Radioisotope Production and Radiation Technology

Objective

To contribute to improved health care, better industrial performance as well as effective quality control processes and a cleaner environment, by supporting technology to strengthen national capability in Member States for producing radioisotope products and applying/adapting radiation technologies for socioeconomic benefits.

Radiation Processing Technology

Industrial, agricultural and domestic pollution threatens the limited supplies of water in many parts of the world. Electron beam processing, which destroys organic compounds as well as certain dyes and pesticides, and which is effective in reducing a number of microorganisms, offers great promise as a cost effective treatment process. In a CRP completed in 2006 on the remediation of polluted water and wastewater by radiation processing, the utility of radiation processing techniques was demonstrated and models were developed to describe the removal of organic compounds (Fig. 1). The results have helped to guide analytical methodology and the economic evaluation of radiation processing.

The technique of radiation induced controlled degradation of polymers is already in use for the degradation of such materials as cellulose, polypropylene and rubber so that these materials can be reused in other industrial processes. A CRP that ended in 2006 on controlling degradation effects in the radiation processing of polymers provided further information on the importance and potential of radiation processing techniques in a wide range of industrial applications. The research showed that the irradiation of certain marine based polymers and other natural polymers, such as cellulose, resulted in a substantial decrease in molecular weight, leading to degraded products with improved properties that could be used in the manufacture of healthcare products such as hydrogel wound dressing, ingredients for cosmetics, plant growth promoters, soil conditioners, and viscosity modifiers in the food and textile industries. In Vietnam, degradation products were tested in the field for the prevention of infection by a pathogenic fungus for rice plants in the tropics.

Industrial Applications of Computed Tomography and Radiotracers

Computed tomography (CT) is a tool for the design, optimization and fault-finding of industrial process systems in the chemical and food industries, among others. A CRP on industrial process gamma tomography that was completed in 2006 focused on developing and enhancing the use of this technique in a range of applications. Hardware for CT and software for image reconstruction were developed, including portable gamma CT systems for use in industrial environments, designed in the Republic of Korea, Malaysia and Mexico. More advanced gamma CT systems were developed in Brazil, France, Norway and the USA (Fig. 2). Some of these are already being used in industry and in research, helping to refine industrial processes for better resource utilization and greater industrial safety.

The use of radiotracers in investigations of industrial process vessels helps to reliably assess the efficiency of their performance and the possibility

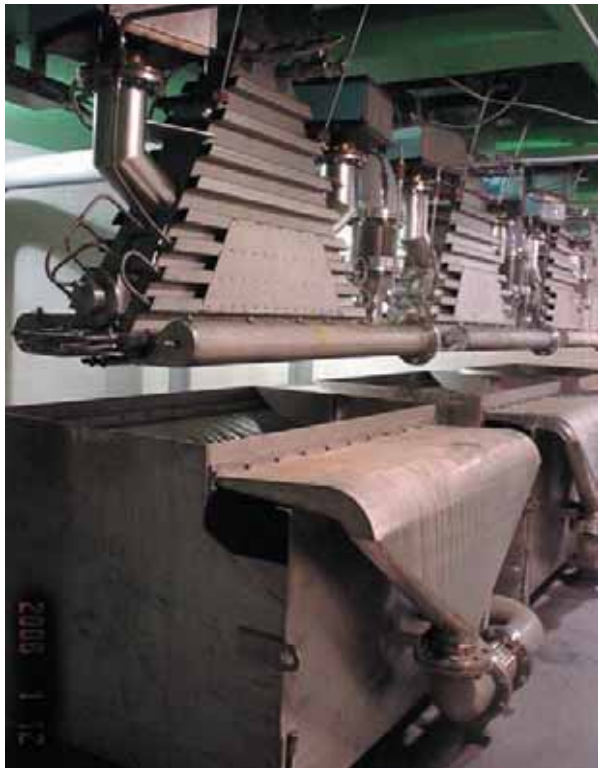

FIG. 1. The first industrial scale electron beam wastewater treatment plant in operation in the Republic of Korea.

FIG. 2. A single photon emission computed tomography system in a French nuclear power plant. The system, installed around the primary circuit of a PWR, improves the estimation of nuclear thermal power in correlation with nitrogen-16 activity produced from oxygen-16 in water.

of any malfunctions. In this regard, the chemical reactors for the production of phosphoric acid in a Tunisian phosphate facility were investigated using an iodine-131 radiotracer as the producer faced problems with the reaction vessels and experienced deterioration in the quality and quantity of the final products. The Agency provided assistance in carrying out tracer tests, which yielded important information on the optimization of the reaction vessels. These vessels were subsequently modified during the shutdown phase.

Radioisotopes and Radiopharmaceuticals in Medicine

Radioisotopes produced with a cyclotron and the radiopharmaceuticals derived from them are extremely valuable in medical applications. Short lived radioisotopes with yields higher than those that are currently available are often required in order to ensure efficient and extensive distribution. A new CRP was therefore started in 2006 to address the need for improving the cyclotron production of radioisotopes, aiming to reliably produce higher yield and higher specific radioactivity for fluorine-18 and carbon-11, which are widely used as positron emission tomography radiotracers for clinical applications.

A CRP completed in 2006 on the comparative evaluation of therapeutic radiopharmaceuticals stimulated collaborative research involving 15 Member State institutions on therapeutic radiopharmaceuticals. The research was successful in establishing several analytical techniques, biological assays, animal tumour models and protocols for the evaluation of such radiopharmaceuticals. In addition, a reliable protocol for the preparation and evaluation of a lutetium-177 labelled peptide for cancer therapy was also developed.

Another CRP focused on the development of technetium-99m (^{99m}Tc) based small biomolecules using novel ^{99m}Tc cores. Researchers developed labelling techniques for the preparation of new technetium complexes with potential application as radiopharmaceuticals. A notable development was the synthesis of a product capable of indicating cancer conditions. Further investigations of this compound will help in the development of a novel radiopharmaceutical for imaging cancer.

Assisting Member States in building capacity for radiopharmaceutical production is a key area of the Agency's technical cooperation programme. In this connection, support was provided to upgrade radiopharmaceutical production standards for radioactive products through training, and some countries were supported in setting up cyclotron PET radiopharmaceutical production, for example at the Chulabhorn Research Institute in Thailand.

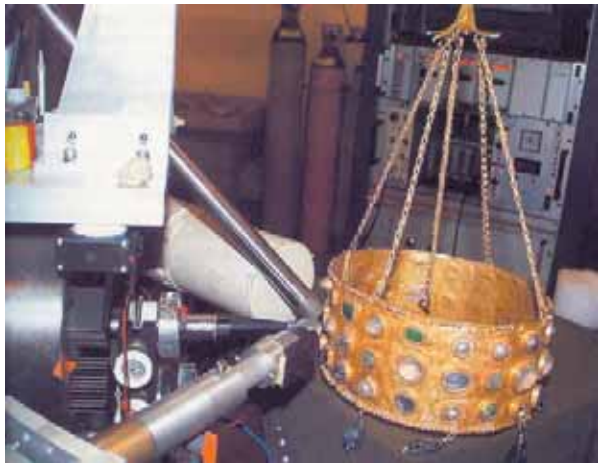

FIG. 3. Analysis using nuclear techniques of a visigothic gold crown in the Louvre, Paris.

Novel Applications of Nuclear Analytical Techniques

Nuclear techniques can help to identify fraud, establish the provenance of and, in some cases, determine the age of artefacts (Fig. 3). Research was carried out on the non-destructive applications of nuclear techniques for the conservation, preservation and investigation of art and cultural heritage objects (for more details of Agency activities in this area, see the chapter 'Issues and Events in 2006' at the beginning of this report). ■