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Virginia Tech Activities on the Design and Analysis of Advanced Subcritical Reactor Systems

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Over the past eight years, the Virginia Tech group has been working on the design and analysis of the GEM*STAR concept. This is a Molten Salt fueled Accelerator-Driven Subcritical Reactor (MS-ADSR) that uses a graphite moderator and a proton accelerator with a uranium target.

In previous analysis of the GEM*STAR reactor system, several simplifying assumptions were made about the neutronics modeling. In this paper, we report on a more detailed study using the Monteburns code system which employs the MCNP6 and CINDER90 code systems for neutronics and burnup calculations, respectively. For the tested fuel-feed compositions, the calculated equilibrium isotopic concentrations and electric multiplication factors are within similar orders of magnitude. Burnup analysis shows that the approach to equilibrium takes approximately two years for natural uranium fuel. Considering a natural uranium fuel, we have examined several feed materials including natural uranium, LWR spent fuel and weapon grade plutonium (WGPu).

Further, we have initiated a multidisciplinary program entitled Safe, Secure and Sustainable Nuclear Power (S3NPower) cluster. S3NPower brings together a group of VT faculty members from Nuclear Engineering, Physics, Material Science and Engineering and Mechanical Engineering to engage in the design and analysis of innovative reactor designs such as GEM*STAR. The team will address topics including Physics and Kinetics, Thermal Hydraulics, Nuclear Materials, Fuel Cycle and Waste, Monitoring Systems, and Nuclear Nonproliferation and Safeguards. This paper will report our preliminary efforts on comparing the safety and physics of a MS-ADSR prototype with a reference Molten Salt Reactor (MSR). The goal is to identify advantages/disadvantages of a subcritical reactor versus a critical reactor.

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