

## One-Group Fission Cross Sections for Plutonium and Minor Actinides Inserted in Calculated Neutron Spectra of Fast Reactor Cooled with Lead-208 or Lead-Bismuth Eutectic

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### Abstract

Since 1999 authors have proposed a new coolant for nuclear power installations with intermediate and fast neutron spectra [1]. This coolant is based on lead enriched with the lead isotope, lead-208, which is characterized by very low neutron capturing and slow neutron moderating. These features of lead-208 allow having some gain in the quantity of plutonium [2] to reach criticality of fast reactor (FR) or in hardening the neutron spectra of the core and its topical and lateral blankets. The gain in the neutron multiplication factor  $K_{ef}$  is about 1.5-2 percent for small sized FRs and hardening of core neutron spectra can reach about 6 percent as compared with other heavy metal coolant as natural lead or lead-bismuth eutectic.

In the present paper the one-group fission cross sections for plutonium and minor actinides inserted in calculated neutron spectra of the FR RBEC-M [3] core are given. Calculations performed show that in this type of 900 MW<sub>thermal</sub> reactor core the replacement of its standard lead-bismuth coolant with lead-208 leads to increasing neutron multiplication factor and neutron spectrum hardening.

Neutron spectra in both cases of coolant, Pb-208 or Pb-Bi, were calculated in using MCNP5 [4] Monte-Carlo code on the basis of the input data given in the RBEC-M project designed in the Moscow Kurchatov Institute.

The microscopic fission cross sections on the basis of files of the evaluated nuclear data for the ENDF/B-VII.0 version were taken and one-group fission cross sections in using this 28 neutron energy groups [5] were calculated.

As follows from calculations, the replacement of coolant from Pb-Bi with Pb-208 in RBEC-M leads to increasing the core mean neutron energy from its standard value 0.3992 MeV to 0.4246 MeV, i.e. on 6.4%. As concerns Pu isotopes, their one-group fission cross sections become slightly changed. More dramatically Am-241 one-group fission cross section is changed, on 9.6%, as a result of neutron spectrum hardening. It must be mentioned that 5-6 % of Am-241 is usually presented in the power grade plutonium obtained from spent fuel of PWR or VVER. Such mix of power grade plutonium and 5-6 % of Am-241 is usually proposed as a fuel for FR's core.

Similar situation occurs in lateral blanket contained small quantities of minor actinides. From calculations performed it follows that as a result of switching coolants from Pb-Bi to Pb-208 lateral blanket mean neutron energy increases from 0.2509 to 0.2662 MeV, i.e. on 6.1%. As a result of the neutron spectrum hardening, the one-group fission cross sections of Np-237, Am-241 and Am-243 increase up to 8-11%. As is known these minor actinides need higher neutron energy, more than 0.1-0.2 MeV, to be fissile. The result of increasing MA one-group cross sections

is very important as it allows reducing the time of minor actinides burning in the FR lateral blanket for their excluding from nuclear wastes.

#### References

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