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Demonstration of Multi-physics (MCNP + Multiphase CFD) calculation for accelerator-driven LEU solution based Mo-99 production

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ABSTRACT

Understanding and improving the predictive capability of system parameters (power, temperature, heat transfer coefficient, etc.) for an accelerator-driven Low Enriched Uranium (LEU) based ^{99}Mo production facility is critical for advanced safety based design and licensing. Thus, the current study aims to develop and demonstrate a unique multi-physics methodology by iteratively coupling neutron transport calculation (MCNP6) and corresponding thermal hydraulic assessment (ANSYS-Fluent17.2). We report on the k-effective (keff) calculation for a baseline system configuration with a selected solution concentration using K-code modeling. A set of thermal properties for the target solution over a range of potential temperatures and concentrations is developed by a multi-variable regression method based on existing experimental measurements. The multi-physics coupling methodology between MCNP and multiphase CFD is successfully demonstrated with four different operating scenarios. Saturated system power and overall heat transfer coefficient at the corresponding power condition are reported. Further, two improved coupling methods are proposed and tested (i.e., dynamic height adjustment and multi-cell approach). The assessment of the multi-physics methodology and preliminary results from the current study will be further evaluated with a system code validation for steady and transient conditions.