Contribution ID: **347** Type: **ORAL**

Metal fuel for fast reactors, a new concept

Monday 26 June 2017 13:20 (20 minutes)

Choice of the fuel composition is important question to improve the competitiveness of fast reactors. It should have a high density and thermal conductivity, a high concentration of fissile nuclide, and high manufacturability. The best fuel composition of fast reactors remains a metallic nuclear fuel, based on uranium and plutonium alloys. The undeniable advantages of a metal fuel composition is high density of 15-18 g/cm3; high thermal conductivity λ = 30-40 W/m·K; the ability to achieve ultra-deep burnup; simplicity of recycling spent nuclear fuel, based on conventional metallurgical methods.
Significant disadvantages of metallic fuels are a large swelling by the gas and the possibility of irradiation growth in the case of injection-molded parts with a pronounced texture, as well as the opportunity to interact with the fuel cladding above 700 C.
As a solution to these problems, connected channel creation in the fuel core to the output of the gas fission products for the entire fuel campaign is proposed. It can be realized by creation of open porosity 15-25% of the entire volume of the fuel pellet by applying the methods of powder metallurgy. Due to the deformation of the porous structure of the fuel core reduces the risk of cladding damage, and close contact “fuel-clad” provides minimal contact resistance, which improves heat dissipation.
Usage of metallic fuel tablet simplifies the fuel element technology and equipment, it makes possible to use fuel elements with gas fuel-cladding gap (as evidenced by the thermophysical calculations).
Compatibility metal fuel with cladding can be increased by usage of vanadium alloys or ferritic steels as cladding materials.
Preparation of porous structure in fuel is impossible without usage the powder metallurgy techniques. Wherein a feature of uranium alloys is the difficulty of obtaining compacts by conventional pressing and sintering, it is associated with high oxidative capacity of uranium powder. We use advance methods of compaction. High-voltage electrodischarge consolidation is based on passing an electric current through the powder compact, with the simultaneous application of pressure. The advantages of this method is the short time of compaction (milliseconds), high density products. Due to the short sintering time consolidation comes with minimal changes in the microstructure (grain growth, recrystallization). Combining technological stages of sintering and pressing has a positive impact on performance. The final density of the product is achieved by selecting parameters such as pressure, voltage, current density.

Country/Int. Organization

Russian Federation

Author: Dr TARASOV, Boris (NRNU MEPHI)

Co-authors: Dr SHORNIKOV, Dmitriy (NRNU MEPHI); Mr KONOVALOV, Igor (National Research Nuclear University ”MEPhI”); Ms TARASOVA, Maria (National research nuclear University ”MEPhI”); Mr NIKITIN, Stepan (NRNU MEPHI)

Presenter: Dr TARASOV, Boris (NRNU MEPHI)

Session Classification: 5.1 Advanced Fast Reactor Fuel Development I

Track Classification: Track 5. Fast Reactor Materials (Fuels and Structures) and Technology