Development and characterization of a graphite-walled ionization chamber as a reference dosimeter for 60-Co beams

Ana Paula Perini, Lucio Pereira Neves, Linda V.E. Caldas

GMR, Instituto de Pesquisas Energéticas e Nucleares, Comissão Nacional de Energia Nuclear (IPEN-CNEN/SP), Av. Prof. Lineu Prestes, 2242, São Paulo, 05508000, Brazil

paulaperini@gmail.com

Ionization chambers are the detectors of choice for clinical and laboratory applications due to their good reproducibility, stability, linearity and portability. The standards of air kerma are usually graphite ionization chambers of various designs (sizes and shapes): parallel-plate, cylinder and spherical, for example. In this work, a graphite parallel-plate ionization chamber, assembled at the Calibration Laboratory of the IPEN, was evaluated to be employed as a reference dosimeter in ^{60}Co beams. This ionization chamber consists of two thick graphite layers separated by a thin gas (atmospheric air) layer. In the middle of the ionization chamber, a collecting electrode was inserted. This electrode was also made using graphite with density of 1.77 g/cm^3. In order to characterize this ionization chamber, several experimental tests: stability of response, saturation curve, ion collection efficiency, polarity effect, leakage current and linearity of response, were carried out using a Gammatron ^{60}Co irradiator unit. All results obtained in these tests were considered satisfactory. The maximum value obtained in the stability test was lower that 0.5%, therefore within the international recommendations. The ion collection efficiency was better than 99.99%, and the polarity effect was lower than 0.5%. The leakage current was also lower than 0.5% of the minimum current obtained during the measurements. The behavior of the ionization chamber was linear with the increase of the irradiation time. The simulations were carried out with the C++ user code cavity, which is an advanced EGSnrc application. This code was employed to determine the correction factors of the wall, collecting electrode and chamber stem. The results obtained in the simulations presented a low influence of the chamber components on its response. Moreover, these correction factors could also be used to determine the air kerma rates. Therefore, the ionization chamber assembled and characterized in this work presents potential application as a reference dosimeter.