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Seminarium Zakładu Energetyki Jądrowej i Analiz Środowiska (UZ3) Departament Badań Układów Złożonych (DUZ)

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Determination of the liquid eutectic metal fuel Dual Fluid Reactor design

Abstract:

The Dual Fluid Reactor (DFR) is a novel concept of innovative, high-temperature and fast nuclear reactor patented by an international group of scientist from the Institut für Festkörper-Kernphysik (IFK) in Berlin. The distinctive feature of its design is the use of two independent liquid loops for the fuel (molten salts - DFRs or molten metal - DFRm) and for the coolant (liquid lead).

During the presentation, a new 250 MWth Dual Fluid Reactor metallic design (DFRm) with liquid eutectic uranium-chromium fuel (composed of enriched uranium ^{235}U) will be presented. It follows the recent patent WO2020088707-A1 by IFK and verifies its basic principles. According to thermal and neutronic analyses, the reactor is critical and can operate for about 17 years without refuelling. The reactor dimensions result from parametric and material analysis with respect mainly to the effective neutron multiplication factor. The unique geometry, the applied materials, and very large values of the working medium parameters lead to a small and compact construction of the reactor.

Further analysis of the safety shows that DFRm is characterized by the negative temperature coefficient of reactivity, which equals about -3.00 pcm/K. All investigated material coefficients (fuel, coolant, reflector) are negative and stay even more negative with progressing burnup of the fuel. The thermal expansion of reactor materials and some minor changes in geometry do not significantly affect reactivity coefficients which always remain negative.

Finally, additional compositions made of spent nuclear fuel (SNF) from Light Water Reactors are investigated. The fuels include series of actinides up to ^{245}Cm . The results show unique DFRm properties: significant reduction of minor actinides (in particular ^{237}Np and americium isotopes) with high breeding capabilities.

Serdecznie zapraszamy
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