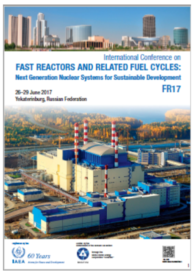

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A Versatile Coupled Test Reactor Concept

A Versatile Coupled Test Reactor (VCTR) is a highly reconfigurable, sodium-cooled, coupled fast and thermal spectrum test reactor, which provides (1) a fast flux irradiation environment prototypical of potential fast reactor designs, (2) thermal and epithermal flux irradiation environments complementary to those of ATR and HFIR, and (3) other possibilities, including beam tubes for scientific experiments, irradiation vehicles for isotope production, etc. The ongoing design of a new versatile coupled thermal-fast test reactor at INL that can accommodate both fast and thermal irradiation, technology and safety features tests is described in this paper.

A coupled reactor is defined as a reactor with two distinct spectral zones (Fast and Thermal), which are neutronically coupled to each other: some neutrons born in fast zone cause fission in thermal zone and vice-versa. Only fast neutrons are allowed to go from one zone to the other, which is assured by a thermal neutron filter. A distinction of coupling can be made depending on the main purpose of using fuel assemblies with some level of neutron moderation (thermal zone) together with fuel assemblies with as little moderation as possible (fast zone). It can be used mainly to minimize the core power and fissile inventory, or it can be used mainly to provide additional control of the irradiation conditions in the thermal zone.

The steady-state neutronics calculations were performed using the three-dimensional continuous-energy Monte Carlo reactor physics burnup calculation code Serpent2. Although, a few changes were necessary to support the Serpent code in calculating the coupling coefficients. Steady state and transient thermal analyses were performed with RELAP5-3D.

One of the core configurations using only low enriched uranium fuel could provide both a high fast neutron flux and a high thermal neutron flux—respectively 3.5E15 n/s.cm2 and 1E15 n/s.cm2—in large volumes while maintaining core power below 300 MW. The use of plutonium in the fast zone provides more flexibility in fuel assembly design than when low enriched uranium is used, the designer has more degrees of freedom to work with; in particular it could provide additional control of the irradiation conditions in the thermal zone.

The results showed that the current design fulfills most R&D needs requirements providing high thermal and fast fluxes and wide possibilities for diversified future reactor features test in appropriate loops, both in steady state and during transients.

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