THERMAL MECHANICAL ANALYSIS OF APPLICATIONS WITH INTERNAL HEAT GENERATION

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ABSTRACT

The radioactive tracer Technetium-99m is widely used in medical imaging and is derived from its parent isotope Molybdenum-99 (Mo-99) by radioactive decay. The majority of Mo-99 produced internationally is extracted from high-enriched uranium (HEU) dispersion targets that have been irradiated. To alleviate proliferation risks associated with HEU-based targets, the use of low-enriched uranium (LEU) sources is being mandated. However, the conversion of HEU to LEU based dispersion targets affects the Mo-99 available for chemical extraction. A possible approach to increase the uranium density, to recover the loss of Mo-99 production-per-target, is to use an LEU metal foil placed within an aluminum cladding to form a composite structure. The composite annular target is expected to contain the fission products and to dissipate the generated heat to the reactor coolant. The target can be deemed thermally and structurally safe as long as the temperature and stresses in the cladding are within the melting temperature and yield strength of the cladding material.

As with the thermal and structural safety of the annular target, the thermally induced deflection of the BORAL®-based control blades, used by the University of Missouri Research Reactor (MURR®), during reactor operation has been analyzed. A finite element model of the control blade is solved as a fully coupled thermal mechanical problem as in the case of the annular target and the resulting deflection is compared with the channel gap to determine if there is a significant risk of the control blade binding during reactor operation.

The common theme in both these applications is the nuclear heat source, high heat flux, non-uniform heating, composite structures and differential thermal expansion. The goal is to establish and document, the operational safety of the annular target and the control blade.