Consistent 1-D Neutronics Modeling using Current Conservation Factors

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Abstract

The 3D neutronics code is the ultimate means of achieving high fidelity in the neutronic simulation of the reactor core, nevertheless the 1D neutronics model is needed to replace 3D model in many practical circumstances.

In this paper a 3D consistent 1D model based on nonlinear analytic nodal method is developed. During the derivation, the current conservation factor (CCF) is introduced which guarantees the same axial neutron currents obtained from the 1D equation as the 3D reference values.

To test the 1D model with CCF, three cases of steady state calculation were performed and compared with 3D reference values. The errors of K-eff values were reduced about one tenth when using CCF. And the errors of power distribution were decreased to the range of one fifth or tenth at steady state calculation.

With the planar averaged group constants and the CCFs introduced in this paper, it becomes possible to reproduce the 3D reference solution from the 1D model. Thus the 1D model with CCF can provide the preciser results at the steady state, and it is expected that the slow transient such as the day range xenon dynamics can be simulated more accurately with 1D model.