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Using of burnable poison in the PIK reactor.

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In the work is investigated the effect of a burnable poison on the rate of reactivity drop in the PIK reactor. The core consists of six 6-sided fuel assemblies in the inner perimeter, six 4-sided fuel assemblies and six 6-sided fuel assemblies in the outer perimeter. The hexagonal fuel assembly contains 241 fuel elements, and the tetrahedral fuel assembly - 161. The fuel elements of the PIK reactor have a cruciform cross-section. The used fuel is UO_2 with the addition of Cu and 0.6% of Be. The mass of ^{235}U in one fuel element is 8.57 grams. There are 6 displacers or rods of a burnable poison in a hexagonal fuel assembly, and 14 or 2 rods of a displacer and 12 rods of a burnable poison in a tetrahedral one. Rods of a burnable poison have a form of half-cylinders in the clad of steel alloy EI-847. The material of the burnable poison is a powder of oxides ZrO_2 + 20%Y_2O_3 + 5.2% Gd_2O_3 mixture[1]. The main absorbing element are gadolinium isotopes ^{155}Gd (14.73%) and ^{157}Gd (15.68%), with cross sections equal to 60,900 × 10^{28} m^2 and 254,000 × 10^{28} m^2, respectively. The total gadolinium content in one rod is 0.7 grams. The fuel assembly cladding is made of zirconium alloy.
The time variation of the multiplication factor was calculated for two core design options. In the first case, only displacer rods made of E-125 zirconium alloy are used and in the second case, the rods of a burnable poison and two steel displacer rods made of 12Kh18N10T steel are used. The calculations were performed using the MCNP Version 6.1 program [2]. The calculation of the multiplication factor showed that the using of burnable poison reduces the multiplication factor at the beginning of operation cycle, but the initial reactivity is still too high to be compensated with the reactor control rods, as shown in the figure. To reduce the initial reactivity it was decided to use additional boric burnable absorber in zirconium alloy.
The bibliography list:
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2.MCNP USER'S MANUAL Code Version 6.2 / Edited by: Christopher J Werner – Los Alamos National Security, LLC, 2017

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