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Application of Heterogeneous Fuel Assemblies in the Core of Modular Fast Sodium Reactor

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The work contains results of calculation studies of neutron physics characteristics of the fast modular sodium reactor core, in which fuel assemblies without casing with heterogeneity inside fuel assemblies are used. Metal fuel (U-Pu-Zr) is the most advantageous fuel of all known challenging fuel types for a fast sodium reactor regarding neutron characteristics. It enables obtaining the maximal mass of heavy nuclei in the core and a harder neutron spectrum due to absence of light nuclei in comparison with other fuel types. However, experience of metal fuel application is extremely little, and this fuel has not been in commercial operation yet. Application of a heterogeneous fuel assembly consisting of fuel elements with highly enriched (<30%) mixed oxide fuel combined with fuel elements of metallic uranium (or alloy) enables increasing concentration of fissionable and fertile nuclides in comparison with homogeneous fuel assemblies with MOX fuel and obtain similar indices to ones of homogeneous fuel assemblies with metal U-Pu-Zr fuel. A heterogeneous fuel assembly consisting of fuel elements with MOX fuel and fuel elements with metallic uranium of natural composition or U-Zr alloy and a homogeneous fuel assemblies were compared in the course of research. Use of U-Zr alloy without plutonium at the beginning of the campaign and its relatively low average burnup reduces requirements to metal fuel and enables using it already in the nearest future. A heterogeneous fuel assemblies can become an intermediate variant during conversion to the metal fuel core or a final variant if it has better indices than fuel assemblies with metal U-Pu-Zr fuel.

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