Modulation of the neutron field in the multiplying condensed matter and coolant

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A problem of the excitation of thermal neutrons density oscillations, of their propagation and spatial damping (or growth) in a multiplying medium with a coolant is studied. A self-consistent system of equations, describing the processes of neutrons density modulation, is formulated. It includes equations of thermal neutron di.usion together with neutron multiplication and capture, as well as the equations of hydro-dynamics of viscous fluid. The heat emission due to nuclear fission is accounted for in the equation of thermal balance. The corresponding entropy production takes place, so the processes in the system are non-adiabatic. The damping of acoustic, neutron and thermal branches of oscillations are found in this neutron multiplying medium with coolant. A dispersion function and complex wave numbers, which determine the particularities of the neutron field modulation, are also obtained. All three branches give additive contribution to the neutron density oscillations. However, their wave numbers and coefficients of spatial damping (at the same frequency) differ greatly from the sound with its high phase velocity and small attenuation to the neutron wave with the damping length, which is comparable with its wavelength. A spatial growth of temperature oscillations is found in the case of large neutron diffusion and weak coupling of neutron density and temperature oscillations. This fact is of importance for the noise diagnostics of the multiplying medium with coolant. Estimations of the neutron field modulation by the different oscillation branches are made. The modulation amplitudes in the neutron and temperature channels are found to be considerably greater than in the acoustical channel. The results of the work can be applied to the development of the methods of noise diagnostics of the incore reactor equipment.