Steady-State and Transient Temperature Distributions of Fuel and Coolant in Radial and Axial Directions in a Cylindrical Nuclear Fuel Element

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Abstract

Steady-state and transient temperature distributions throughout a nuclear fuel element composed of fuel, gap and clad regions as well as the mean coolant temperature are predicted using a finite difference conduction-convection numerical analysis. The implicit Crank-Nicolson scheme is used to predict temperature in the fuel pin nodes and the mean coolant temperature in each axial section. These temperatures are then used to solve the explicit governing equation for the coolant and give the outlet temperature from each axial section. The numerical analysis is based on energy equation for a node, to make sure that energy is always conserved in a strict sense, especially at the boundaries of four different regions (fuel, gap, clad, coolant) when the adjacent nodes belong to the non-homogeneous regions.

Keywords: Heat conduction equation – analytical, numerical approach – accuracy, stability and truncation error