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 processes.

Radioisotopes and Radiopharmaceuticals

Self-reliance in the production and use of radioisotope products is a major interest for many Member States. In this regard, Bangladesh received support in the establishment of a new, larger facility for the production of technetium-99m generators used for diagnostic imaging procedures. In the Latin America region, the protocols for the production, quality control (QC) and validation of some radiopharmaceuticals based on monoclonal antibodies and peptides were developed and adopted by Member States.

A CRP on the development of radioactive sources for the treatment of prostate and eye cancer, and for the development of portable radiation sources for radiographic monitoring, stimulated collaborative research for the production and QC of small sealed sources. The participants in the CRP developed or improved new methods of production, testing, QC methods and encapsulation technology for a variety of sealed sources for applications in medicine and industry.

At an international symposium on trends in radiopharmaceuticals, held in Vienna in November, developments in the design, production, evaluation and application of radiopharmaceuticals were reviewed. The symposium highlighted the continuing relevance of advances in the chemistry and pharmacology of technetium-99m radiopharmaceuticals for diagnostic imaging. Furthermore, it underlined the need for continued support to Member States in strengthening the local production and utilization of emerging therapeutic radiopharmaceuticals, and for medical cyclotron facilities for producing and using fluorine-18 labelled compounds. It also stressed the need for diversified radiopharmaceutical production facilities for greater availability worldwide.

Nuclear and Radioanalytical Techniques

Recognizing the problem posed by declining training opportunities in radiochemistry, the Agency initiated the development of modular distance learning tools for university and research students. A module on radiochemical separations was developed in cooperation with the Institute of Applied Sciences and Technologies in Havana, Cuba. The exercise was evaluated by an expert group, which will help develop other similar modules for further distribution to Member States.

A CRP on new applications of prompt gamma neutron activation analysis (PGNAA) was completed in 2005. The CRP demonstrated the suitability of PGNAA for: the analysis of long lived radioisotopes in nuclear waste; investigating fatigue in batteries; the analysis of mineral deposits from the ocean floor; estimation of major elements in cement; and multi-element analysis of archaeological materials.

The Agency convened a meeting on the use of neutron generators for the detection of explosives and illicit materials to review the successes and limitations of existing technologies and to identify developmental areas in which significant advances could be made. As a result, a CRP was initiated for further research in this area, which will also serve to promote awareness in Member States of nuclear methods and the use of small neutron sources for the detection of bulk explosive materials.

The analysis of heavy metals in bulk and large samples remains a challenge in the field of analytical sciences. An expert group was convened to review current experience and the suitability of small and low flux irradiation facilities for the neutron activation analysis of large samples (i.e. greater than 10 g). This technique could provide additional advantages for the analysis of precious objects in art and archaeology, high purity materials (silicon wafers, high purity metals and alloys), non-homogeneous materials (municipal waste and electronic waste), and for in vivo applications (whole body calcium, kidney cadmium, etc.).

Strengthening and developing gamma radiography techniques as a tool for non-destructive testing (NDT) is important for improving industrial safety and reliability of performance. A CRP on 'Corrosion and Deposit Determination in Large Diameter Pipes with and without Insulation by

Radiography Testing' was completed. Procedures for setting the correct exposure conditions, radiation source and exposure geometry were developed. Periodic testing using this technique enables end-users to predict pipe lifetime, thus saving on maintenance costs as a result of shorter inspection and exchange periods. Written procedures and practical guidelines developed through this CRP will be submitted for review by the International Organization for Standardization (ISO).

Non-destructive testing is important for the quality assurance (QA) of manufactured products and for in-service inspections. Approximately 80 national training courses in five major NDT methods were conducted by Member States in 2005, with a total of over 2000 persons being trained and 1600 being certified. Through earlier technical cooperation projects, many RCA Member States have established the necessary infrastructure for providing NDT services and for conducting training programmes. In this connection, Bangladesh, China, India, Malaysia, Pakistan, the Philippines, Thailand and Vietnam have implemented national qualification and certification schemes for NDT personnel based on ISO 9712.

As a result of the increased application throughout Africa of NDT techniques in industrial QC, the training, qualification and certification of personnel have assumed greater importance. Under a regional AFRA project, the Agency assisted several Member States in strengthening their national capability for providing training in NDT methods and techniques; and in establishing competent authorities for certification/accreditation and for promoting market opportunities for NDT applications.

An example of the expanded use of NDT techniques in Africa is the United Republic of Tanzania, which has increased its use of NDT in the transport of petroleum products. The Agency assisted the Tanzania Industrial Research and Development Organization (TIRDO) in establishing a quality certification scheme. As a result, TIRDO now has the capability to compete with foreign companies in NDT activities related to the inspection of engineering components.

Applications of Industrial Radiotracers

As a result of Agency sponsored research, a new software package for radiotracer data analysis was developed by the Czech Technical University

FIG. 1. Radiotracer injection at an offshore oil platform in Vietnam.

to obtain more reliable results from experimental data. A computer controlled, single source–single detector system for on-line measurement and image reconstruction software was developed by a group from the Republic of Korea participating in a CRP on industrial process gamma tomography. To improve interpretation capabilities, a new version of a software package for the modelling and analysis of oilfield interwell tracer test data was developed by a group from Argentina participating in a CRP on the validation of tracers and software for interwell investigations. In Vietnam, technology for the application of the multi-tracer technique for interwell communication studies in offshore oil fields was established through a national technical cooperation project and is now in service in the oil fields (Fig. 1).

Radiation Processing Technology and Applications

Radiation treatment has been shown to be effective in converting some pollutants into harmless end products. In this regard, a CRP was launched with the objective of developing reliable analytical methods for the investigation of radiation degradation of volatile organic compounds in their gaseous phase. The research will also focus on

the feasibility of the radiation aided destruction of certain pollutants in exhaust gases from power generation plants, chemical and metallurgical industries, and municipal waste incinerators.

The treatment of municipal and industrial wastewater is an important part of environmental engineering, and electron beam treatment is a comparatively new method for wastewater purification. For example, in the Republic of Korea, wastewater discharge from the Daegu Dye Industry Complex (DDIC) is more than 80 000 m^3. In December 2005, a high power accelerator and wastewater treatment system was installed at DDIC. This system treats up to 10 000 m^3 of textile dyeing wastewater and has shown positive results for the removal of non-degradable organic impurities. The project was supported by the Government of the Republic of Korea, the City of Daegu and the Agency. DDIC is planning to install several more plants to treat its total wastewater output with electron accelerator plants.

Under a regional technical cooperation project, the radiation processing of indigenous natural polymers such as alginates (seaweed extracts) and chitosans was achieved. Hydrogel wound dressings based on these complex carbohydrates have already been put into commercial production in China, India, Japan and Malaysia.

Assisting Quality Assurance in Member State Laboratories

The Agency organizes proficiency tests for laboratories from Member States to assist in evaluating their analytical performance. It also provides analytical QC services and produces and distributes reference materials. Three proficiency tests on the analysis of radionuclides and trace elements were conducted, and 68 Member States were provided with a total of 850 units of matrix reference materials. ■