Automatic Time Step Selection for Numerical Solution of Neutron Diffusion Problems

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Considering the approximate solution of the boundary value problems for nonstationary equations, the focus should be on the choice of time approximation schemes. For parabolic equations of the second order, unconditionally stable schemes are constructed on the basis of implicit approximations. In computational practice two-layer schemes are mostly used, compared with three-layered and multilayered schemes which are not so often used.

We propose an algorithm allowing automatic time step evaluation when solving the boundary value problems for parabolic equations. The solution is obtained using guaranteed stable implicit schemes, and the step choice is performed with the use of the solution obtained by an explicit scheme. Formulas for explicit calculation of the time step are derived using the estimation of the approximation error at new time step.

Calculation results obtained for some neutron diffusion problems demonstrate reliability of the proposed algorithm for time step choice. The algorithm takes into account the features of neutron diffusion problems, for instance, sharp changes in the solution or instability with respect to the initial data. When using the algorithm, you can expect a noticeable saving in calculation time compared with the fine mesh calculation, while maintaining the required accuracy of the calculation.