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X-Ray Dosimetry by a Low-Cost Current Mode Ion Chamber

Authors : Ava Zarif Sanayei, Mustafa Farjad-Fard, Mohammad-Reza Mohammadian-Behbahani, Leyli Ebrahimi, Sedigheh Sina

Abstract : The fabrication and testing of a low-cost air-filled ion chamber for X-ray dosimetry is studied. The chamber is made of a metal cylinder, a central wire, a BC517 Darlington transistor, a 9V DC battery, and a voltmeter in order to have a cost-effective means to measure the dose. The output current of the dosimeter is amplified by the transistor and then fed to the large internal resistance of the voltmeter, producing a readable voltage signal. The dose-response linearity of the ion chamber is evaluated for different exposure scenarios by the X-ray tube. kVp values 70, 90, and 120, and mAs up to 20 are considered. In all experiments, a solid-state dosimeter (Solidose 400, Elimpex Medizintechnik) is used as a reference device for chamber calibration. Each case of exposure is repeated three times, the voltmeter and Solidose readings are recorded, and the mean and standard deviation values are calculated. Then, the calibration curve, derived by plotting voltmeter readings against Solidose readings, provided a linear fit result for all tube kVps of 70, 90, and 120. A 99, 98, and 100% linear relationship, respectively, for kVp values 70, 90, and 120 are demonstrated. The study shows the feasibility of achieving acceptable dose measurements with a simplified setup. Further enhancements to the proposed setup include solutions for limiting the leakage current, optimizing chamber dimensions, utilizing electronic microcontrollers for dedicated data readout, and minimizing the impact of stray electromagnetic fields on the system.

Keywords : dosimetry, ion chamber, radiation detection, X-ray
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