Physical and Chemical Applications

Objective

To increase socioeconomic benefits in key sectors of Member States through the application of radioisotopes and radiation technology for producing goods and services which result in improved health care and industrial performance as well as effective quality control services.

Radioisotope Production and Radiopharmaceutical Development

One of the major goals of the Agency is to support Member States in the development of technologies for the local production and use of radioisotopes. In this regard, coordinated research commenced on the technology for the production of yttrium-90 and rhenium-188 for therapeutic use.

Immunoassays that are primarily used for clinical applications are also useful in other fields, such as livestock management, industrial hygiene, environmental surveillance, drug research and forensic applications. A CRP on the development of radioimmunoassays for non-clinical applications was completed during the year, which resulted in the development of three assay procedures. In order to aid livestock management, an immunoassay method was developed for the measurement of progesterone in milk samples. A method to measure aflatoxin B1 in food extracts was developed for monitoring contamination in food products. And an assay was developed to measure atrazine in environmental samples in support of environmental surveillance activities.

Nuclear and Radioanalytical Techniques

The detection, identification and removal of abandoned land mines remain a major challenge, and no new technology has been effectively deployed in the field to complement or replace metal detectors and manual prodding. As a result, clearing operations remain time consuming, costly and dangerous. In the framework of a recently completed CRP on the application of nuclear techniques to anti-personnel land mine identification, 13 research groups from 11 countries published their research results in a special issue of the international journal *Applied Research and Isotopes*. One of the conclusions was that although individual sensors show promise, no single sensor operating alone appears able to reliably detect and identify land mines. Consultants recommended additional research efforts to determine how different sensors may be combined to enhance the ability to detect and characterize the wide variety of land mines found in the field. A new CRP on this subject is being formulated.

A new CRP on the applications of nuclear analytical techniques for the identification of art objects was initiated. The aim of this CRP is to demonstrate the utility of nuclear analytical techniques in establishing the authenticity of objects in the fields of art and archaeology for cultural heritage investigations and protection.

An expert group was commissioned to prepare a report on the role of nuclear analytical techniques in forensic investigations and the use of these techniques to meet the requirements of law enforcement agencies. Case studies and guidance on the appropriate handling of samples for police investigations will be included in the report.

The Agency continued to receive numerous requests for the training and certification of personnel in non-destructive testing (NDT) techniques. More than 40 scientists participated in Agency training courses in different regions. In addition, an 'NDT society' for AFRA countries was established with the support of the Agency.

Radiation Processing Technology and Applications

Advances were made in the development of new materials using radiolytic methods through a CRP on the radiation synthesis of stimuli responsive membranes, hydrogels and adsorbents for separation purposes. One particular hydrogel that was developed could ensure high efficiency in the removal of zinc, cadmium, cobalt and lead from wastewater. Other sorbents developed in this CRP can be applied for the purification of wastewater for recycling, as well as for the recovery of valuable metals used in electronics and other industries. Sorbents for the investigation of uranium recovery from sea water were also demonstrated. The research generated several proposals for technical cooperation

FIG. 1. Pilot plant for electron beam flue gas treatment at the Maritsa East 2 thermal power plant in Bulgaria.

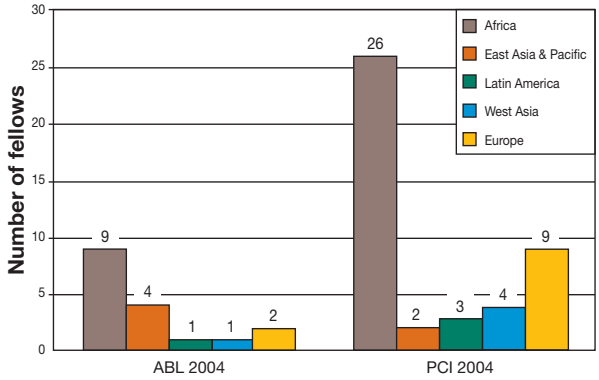

FIG. 2. Number of fellows receiving training in 2004 at the Agency's Laboratories at Seibersdorf, by geographical region (ABL: Agriculture and Biotechnology Laboratory; PCI: Physics, Chemistry and Instrumentation Laboratory).

projects from Member States affected by wastewater contamination problems. Field testing of the newly developed materials is foreseen as the next step.

Radiation treatment, or a combination of radiation technology with conventional biological–chemical–physical processes, can help in the remediation of contaminated surface water and in combating air pollution. In this connection, construction of an industrial scale plant commenced in the Republic of Korea following the successful operation of a pilot plant for wastewater treatment in a dye complex. With regard to atmospheric pollution, the Agency provided support for operation of a pilot plant in Bulgaria for the purification of flue gases from the combustion of high sulphur lignite (Fig. 1). Removal efficiencies of 95% for oxides of sulphur and 80% for oxides of nitrogen were recorded, illustrating the potential of this technology in treating different low grade fossil fuels. The fact that fertilizer is a by-product of the process makes it a particularly attractive technology.

Applications of Industrial Radiotracers

A new CRP was initiated on the use of radioisotopes as tracers to monitor processes for enhancing oil recovery and optimizing geothermal reservoir operation for power production. In the same area, research produced several case studies where radiotracer techniques could be used as a tool for the validation of computational fluid dynamics (CFD) models. The CRP led to the development of an educational software package providing guidance on the basic principles and applications of CFD and residence time distribution technologies.

The Agency's Laboratories at Seibersdorf

Activities at the Agency's Laboratories at Seibersdorf emphasize quality assurance procedures meant to improve confidence in the use of transferred technologies as well as to provide reliance on data generated by national and regional laboratories. The focus is on promoting techniques that contribute to environmental monitoring and

FIG. 3. The microparticle manipulation system assembled at the Agency's Laboratories at Seibersdorf.

assessment for sustainable development, with a strong emphasis on quality management leading to accreditation. The Laboratories also support the scientific and technical programmes of the Agency by providing experimental facilities and services. For example, the Safeguards Analytical Laboratory (SAL) conducts sample analysis for the Agency's safeguards verification programme. In 2004, SAL's Clean Laboratory analysed 620 environmental safeguards samples.

An important mission of the Seibersdorf Laboratories is to train scientists from developing countries in the use of nuclear techniques and technologies. In 2004, the Agency hosted 61 scientific fellows for training in the various laboratories at Seibersdorf (Fig. 2).

A low-cost microparticle manipulation system was assembled and tested at the Agency's Laboratories at Seibersdorf. The system is based on a stereo microscope and operates in a single step, 'touch and go' mode (Fig. 3). When combined with analytical techniques such as X ray fluorescence or X ray tomography, it can be used for the characterization of individual microparticles and other microscopic objects.