Radioisotope Production and Radiation Technology

Objective

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

Radioisotopes and Radiopharmaceuticals

There is a continuing increase in the demand for positron emitters for diagnostic studies in developing countries, in particular fluorine-18–fluorodeoxyglucose (FDG) for positron emission tomography (PET)/computed tomography (CT) studies in cancer patients.

To help Member States build and/or strengthen national capabilities, the Agency released in 2008 the first in a series of publications on cyclotron produced radionuclides that covers principles and practices (Technical Reports Series No. 465). The series is intended as a reference for practitioners and regulators, as well as for use in teaching and training of personnel for sustainable, effective and safe operations. In related work, the Agency convened a workshop on the establishment of a cyclotron radiopharmaceutical production facility and implementation of good manufacturing practices in Thailand as part of a regional technical cooperation project.

Responding to a growing demand for support in setting up cyclotron and PET radiopharmaceutical production facilities, the Agency has assisted more than 15 countries through technical cooperation projects. For example, in 2008 one project facilitated the establishment of a 16.5 MeV cyclotron in Belo Horizonte, Brazil, where FDG is being produced for cancer diagnosis. Another cyclotron is being installed in Recife, in north-eastern Brazil.

The application of radioisotopes for therapy in nuclear medicine is also growing, with increased use of beta emitting isotopes such as yttrium-90 and lutetium-177. The development of an automated module for the electrochemical separation of yttrium-90 from strontium-90, demonstrated through a recently concluded CRP, has been taken up by a company specializing in equipment for isotope processing. This will assist many Member States in having access to regular supplies of yttrium-90. The Agency's work in this area was recognized by experts in the field, including Professor H.N. Wagner, Jr., who said:

> "New $^{90}Sr/^{90}Y$ generators for radiotherapeutic applications, developed with funding by the International Atomic Energy Agency (IAEA) in association with investigators… are simple to operate and can be scaled up and automated. This type of collaborative and beneficial work is an example of what the IAEA continues to do for the field of nuclear medicine, particularly in developing countries." (*Journal of Nuclear Medicine*, August 2008, pp. 15N–34N.)

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In order to provide relevant updates on technetium-99m products, widely used in diagnostic imaging, the Agency published *Technetium-99m Radiopharmaceuticals: Manufacture of Kits* (Technical Reports Series No. 466). The publication details the preparation and testing of these kits and is intended as a reference for practitioners as well as for new entrants in this field.

Radiation Processing Technology

Volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs) are contaminants that are emitted in different — mostly combustion based — processes, for example, in the power, chemical and metallurgical industries, and as a result of municipal waste incineration. A CRP that ended in 2008 demonstrated that electron beam technology is a promising technique to decrease VOC and PAH concentrations in flue gases. The Agency, in cooperation with UNIDO, organized a training course for the European region to disseminate the technology for electron beam flue

FIG. 1. Injection of tritiated water (HTO) as a tracer for interwell study at an oilfield in Indonesia.

gas treatment (EBFGT). The training focused on conducting feasibility studies on EBFGT for coal fired boilers of the size most commonly used in this region.

To demonstrate the use of radiation aided synthesis, modification and characterization of advanced materials by nanoscale control of their properties, the Agency initiated a new CRP in 2008 focusing on potential biomedical applications of this technology. Specifically, this CRP will investigate the application of radiolytic methodologies for the synthesis of nanoparticles and nanoporous membranes. In related work, the Agency published three monographs on radiation processing techniques including *Trends in Radiation Sterilization of Health Care Products*, which details the status of recent developments and also provides comprehensive information on the practical aspects of radiation sterilization.

Industrial Applications of Radioisotopes

The interwell tracer technique is an important engineering tool for the efficient recovery of oil and is also used in geothermal reservoirs. Significant advances in research and field studies were made by 11 Member States through a CRP that ended in 2008, on the validation of tracers and software for interwell investigations. The CRP established methods for the synthesis, analysis and quality control of several radioactive tracers, field tested new radiotracer injection systems and automatic sample collection systems developed in the CRP, and validated processes to analyse low activity interwell radiotracer samples through laboratory intercomparison tests. In addition, the software packages *Anduril* and *Poro* were developed and tested by analysing interwell tracer data from different countries, and were validated through round robin analysis tests and interpretation of data. The results of the CRP enhance the reliability and quality of data in field applications (Fig. 1).

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An important component of the Agency's technical cooperation assistance to Member States is the provision of training tools. In this regard, two publications were issued in 2008: *Training Guidelines in Non-destructive Testing Techniques: 2008 Edition*; and *Radiotracer Residence Time Distribution Method for Industrial and Environmental Applications* (Training Course Series No. 31).

African Member States have given high priority to non-destructive testing (NDT), opting for a regional approach to maximize scarce resources

in this field. Currently, most countries rely on the training and certification of NDT personnel at the two AFRA Regional Designated Centres in South Africa (for countries where English is spoken) and in Tunisia (for francophone countries). To support these efforts, the Agency organized several regional training courses in 2008 to certify NDT personnel. In addition, a mutual recognition scheme of NDT certification was put in place as a basis for the promotion of NDT services and mobility of NDT personnel at the regional level. Several NDT practitioners were certified to Level III through this programme and, in turn, national capabilities to train and certify NDT personnel at Levels I and II were established in the region.

Application of Nuclear Techniques for Protecting Cultural Heritage

Scientific studies of art and archaeology can help protect humanity's cultural heritage. Nuclear techniques such as neutron activation analysis, X ray fluorescence and ion beam analysis can help to repair damaged objects, identify fraud and assist archaeologists in the appropriate categorization of historical artefacts. Through a CRP completed in 2008 on the applications of nuclear analytical techniques to investigate the authenticity of art objects, the Agency supported 16 Member States in applying these non-destructive nuclear techniques in their cultural heritage investigations.

For example, pottery shards analysed from an ancient site in Ghana showed that the pottery was produced locally, dispelling an earlier belief that the pottery had been brought by outsiders. In Peru, a combination of techniques applied to Inca pottery samples to distinguish between authentic and fraudulent pieces identified the place of production and shed light on the production process, such as firing temperature and the composition of the paste used. In Croatia, ion microprobe and other complementary techniques were used to select the best strategy for the restoration and conservation of paintings, and to help clarify suspicious attributions, authorships and possible earlier restoration attempts or interventions (Fig. 2).

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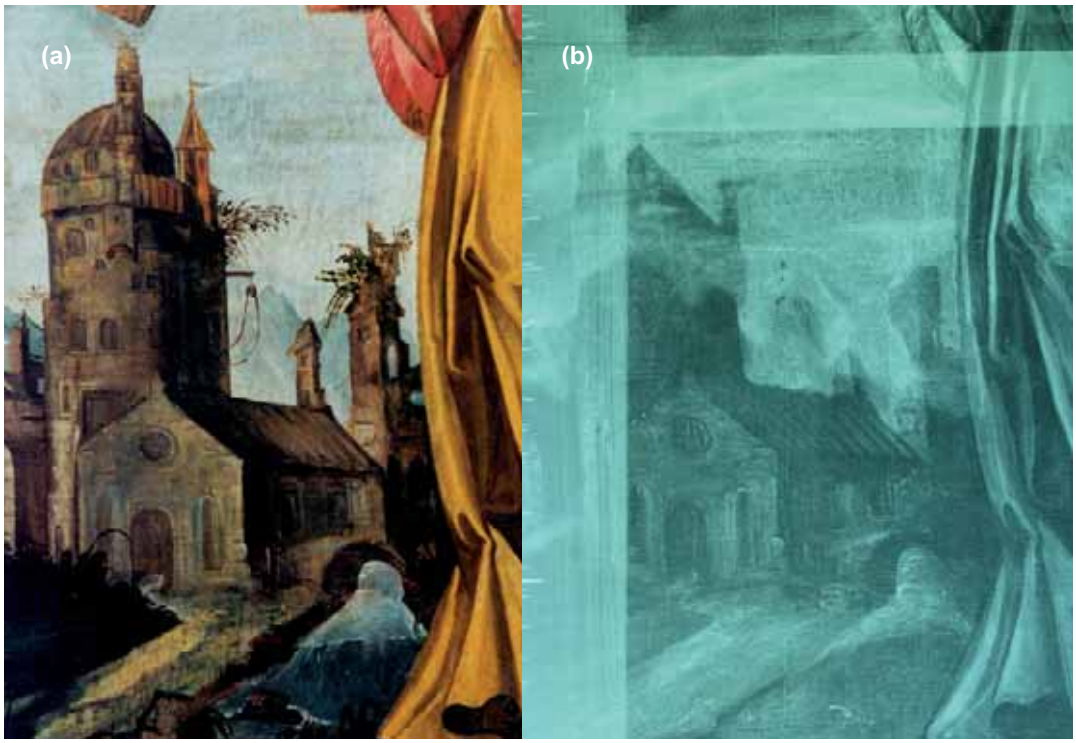

FIG. 2. (a) Detail of the painting of St Michael from Gračani; (b) the X ray image of the same detail. The difference between the church towers indicates that some type of restoration was done in the past (photographs courtesy of the Croatian Conservation Institute).