



Business paper

A small size continuous run industrial gamma irradiator

Wilson A.P. Calvo*, Paulo R. Rela, Francisco E. Springer, Fábio E. da Costa,
Nelson M. Omi, Leonardo G.A. e Silva

*Instituto de Pesquisas Energeticas e Nucleares (IPEN-CNEN/SP), Centro de Tecnologia das Radiações (CTR),
Av. Prof. Lineu Prestes, 2242 - Cidade Universitária, São Paulo, SP 05508-000, Brazil*

Abstract

A new small size gamma irradiator is being set up at Instituto de Pesquisas Energeticas e Nucleares (IPEN-CNEN/SP), Brazil, with a revolutionary design. The developed technology for this facility consists of continuous tote box transport system, comprising a single concrete vault, where the automated transport system of products inside and outside of the irradiator utilizes a rotating door, integrated with the shielding, avoiding the traditional maze configuration. Covering 76 m² of floor area, the irradiator design is product overlap sources and the maximum capacity of Cobalt-60 wet sources is 37 PBq (1 MCi). The irradiator is being installed in a Governmental Institution and it will be used as a demonstration facility for manufacturers, who need an economic and logistic in-house irradiation system alternative. Also, it will be useful for supporting the local scientific community on development of products and process using gamma radiation, assisting the traditional and potential users on process validation, training and qualification of operators and radioprotection officers.

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1. Introduction

Some decisions regarding the cost analysis and the installation safety in gamma irradiation plant design, operation and maintenance optimization should be taken before the irradiator construction. These decisions are to define the plant capacity, the installation performance (the cost of processed product per kilogram), radioactive source storage type (dry or wet), the irradiation geometry (source or product overlap), the products passage path in front of the source rack and the product conveying system (Rela, 2002).

The trends of new Cobalt-60 compact irradiators have been developed to be installed integrated to the producing units, having as main characteristic the batch processing cycle (Beers, 2000; McKinney and Perrins,

2000; Clouser and Beers, 1998). The most recent models available are the BREVION™ (MDS Nordion) and the MINICELL™ (SteriGenics International).

The Cobalt-60 compact type irradiator, that has been developed and being implemented at IPEN-CNEN/SP is classified as a Group I irradiation facility according to Brazilian Nuclear Energy Commission and category IV irradiator according to International Atomic Energy Agency—IAEA and United States Nuclear Regulatory Commission, USA (CNEN-NE-6.02, 1998a; IAEA SS-107, 1992; NRC Title 10-Part 36, 1994). The development of this multipurpose irradiator adopts fully electrical and mechanical interlocks, automation system and effective alarms and warning devices to achieve a safe working environment.

The construction of this multipurpose compact type gamma irradiator in a governmental institution has a main subject to promote the use the ionizing radiation as part of the productive processes. The size of this irradiator will allow the development of the appropriate

*Corresponding author. Fax: +55-11-3816-9186.

E-mail addresses: wapcalvo@ipen.br (W.A.P. Calvo),
prela@ipen.br (P.R. Rela), lgasilva@ipen.br (L.G.A.e Silva).

lots for optimization studies of industrial scale production. Also, to validate irradiation process, dosimetric systems and dose distribution computer codes.

2. Design characteristics

The multipurpose irradiator is based on the design of a continuous product overlap source type for products handling system, double piling up of boxes, single step. The transport system is tote type and the sources can be positioned in two independent racks allowing the balance of different dose rate delivery in a consistent way according to the products to be processed.

The originality of design remains on the rotating concrete door, that integrates the shielding system with the product handling system, permitting the input and output of the products in a continuous way, without the necessity to lower the sources and open the irradiator chamber to change the batch. This feature allows the reduction of the dead time of the irradiator and the lack of internal mazes the reduction of the floor space area and shielding material lowering dramatically the cost of the installation.

The Cobalt-60 compact type multipurpose irradiator schematic design is shown in Fig. 1 with the following characteristics:

- cobalt-60 capacity load: 37 PBq (1 MCi);
- storage pool: 7.0 m deep and 2.7 m diameter;
- vault floor area: 76 m²;
- warehouse area: 1100 m²;
- concrete shield doors: one sliding door for intervention inside the radiation chamber and one rotating door integrated with the products handling system to introduce and remove products from the irradiator;
- concrete shield walls: 1.8 m thick (density = 2.35 g/cm³);

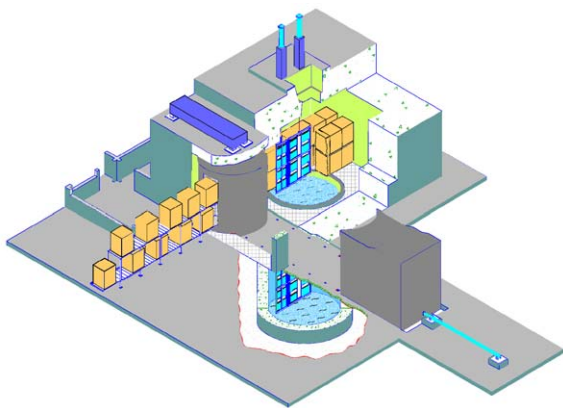


Fig. 1. Schematic design of the cobalt-60 compact-type multipurpose irradiator.

- source geometry: two rectangular source racks with capacity 600 industrial sources of ⁶⁰Co;
- product handling system: overlapping product design, double piling up of totes, single pass;
- irradiation room capacity: 16 totes, and
- tote capacity: maximum load 300 kg and volume 270 l.

The products to be processed in the multipurpose irradiator, in its final packing, will be put inside the totes and moved in an indexing motion on roller-bed conveyors around the source rack in a selected time. The movement of the totes will be made by hydraulic drives positioned outside of the irradiation chamber and free from the radiation environment increasing their operation life. The irradiation drives with the capacity to move heaviest products, do not transmit impact to the totes in the beginning of each movement, reducing the stress on the products. After the irradiation cycle was completed, the totes will be conveyed to the processed product area, where the totes are unloaded.

The process control and safety systems are fully automated, independent and composed by programmable logical controllers (PLC), increasing the installation operation safety. The safety system is also fitted with a redundant circuit of fail indication controls the critical functions of the radioactive installation, besides they are monitored continually, controlled and registered. The safety system of this radioactive facility follows the safety philosophy principles: defense in depth, redundancy, diversity and independence, in order to achieve the national and international required degree of safety (IAEA, 1996).

The annual throughput depends on the source loads, the required doses and products densities. As a multipurpose facility, the irradiator will process different products in a year; thus, previous annual throughput is not predictable.

The water pool liner, contention vessel weighting 4000 kg, manufactured in AISI 304 stainless steel is already set up in the radioactive facility place to store the Cobalt-60 sources.

The main applications of this gamma facility will be to study in large medium scale:

- sterilization of medical products (IAEA, TR-539, 1990);
- food ingredients products disinfestation and preservation (spices, lyophilized aromatic herbs, animal and vegetable proteins), ornamental plants and fruits (FAO/IAEA/WHO, 1999);
- agricultural products (peat and seeds);
- sterilization of biological tissues for surgical implants;
- improvement of color in gems (tourmalines, topaz, citrines and amethyst);

- treatment of industrial effluents, domestic sewers, sludge and hospital wastes;
- development and test of components for irradiators and irradiation devices;
- development and tests of detectors and radiation sensor, and
- modifications in polymeric materials induced by radiation.

The Brazilian Nuclear Energy Commission has already granted for IPEN-CNEN/SP the site, construction and the safety analysis report approval licenses for the Cobalt-60 compact type irradiator, according to IAEA and United Nuclear States Regulatory Commission standards USA (CNEN-NE-6.02, 1998a; IAEA SS-107, 1992; NRC Title 10-Part 36, 1994; CNEN-NE-3.01, 1998b; CNEN-NE-3.02, 1986; CNEN-NI-001, 1994; NCRP 49, 1976).

3. Conclusion

With the construction and operation of multipurpose irradiator, scheduled for the end of March 2004, several research and development projects will be held at IPEN-CNEN/SP and in others national and international academic community Institutions, which have already formal or informal partnerships. The multipurpose irradiator construction is a fundamental requirement to make it possible the radiation applications in industrial processes, contributing to the updating and technological development in the Country, and also the optimization of the productive processes, increasing the competitiveness of the national products.

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