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Development of a liquid Fricke dosimeter for boron neutron capture therapy

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Boron neutron capture therapy (BNCT) is a binary form of radiation therapy based on the selective destruction of malignant tumor cells by accumulating a stable isotope ^{10}B in them and subsequent irradiation with epithermal neutrons. As a result of neutron absorption by boron, a nuclear reaction $^{10}B(n,\alpha)^{7}Li$ occurs with a large release of energy in the cell that contained the boron nucleus, which leads to its death. Clinical trials of the technique were conducted at nuclear reactors and accelerator-based neutron sources, positive results were obtained. However, for the widespread introduction of the technique into clinical practice, compact neutron sources, effective drugs for targeted boron delivery, as well as a therapy planning system, including dosimetric control, are required.

Currently, there are no clinically applicable dosimetry methods that would take into account all doses in BNCT. The VITA setup uses such dosimetry methods as activation foils, prompt gamma spectroscopy, water phantom and calculations on the NMC-based software package [1] for the treatment of domestic animals with spontaneous tumors.

It is proposed to use a chemical dosimeter, namely a ferrosulfate system or a Fricke dosimeter, to measure the total dose.

The aim of the work is to develop a ferrosulfate dosimetry system for BNCT.

As a result of the work, a method for chemically measuring the dose for BNCT was proposed, "conventional" and "neutron-sensitive" dosimeters with a complexing agent were developed, the developed

dosimeters were calibrated in the range from 0 to 8 Gy, and a test irradiation was performed on the VITA neutron source, samples were analyzed on a spectrophotometer and spectra were obtained for further determination of the dose associated with neutrons. As an intermediate result, the total equivalent dose was calculated, which was 35 Gy.

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[1] M. Bikchurina, T. Bykov, I. Ibrahim, A. Kasatova, D. Kasatov, Ia. Kolesnikov, V. Konovalova, T. Kormushakov, A. Koshkarev, A. Kuznetsov, V. Porosev, S. Savinov, I. Shchudlo, N. Singatulina, E. Sokolova, T. Sycheva, I. Taskaeva, G. Verkhovod, S. Taskaev. Dosimetry for Boron Neutron Capture Therapy Developed and Verified at the Accelerator based Neutron Source VITA. Front. Nucl. Eng. 2 (2023) 1266562.