Basic Technology Subjects

Environmental Science Research Laboratory

Brief Overview

The Environmental Science Research Laboratory has promoted basic research on atmospheric, river, coastal, and marine environments, as well as on biology, chemistry, and biotechnology, with an aim toward the construction and stable operation of electric power facilities, the establishment of a low-carbon society, and a reduction in the various environmental risks associated with the electric power industry.

Achievements by Research Theme

Atmospheric and Marine Environment

The target of research in this field is to develop technologies for predicting and assessing atmospheric and marine environments in order to deal with the problems of global warming and air pollution in urban areas.

- The concentration of photochemical oxidants is increasing across Japan, and the causes should be clarified. We have clarified the contributions of the pollutants emitted in Japan and overseas to the atmospheric ozone, a major photochemical oxidant, by model analysis (V11053).
- A computational model that can simulate thermal environments and wind distribution in urban areas was developed to support the design of energy-efficient cities. The applicability of the model was confirmed through a comparison between simulation results and the results of field observations in a real urban area (V11016).

River and Coastal Environment

The target of research in this field is to develop technologies for investigating, predicting, and assessing river environments associated with hydraulic power stations, as well as coastal environments near thermal and nuclear power stations, in order to solve the environmental problems related with their operation.

- The factors causing the sedimentation of reservoirs with different sizes and locations were determined to support the maintenance and management of hydroelectric dams. We also developed a method of estimating the sedimentation rate of dam reservoirs using satellite data (V11039).
- The erosion and sedimentation of nearshore sand would affect the cooling water intake and discharge facilities of coastal power stations. We developed a cost-effective and nearly maintenance-free video system that can monitor the change of coastlines and demonstrated its applicability to the coastal areas in front of power stations (V11040).

Biological Environment

In order to reduce the labor required to maintain power stations and to contribute to environmental measures, our research aims to develop methods for preventing electrical accidents caused by biofouling organisms, birds, and mammals, as well as for assessing the environmental impact of power stations on ecosystems.

- To support the stable operation of maritime power stations, we have developed techniques using genetic information and ultrasound to quantitatively detect any abundance of jellyfish or larvae of sessile organisms, such as barnacles, which can enter the channels of maritime power stations and reduce water intake (V11031) (V11012).
- To assess the coastal environment affected by sand discharge from hydroelectric dams, the effect of suspended materials on the survival of fish or the growth of seaweed was clarified (V03) (V11020).

Environmental Risk Assessment

Our aim is to develop technologies for assessing and managing environmental risks due to chemicals and electromagnetic fields as well as for measuring the quality of process effluents and utilizing wastes for recycling, in order to support environmental risk management in the electric power industry.

- A selenium monitor, which can automatically measure the concentration of selenium in process effluents, was developed to manage selenium in desulfurization wastewater from coal-fired power stations. The applicability of the selenium monitor was demonstrated in actual coal-fired power stations (V11044) (Fig. 1).

■The effect of exposure to magnetic fields was experimentally assessed using rats and animal cells including human cells. It was clarified that neither carcinogenic genotoxicity nor the developmental toxicity in the preimplantation and organogenesis stages occurred in intermediate-frequency magnetic fields generated from home appliances (V04).

Biotechnology

The target of research is to develop technologies that use micro-organisms to reduce and recycle wastes and to treat drainage water, as along with technologies that use plants to create an energy-efficient environment and that utilize renewable energy.

■Cost reduction is required for the treatment of selenium-containing water discharged from coal-fired power stations. Using actual drainage water, the research team demonstrated at the laboratory scale that a biological selenium treatment method developed by the laboratory, which is more cost-effective than conventional methods, is useful for treating drainage water (V11059).

■A practical mercury immunoassay was developed by combining a simple pretreatment method for samples and microbiosensors to appropriately control the release of mercury (V11045).

■The adjustment of the conditions of a thermal and air environment using heat pumps within agricultural factories growing plants was investigated as a means of saving energy at such facilities using heat pumps. We also proposed a technique for analyzing the air flow and temperature distribution (V11017) (V11018).

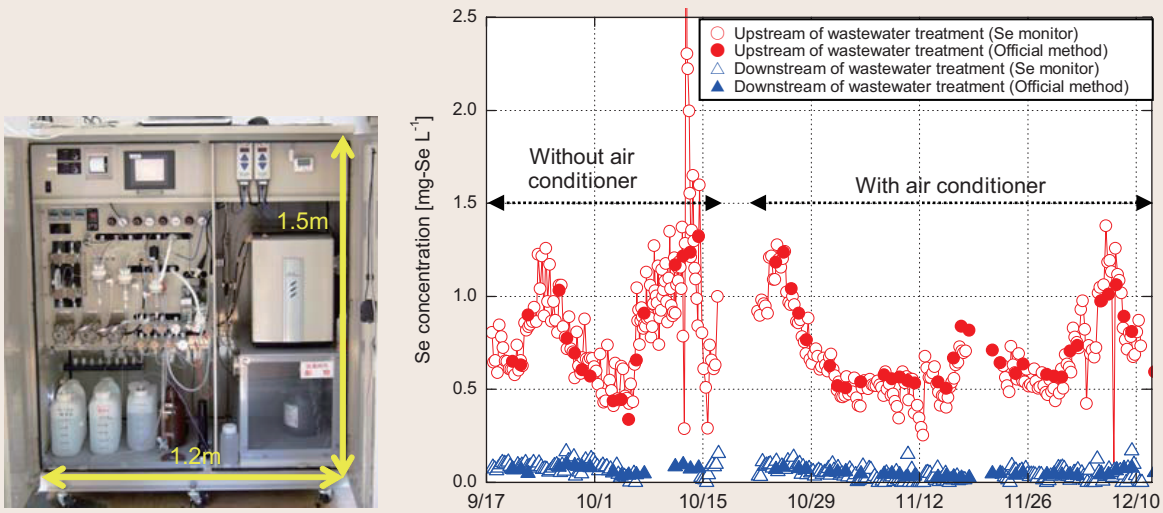

Fig. 1: Developed selenium monitor and the monitoring results of treated desulfurization wastewater at coal-fired power stations

The developed monitor (left figure) measures the concentration of selenium in process effluents using a commercially available gas sensor by reducing aqueous selenium in the sample into hydrogen selenide. Hence, the monitor enables measurement within a shorter time than that required by the official Japanese method and also enables automatic continuous measurement. The demonstration test was carried out on treated desulfurization wastewater at a coal-fired power station over three months (right figure). The fluctuations in the measured values with the monitor (○ and △) between September 17 and October 21, 2011 were attributable to changes in the room temperature between day and night. After an air conditioner was installed in the measurement room, the measured values were stabilized and were in good agreement with those obtained by the official method (● and ▲).