Radioisotope Production and Radiation Technology

Objective

To strengthen national capabilities for producing radioisotope products and utilizing radiation technology, and contribute to improved health care and safe and clean industrial development in Member States.

Radioisotopes and Radiopharmaceuticals

The Agency continued to strengthen its efforts to promote the development and availability of radiopharmaceuticals for diagnostic and therapeutic applications in Member States. A CRP entitled 'Development of Fluorine-18 (^{18}F) Labelled Radiopharmaceuticals for Use in Oncology and Neurosciences' led to the development of new ^{18}F radiopharmaceuticals. Fourteen Member States worked over a period of three years on eight radiopharmaceuticals of high value in tumour characterization and developed detailed protocols for their synthesis and quality control. The CRP facilitated the introduction of these radiopharmaceuticals in Member State institutions, as well as preparing guidelines and documentation on their production and use in nuclear medicine and diagnosis.

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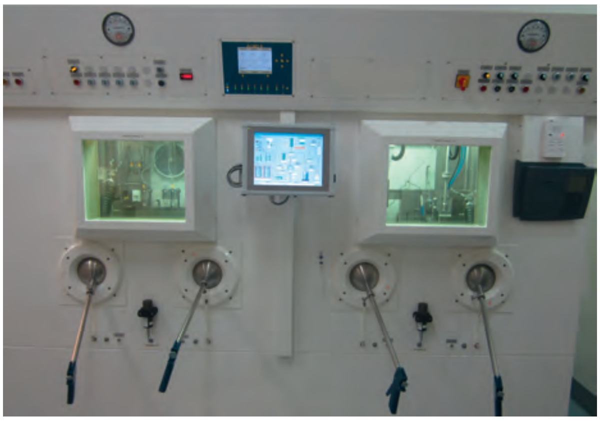
In the area of capacity building, the Agency assisted Member States in the local production of radiopharmaceuticals. For example, the first technetium-99m (^{99m}Tc) generator production facility in the Philippines was put into operation (Fig. 1). This facility has the capacity to produce 25–50 molybdenum-99/technetium-99m sterile generators per week. Local availability of this important medical isotope is expected to result in the wider use of ^{99m}Tc based radiopharmaceuticals.

Another example of capacity building was the inauguration of a cyclotron facility for positron emission tomography (PET) radiopharmaceutical production in the Radiopharmaceuticals Production and Research Centre of the University of Warsaw, in Poland (Fig. 2). The facility is capable of producing large amounts of ^{18}F labelled radiopharmaceuticals, as well as other PET radiopharmaceuticals, for diagnostic use.

Two publications in the IAEA Radioisotopes and Radiopharmaceuticals Series — *Cyclotron Produced Radionuclides: Guidance on Facility Design and Production of [F-18]Fluorodeoxyglucose (FDG)* and *Cyclotron Produced Radionuclides: Operation and Maintenance of Gas and Liquid Targets* — were issued. These manuals provide guidelines on the production of radiopharmaceuticals.

Radiation Technology Applications

Applications in radiation technology continue to increase as new radiation processing modalities are introduced and existing radiation technologies are enhanced. When applied under well defined



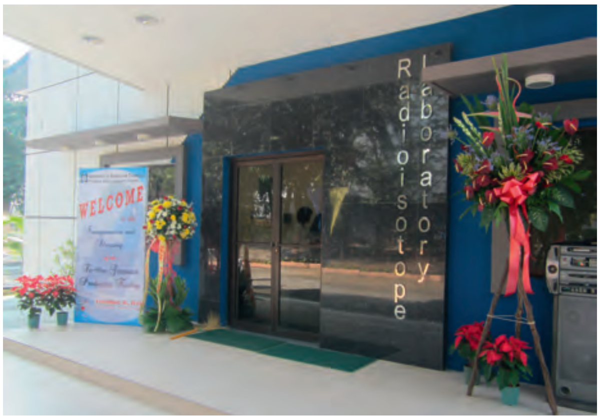


FIG. 1. The molybdenum-99/technetium-99m generator production facility in the Philippines.

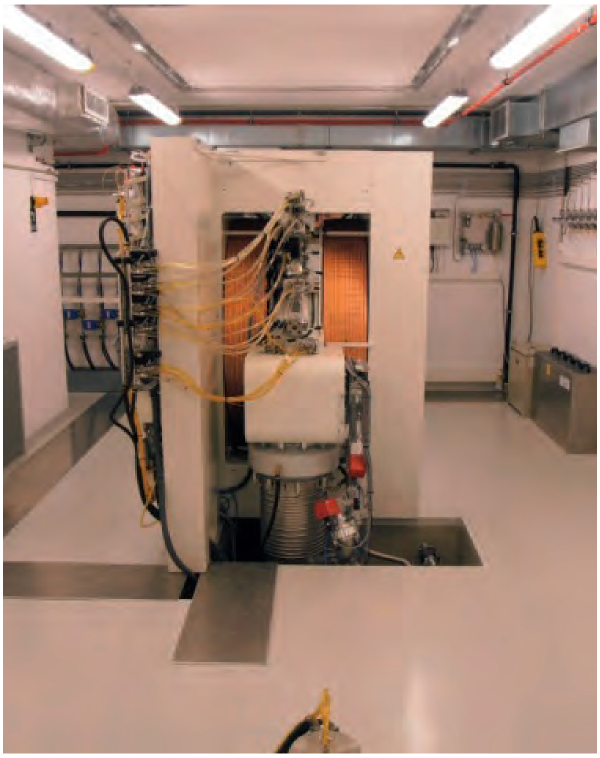


FIG. 2. The cyclotron facility for PET radiopharmaceutical production in Poland.

conditions, radiation degraded, low molecular weight alginate, carrageenan and chitosan — which are natural, non-toxic, non-polluting and biodegradable — can be used to promote plant growth, to protect against plant diseases, and as a natural antioxidant for the preservation of food and allied products. Using such products, instead of chemical fertilizers, yields significant environmental benefits.

A CRP on the 'Development of Radiation Processed Products of Natural Polymers for Applications in Agriculture, Health Care, Industry and Environment' was completed in 2012. Sixteen participating institutions developed guidelines to produce radiation degraded chitosan from shrimp/prawn and crab exoskeleton and squid pen. Research in Brazil showed that electron beam processing of sugarcane bagasse could be beneficial and economical for enhancing the enzymatic hydrolysis of cellulose when combined with thermal pre-treatment for the production of biofuel from non-food resources. Superabsorbents based on radiation cross-linked natural polymers developed under this CRP pointed to their suitability for producing transparent, flexible, mechanically strong, biocompatible, effective and economical hydrogel dressings. Certain other commodity products, such as tableware, heat shrinkable tubes and dummy lenses for eyeglasses were also developed from bio-based materials under this CRP.

Another CRP that concluded in 2012 aimed at using radiation techniques in creating biomaterials of enhanced specific functionalities, improved biocompatibility and minimal natural rejection, but with enhanced interfacial adhesion. Seventeen Member State institutions collaborated and developed methodologies for nanogel and nanoparticle synthesis, enabling precise control of the product structure, size and functionality. Products such as hydrogel–nanoparticle composites for anti-leishmania drug release and to treat 'dry eye' syndrome, a protective drug-eluting coating for medical implants, coatings with antimicrobial properties, biodegradable polymer/inorganic nanocomposites for bone fracture setting devices, amphiphilic chitosan nanoparticles for encapsulating anti-cancer drugs, and nanoparticles for sustained release of thymoquinone were among the results reported.

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Considerable R&D is being carried out in Bangladesh, Brazil, Canada, Egypt, India, Italy, Pakistan, Poland, Romania, Thailand, the United Kingdom and the USA to improve and develop new packaging materials and coatings for use in the food industry. In support of such efforts, a CRP on the 'Application of Radiation Technology in the Development of Advanced Packaging Materials for Food Products' was initiated in 2012. The CRP's objective is to develop new packaging materials based on natural and synthetic polymers using radiation techniques, and to assess the effects of ionizing radiation on commercial food packaging materials, especially for their use in pre-packaged foods intended for radiation processing. This research includes developing recyclable, biodegradable, bioactive and smart packaging and coatings.

Nuclear Malaysia, an IAEA Collaborating Centre, developed a radiation curable green nanocomposite coating, which is a solvent free formulation with essentially no emission of volatile organic compounds (Fig. 3). The coating is based on epoxidized palm oil acrylate. The cured coatings are non-toxic and transparent, with high mechanical and abrasion and scratch resistant properties.

A CRP that ended in 2012 focused on the application of neutron activation analysis (NAA) in the areas of archaeology and geology. Fifteen Member States studied NAA application in archaeology, as well as geology, food and nutrition, material science and waste characterization. Large sample NAA facilities are now operational in all participating Member States.

Multiphase flow systems are widely used in large industrial and environmental processes such as chemical and mineral processing, oil production, wastewater treatment, and sediment and solids transport. Optimized design and scale-up of multiphase flow systems are important in ensuring enhanced performance, economic viability and environmental acceptability. In 2012, a new CRP was initiated with the aim of developing and integrating nuclear methods for the investigation of multiphase flow systems for efficient management of industrial processes. The CRP includes 18 institutes from 17 Member States.

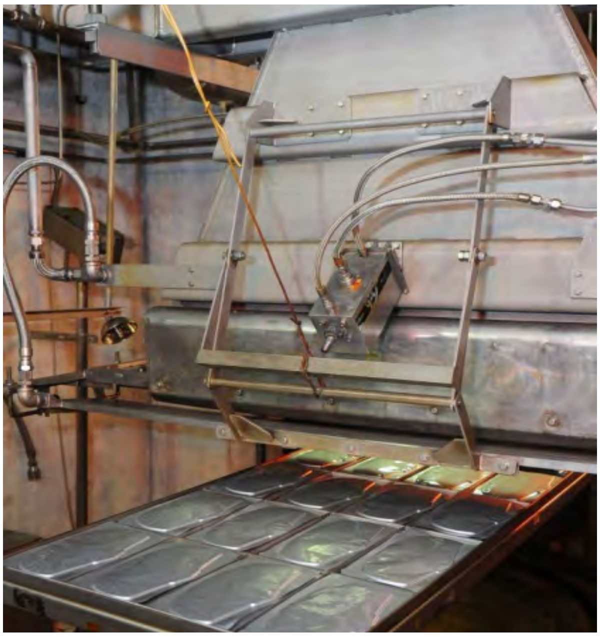

FIG. 3. Radiation processing (cross-linking and sterilization) of nanocomposite, bio-based hydrogels for biomedical applications at Nuclear Malaysia.