Modeling on thermal conductivity of MOX fuel considering its microstructural heterogeneity

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Abstract

This paper describes a new mechanistic thermal conductivity model considering the heterogeneous microstructure of MOX fuel. Even though the thermal conductivities of MOX have been investigated numerously by experimental measurements and theoretical analyses, they show the large scattering making the performance analysis of MOX fuel difficult. Therefore, a thermal conductivity model that depends on the heterogeneous microstructure of MOX fuel has been developed by using a general two-phase thermal conductivity model. In order to apply this model for developing the thermal conductivity for heterogeneous MOX fuel, the fuel is assumed to consist of Purich particles and UO2 matrix including PuO2 in solid solution.

Since little relevant data on Purich particles is available, FIGARO and SiemensKWU results are only used to characterize the microstructure of unirradiated and irradiated fuel. Phillipponneaus and HALDEN models are selected for the local thermal conductivities for Purich particles and matrix, respectively. Then by combining the two models, overall thermal conductivity of MOX fuel is obtained. The new proposed model estimates the MOX thermal conductivity about 10% less than the value of UO2 fuel, which is in the range of MOX thermal conductivity from HALDEN.

The developed thermal conductivity model has been incorporated into KAERIs fuel performance code, COSMOS, and then verified using the measured data in the FIGARO program. Comparison of predicted and measured temperatures shows the reasonable agreement within acceptable error bounds together with satisfactory results for the fission gas release and gap pressure.