THERMAL MODEL OF THE **IGR** RESEARCH REACTOR

Surayev A.S., Vityuk V.A., Vityuk G.A., Irkimbekov R.A., Zhanbolatov O.M.

National nuclear center of the Republic of Kazakhstan, Kurchatov, Kazakhstan

The IGR reactor is a research pulsed reactor with a heat-capacitive type graphite core. It is one of the research reactors operated by the National Nuclear Center of the Republic of Kazakhstan. At present, along with irradiation devices testing studies are underway on the neutron-physical and thermophysical characteristics of the IGR core [1]. This requires specialized calculation tools. Therefore, this work aims to create a new high-precision model of the IGR reactor for thermophysical calculations.

The core of the IGR reactor consists of 340 graphite columns formed from graphite blocks, one part of which is impregnated with a uranium solution, and the other is not impregnated and acts as a reflector. Depending on the purpose of the column, the blocks included in its composition differ in design. They have technological holes, lugs, and grooves, which provide the possibility of their mutual fastening (fig.1a). For example, blocks with a cross-section of ~ 98 × 98 mm are used to form fuel columns, and unimpregnated graphite blocks with dimensions of ~ 197×197 mm are used for the side reflector. The height of the blocks varies from 140 mm to 148 mm. To accurately describe graphite blocks by finite element methods, grid structures were developed based on which hexahedral finite elements were generated (fig.1b).

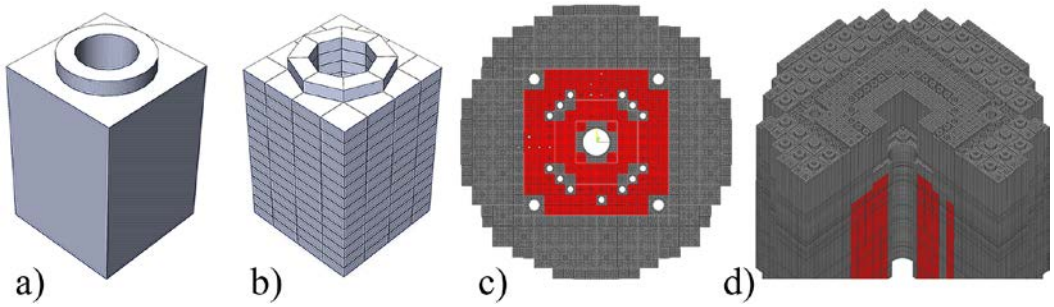

Fig. 1. IGR model: a) block geometry; b) block mesh; c) horizontal section; d) 3D view

The developed thermal model of the IGR reactor is an ordered and structured set of finite elements (fig. 1c), built with the preservation of important geometric parameters of graphite blocks. The model has 4 700 304 nodes, 4 614 328 elements, 8 427 element types, and 3 materials.

A full-scale three-dimensional model of the IGR reactor (fig.1d) is built from structured and optimized finite elements associated with the neutron model of the reactor. Implemented full interaction of models at the element level guarantees the transfer of data from one model to another in an explicit form. The model was created in the VB.NET programming environment for thermal analysis using the ANSYS program. The core temperature measured using thermocouples during the reactor start-up validated the model. The average deviation of the calculated temperature from the measured one was obtained when the core is heated up to 1400 K.

The work was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP09058353).

[1] E. Batyrbekov, V. Vityuk, A. Vurim, and G. Vityuk. 2023. "Experimental Opportunities and Main Results of the Impulse Graphite Reactor use for Research in Safety Area" *Annals of Nuclear Energy* 182. doi:10.1016/j.anucene.2022.109582.