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 biology, chemistry, and biotechnology, for the construction and stable operation of electric power facilities, establishment of a low-carbon society, and reduction of various environmental risks associated with the electric power industry.

Achievements by Research Theme

Atmospheric and Marine Environment

Research objectives are to develop technologies for predicting and assessing atmospheric and marine environments in order to deal with problems, such as air pollution associated with thermal, geothermal, and nuclear power plants and the marine dispersion of radioactive materials.

- A wind tunnel experimental technique that can reproduce a stable thermally stratified boundary layer was developed to clarify the effects of surrounding buildings and atmospheric stability on the gas dispersion from power plants. An experiment on gas discharged from the vicinity of a reactor building using the developed technique clarified that the effect of atmospheric stability on gas concentration at the ground surface is small.
- A model that reproduces the formation of the low-temperature, low-salinity North Pacific Intermediate Water was developed to assess the marine dispersion of radioactive materials. This model enables the accurate assessment of the vertical movement of radioactive materials and thus the accurate simulation of their dispersion in surface layers (V13009).

River and Coastal Environment

Research objectives are to develop technologies for monitoring, predicting, and assessing hydrospheric environments in order to solve related environmental problems. Hydrospheric environments include rivers and reservoirs affected by hydroelectric plants, as well as environments near coastal power plants, such as thermal and nuclear power plants.

- A ground 3D laser scanner, photogrammetry technique, and a drone helicopter were combined into a tool for the comprehensive assessment of river environments that can be used for updating water rights and supporting sediment throwing in hydropower dams. This research provides insight into the development of a method for visualizing the complicated river-channel topography of mountain streams.
- The operation of a PC simulation program was developed for a quick estimation of the dispersion area of submerged thermal discharges from coastal power plants. A graphical user interface (GUI) was applied to help users set conditions for a simple model simulation and display its results. A manual for the simulation program was also prepared to encourage relevant electric utilities.

Biological Environment

Research objectives are to develop technologies to address problems related to biofouling and jellyfish, as well as to prevent accidents at power facilities caused by birds and animals, and thus contribute to realizing a stable power supply and rationalization of maintenance. The effects of commercial and intermediate-frequency electromagnetic fields on health were also examined to promote general public understanding.

- An automated jellyfish monitoring system was developed to ultrasonically quantitatively evaluate jellyfish patches arriving at coastal power plants. The system can detect jellyfish patches to depths of up to 50 m. Efficient operation of countermeasure equipment such as rotary screens can be expected by installing the system in the coastal area in front of power plants.
- Due to the lack of relevant biological studies to date, the possible health risks of 20 kHz, intermediate frequency, magnetic field generated from home appliances were investigated. Exposure to a 20 kHz magnetic field exerted no changes in the hematology and histopathology of rats. Together with previous rat studies on 60 kHz magnetic fields, the obtained results did not indicate toxicity of the intermediate frequency magnetic fields under experimental conditions examined (V13010).

Bioengineering

Research objectives are to develop technologies related to the economic treatment of transformers contaminated with trace polychlorinated biphenyl (PCB) and the advanced utilization of unused carbon resources, as well as energy-saving technologies for customers in the agricultural sector.

- The circulative and energizing cleaning techniques, both under development, were attested as

decontamination techniques for PCB-contaminated transformers by the Ministry of Environment (Government of Japan). Guidelines on circulative cleaning techniques were published by the Ministry leading to the realization of guideline-based decontamination facilities for contaminated transformers.

- The use of Jatropha oil in diesel engines for power generation is being examined. A mixture of Jatropha and diesel oil less than 1:4 exhibited engine suitability (in terms of fuel consumption and exhaust gas properties, for example) comparable to that of light oil (V13011).
- The power-generating potential of biogas produced by methane fermentation was assessed on the basis of the amount of high-water-content waste biomass such as sewage and sludge from livestock generated in Japan. Sites that can generate power exceeding 1,000 kW (above which power generation is possible on a commercial scale) were estimated to be approx. 60 sewage treatment facilities and approx. 130 animal excrement treatment facilities (V13012).

Environmental Chemistry

Research objectives are to develop technologies for the effective use of coal fly ash and desulfurization gypsum generated at power plants, as well as cost-effective technologies for the management and treatment of trace elements in wastewater from power plants, in order to support the high-performance and stable operation of coal-fired power plants.

- A method for quickly assessing the elution of fluorine was developed to streamline the quality control of desulfurization gypsum. In this method, a wet ball mill is used, which greatly shortens the elution process that previously required a considerable amount of time through optimization of operations (V13014, V13015).
- An X-ray fluorescence analysis of simultaneously quantifying the Se, As, and Cr concentrations in coal fly ash in 1 h was developed to promote the effective utilization of coal fly ash. Compared with the conventional wet analysis method, the developed method requires neither complicated pretreatment nor advanced analytical expertise and can reduce the measurement time to 1/15. Hence, it is effective for the onsite quality control of coal fly ash in power plants (Fig. 1) (V13023).

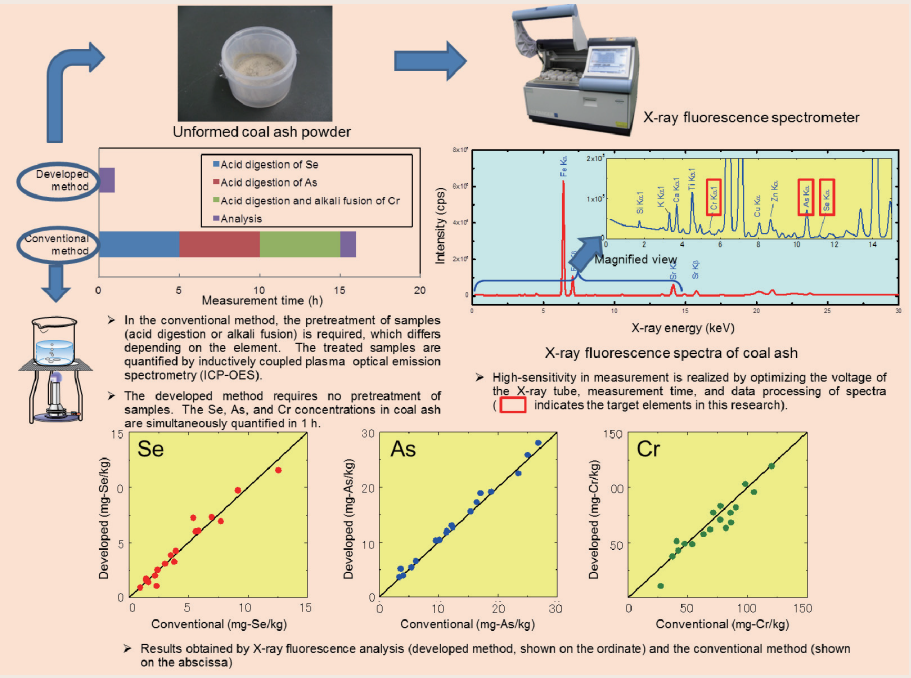

Fig. 1: Simple and rapid quantification of Se, As, and Cr concentrations in coal ash

The accuracy of the developed method was examined using 18 types of ash obtained from existing power plants. Results obtained by this method were practically equal to those obtained by the conventional wet analysis method. In this method, the effect of interfering components is minimized by data processing of spectra and the measurement time is optimized, thus achieving a simple and rapid analysis. The method can be used for the onsite quality control and selection of coal ash in power plants.