FAST NEUTRON FLUENCE IN BERYLLIUM MATRIX OF MARIA REACTOR USING DIFFUSION MODEL.

Z. Marcinkowska, K. Pytel, R. Wójcik, A. Struski*, Ł. Koszuk

National Centre for Nuclear Research
A.Sołtana 7 St.
05-400 Otwock-Świerk, Poland

Tel:+48-22-273-10-21
E-mail : zuzanna.marcinkowska@ncbj.gov.pl

* *Poznan University of Technology Faculty of Electrical Engineering*

The purpose for this study was to prepare and test the method for determination of the fast fluence of beryllium matrix in MARIA reactor core. The method was based on results of operating, diffusion model and has taken into account data from 2010 to 2013. The results of this work were used to verify the method used previously by the Operator.

The moderator in MARIA reactor core is beryllium matrix, consisting of 45 blocks. Each block is exposed to fast neutron flux, sourced from the fission. The moderator slows down neutrons from fast to thermal by the scattering. However fast neutrons can be absorbed by beryllium blocks by *(n,γ)* reaction, where and ^{3}He isotopes are produced. The ^{6}Li and ^{3}H are strong absorbers, therefore they determine the poisoning of beryllium matrix.

The Fast fluence of beryllium Block increases with time, which causes degradation of mechanical and nuclear properties of the moderator. The reason is the presence of gas tritium, helium, including α particles (helium nucleus) and protons (hydrogen nucleus). The beryllium block fluence does not measure the material exhaustion, but is the simplest criterion for estimation of it's effects, including gas generation rate.

The developed method is based on fact, that the sum of beryllium, lithium, tritium and helium concentration is constant in time and is equal to initial beryllium concentration. Additionally the sum of lithium, tritium and helium concentration is linearly dependent on the fast fluence, which the block has received. In this work, the linear dependence was determined which introduced the possibility of instant fluence calculation (without considering whole irradiation history of each beryllium block). Due to character of operational calculations, the fluence can be determined promptly.

Method used by the Operator brought the fluence values over 1.5 times higher than the proposed method, which is based on sum of isotopes concentration. This discrepancy is mainly caused by more conservative approach used in Operator's method. The Operator's method assumes that the contribution to the fluence from neighboring beryllium blocks simple summates.

The analysis shows that under the current neutron fluence limit specified in the operational Safety Report, you can lengthen the shelf-life of beryllium matrix of MARIA reactor core.