Iranian Journal of Physics Research, Vol. 24, No. 4, 2025
DOI: 10.47176/ijpr.24.4.11817

Design and construction of a self-shielded radiation system for agricultural products

A Monshizadeh, A Soleimani, MKhosravani, M Yahaghi, H Sayar, R Rozedar Moghadam, A Ghaleh Asadi, A Salehizadeh, H Aleebrahim Dehkordi, M S Eslami, A Farokhizadeh, O Haghighi, H Saravani, A Taheri, and S P Shirmohammadi

Iran Radiation Application Development Company (IRAD Co.), Atomic Energy Organization of Iran, Tehran, I.R. of Iran, PO Box:14395-836

E-mail: atahery@aeoi.org.ir

(Received 3 January 2024 ; in final form 10 June 2024)

Abstract

It is possible to extend the shelf life and reduce the waste of agricultural products due to removing bacteria, viruses, insects and pests by means of gamma irradiation with the absorbed dose amount determined by microbiology and food laboratories. For this purpose, the design and construction of a self-shielded gamma irradiation system for irradiation of grains and legumes with radioactive sources of cobalt-60 with activity of 50 kilocuries was performed. In this system, agricultural products are fed in bulk into the input funnel with a conveyor belt. The products move from the inlet funnel to the spiral due to gravitational force and after passing through it, they enter the cask (irradiation chamber) to be irradiated. The absorbed dose amount of agricultural products depends on the time duration that they stay in the irradiation cask, their density, and their type of products, etc. Irradiation time can be adjusted by changing the rotational speed of the screw conveyor considering the last amount of activity remained in the cask at the time of irradiation by means of a software product. The design and construction of type 1 radiation system is based on ANSI/HPSN43.7-2018 standard designed using Solidworks software and basic biological shielding standard ISIRI7751 modeled and calculated by MCNPX software. Other designs and constructions, including industrial and facility drawings, electrical drawings, structural analysis, welding and electrical and control systems were also carried out based on their respective standards. The built mechanical structure can withstand 140kN of loading. The unique design of the entrance chamber in a form of a step instead of a spiral reduces the volume of lead material required for shielding by 2 tons compared to a similar irradiation system made in Hungary. The output mass flow rate of irradiated products in this system is about 1 ton/hour for wheat with dose of 200 grays. The dose uniformity ratio of 2 was obtained, which is acceptable for industrial radiation works.

Keywords: irradiation system, self-shielded system, gamma-ray Cobalt-60, MCNPX simulation

For full article, refer to the Persian section