Evaluation of Thermal Conductivity of Metallic Tubes in Nuclear Applications

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Abstract:

Heat conduction, transfer and thermal management are critical in nuclear reactors, nuclear fuel management and irradiation of materials. Thermal conductivity of thin-wall aluminum-copper-aluminum tubes have been evaluated using a modified Transient Plane Source (TPS) method. The 30-40 cm long tubes have a diameter of 25 mm and wall thickness of 2 mm. The copper foil sandwiched between two aluminum tubes was bonded by hydroforming. This structure is used to simulate nuclear fuel to be irradiate in the High Flux Isotope Reactor (HFIR) at Oak Ridge National laboratory. The final thermal conductivity measurement needs to be performed inside a Hot Cell with high radiation and controlled by mechanical manipulators. The TPS or Hot Disk sensor is pressed against the tube using Styrofoam insulation. A combination of the Thin Slab mode and single-side measurement was used to obtain thermal conductivity of the tubes. In order to validate this approach, metal tubes of 316 stainless steel and copper water pipe were tested under the same configuration. Thermal conductivity is a critical design parameter for the nuclear fuel applications. An accurate thermal conductivity of the tube allows system cooling design and enables sufficient temperature control. The modified test method, sensor wiring, and sample holder have been confirmed to be suitable for Hot Cell operations.