficiently and satisfying the customer's requirements.



Thermal power online data management system of Kyushu Electric Power Company, Inc.

Bulb Turbine Generators for Qingshuitang and Cuijiaying Hydropower Stations in China Put into Commercial Operation



Runner for Cuijiaying Hydropower Station, China

The bulb turbine generators at the Qingshuitang and Cuijiaying Hydropower Stations in China have commenced commercial operation as follows:

- Bulb turbine generators at Qingshuitang Hydropower Station

These machines provide the maximum output among bulb turbine generators of large diameter and ultra-low speed manufactured by Toshiba Hydro Power (Hangzhou) Co., Ltd. (THPC), with a runner outside diameter of 7.5 m. Operation of the first unit began in April 2009, and all units are now operating.

Output: 32.83 MW Revolution speed: 62.5 min⁻¹
 Net head: 9.5 m Number of units: Four

- Bulb turbine generators at Cuijiaying Hydropower Station

These large-diameter, low-speed machines, also manufactured by THPC, have a runner outside diameter of 6.91 m. The first unit started operation in November 2009.

Output: 15.432 MW Revolution speed: 71.4 min⁻¹
 Net head: 4.7 m Number of units: Six

Construction of CO₂ Capture Pilot Plant Completed



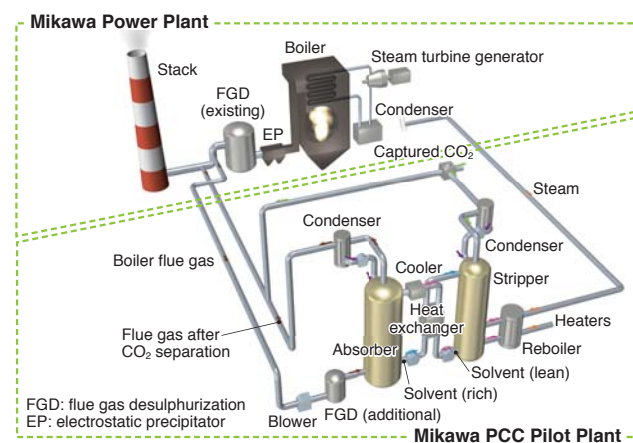
PCC pilot plant at Mikawa Power Station

Toshiba has recently completed its construction of a carbon dioxide (CO₂) capture pilot plant situated within Sigma Power Ariake Co., Ltd.'s Mikawa Power Plant. Engineering work for the plant started in October 2008, construction began in March 2009, and the work was completed in September of the same year after commissioning operation.

The objective of the pilot plant is to validate post-combustion capture (PCC) technology that we have continued to research and develop. Part of the flue gas generated by the Mikawa Power Plant, a coal-fired thermal power generation facility, is extracted and fed to the pilot plant. The flue gas comes into contact with an absorption solvent in an absorber tower, where the solvent selectively captures CO₂. The solvent is then fed to a stripper tower where the CO₂ is released. Through this continuous process, the plant captures 10 tons/day of CO₂ from the flue gas.

The absorption solvent developed by us has the characteristic of capturing CO₂ with comparatively low energy input. Through the pilot plant test, the performance of this solvent system was verified under the condition of using the actual live flue gas of a coal-fired plant.

It is anticipated that CO₂ capture technology will play a vital role in meeting global targets to reduce CO₂ emissions by more than 50% by 2050. This pilot plant will further enhance our activities toward commercialization of this technology through verification of its applicability, operability, reliability, and efficiency.



System configuration of PCC pilot plant