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INFLUENCE OF A COMPLEX SHAPE OF AN OBJECT ON UNIFORMITY OF DOSE DISTRIBUTION

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Observance of the uniformity of the dose distribution over the volume of the irradiated object is an urgent task in the field of sterilization of medical devices. Under-irradiation can lead to the non-sterility of the processed object. Over-irradiated leads to unwanted chemical changes in the object.
Most medical devices have a complex shape, so this must be taken into account when selecting the physical and technical processing parameters.
The purpose of the study was to calculate the absorbed dose distribution uniformity throughout the volume of the balloon complex shape and to evaluate the effect of the shape of its bottom on the degree of uniformity of irradiation.
Dose distribution uniformity over the irradiated complex geometry object volume was calculated with the computer simulation using the Geant4 toolkit. Complex geometry object in the model of Geant4 corresponded to the real prototypes of aluminum cylinders with thermal water. The total height of the balloon was 15.5 cm, of which 4.5 cm was occupied by a cavity with water. The radius of the balloon was 2.5 cm, the wall thickness was 0.5 mm.
During the simulation, the object was irradiated by electrons with 9.5 MeV (according to the operating mode of the accelerator of the radiation sterilization center) from two opposite sides along the vertical direction parallel to the cylinder axis. Simulation of ordinary cylinders forms balloons irradiation under the same conditions was also carried out for comparison. The volume of the balloon was divided into virtual layers in the height and the radial direction by a cylindrical grid with a constant pitch. The data on the absorbed dose, obtained for each virtual volume, was used to calculate the uniformity of the distribution of the absorbed dose depth in the volume of the cylinders. The evaluation criterion was the ratio of the minimum dose value to the maximum dose value in the cross-section of a cylindrical phantom.
The study showed a large irradiation irregularity in both object shapes. It was confirmed that the complex shape of the balloon's bottom has no significant effect on uniformity. For the balloon of a complex shape, the irregularity was 5.27, while for ordinary cylinders object this value was 5.25. The absence of significant corrections of a complex shape in the dose profile makes it possible to model an object with a cylinder or to calculate distributions analytically.
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