Design of BSA for Experimental Channel HEC-1 with Compact Beam Shutter at the IRT-T Reactor

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Introduction

The growing interest in the treatment of malignant tumors with by neutron capture therapy creates a high demand for nuclear-physical facilities, allowing to conduct such studies. This paper is devoted to the development of the BSA design for the horizontal experimental channel HEC-1 of the IRT-T reactor using a compact shutter.

Materials and Methods

The research nuclear reactor IRT-T is the only reactor on the territory of Siberia and the Far East, which allows implement research using neutron radiation. Previous studies have shown the possibility of using one of the horizontal channels of the IRT-T reactor for conducting BNCT. As a first step in upgrading the experimental volume, a design study was carried out to create a compact shutter.

The second step to optimize the conditions of irradiation of objects involves the development and optimization of BSA. PHITS software based on the Monte Carlo method and intended for solving the radiation transfer problem was used to carry out neutronic calculations. The angular and energy distributions of neutron and photon fluxes, obtained using the MCU-PTR precision software, were used as initial data for the calculation. The MCU-PTR program is designed for the calculation of pool-type reactors and certified for the IRT-T reactor.

In the framework of this work, we optimized the location and thickness of filters made of Al, AlF_3, fluental, MgF_2, lead, bismuth, graphite and polyethylene with lithium.

Results

BSA for a compact shutter consists of three parts. The first part is a shell for the channel inside the volume of the shatter, made of lead and polyethylene with lithium. The second part is a primary filter consisting of 4 cm aluminum and 8 cm bismuth. The third part is an additional filter consisting of 4 cm aluminum and 2.5 cm bismuth. At the output of the experimental channel is an insert of graphite, which allows to reduce the relative shares of fast neutrons and photons.

The described BSA arrangement makes it possible to obtain a thermal neutron value of 2.21E+08 n/cm^2/s, and fast neutrons and photons component of 3.31E-12 Gy·cm^2 and 2.69E-12 Gy·cm^2 per thermal neutron, respectively.

Conclusion

Since the purpose of this study was to create a thermal neutron beam, the use of classical materials for BNCT used to create an epithermal neutron beam is impossible due to the significant absorption of thermal neutrons.

Based on the calculations, it can be concluded that the developed BSA arrangement will allow for preclinical studies in the field of BNCT using a thermal neutron beam at the IRT-T reactor.