Numerical simulation of dynamic processes in a nuclear reactor by state change modal method

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Modelling of dynamic processes in nuclear reactors is carried out, mainly, on the basis of the multigroup diffusion approximation for the neutron flux. The basic model includes a multidimensional set of coupled parabolic equations and ordinary differential equations. Dynamic processes are modelled by a successive change of the reactor states, which are characterized by given coefficients of the equations. It is considered that the transition from one state to another occurs instantaneously. In the modal method the approximate solution is represented as eigenfunction expansion. The numerical-analytical method is based on the use of dominant time-eigenvalues of a multigroup diffusion model taking into account delayed neutrons. For each reactor state the eigenvalues and eigenfunctions of the α-eigenvalue problem are calculated in advance. This provides very fast calculations in real-time scale. Numerical simulations of the dynamic process were performed in the framework of the two-group approximation for the VVER-1000 reactor test model. The last is characterized by the fact that some eigenvalues are complex. The dynamic model includes two reactor states, namely the regular regime of the supercritical state with further transition to the subcritical state. The results of the dynamic process simulation demonstrate the acceptable accuracy in calculation of neutron power and delayed neutrons source in comparison with the direct dynamic calculation.