Calibration coefficients in terms of absorbed dose to water for two ionization chambers Standard Imaging A12 and A19 exposed to low-energy x-rays from 20 kV – 150 kV.

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The current codes of practices for low-energy photon dosimetry are based on calibration coefficients for ionization chambers in terms of air kerma while for the high-energy photon, they are centered on calibration coefficients in terms of absorbed dose to water. One of the difficulties to determine absorbed dose to water in low-energy photon beams is the rapid attenuation of the photon fluence as a function of the distance caused by the photoelectric effect. This work aims at determining the calibration coefficients in terms of absorbed dose to water, through a combination of Monte Carlo simulations and measurements of two ionization chambers exposed in water and in air to low-energy X-rays from 20 kV to 150 kV (effective energy: 13.5 keV – 65.3 keV). The measurements were performed using the farmer-type ionization chambers Standard Imaging A12 and A19 situated at 2 cm liquid water depth and 61 cm source to detector distance (SDD) and in air, at 63 cm SDD. The charges were collected in water and in air by each chamber. The experimental geometry was reproduced in the Monte Carlo simulation to calculate the absorbed dose to water and the air kerma in the absence of ionization chamber, using the unfiltered x-ray spectra reported by PTB. Under charged particle equilibrium we established the following relationships:

$$\left(\frac{D_w}{K_{air}}\right)_{exp} = \left(\frac{D_w}{K_{air}}\right)_{MC}$$

$$\frac{M_w N_{D,w}}{M_{air} N_{D,air}} = \left(\frac{D_w}{K_{air}}\right)_{MC}$$

$$N_{D,w} = \frac{M_{air} N_{D,air}}{M_w} \left(\frac{D_w}{K_{air}}\right)_{MC}$$

Where M_w and M_{air} are the responses corrected for pressure and temperature of the chamber situated in water and in air, respectively, $N_{D,air}$ is the calibration coefficient in terms of air kerma obtained from NIST and $N_{D,w}$ is the calibration coefficient in terms of absorbed dose to water and $(D_w/K_{air})_{MC}$ is the ratio of absorbed dose to water to air kerma calculated by MC. The results indicate that $N_{D,w}$ increases with the photon energy and reaches a maximum at 40 keV and after decreases to a constant value at energies greater than 47 keV. With this method is possible to obtain calibration coefficients for ionization chambers in terms of absorbed dose to water.

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