OPERABILITY ESTIMATION OF ROD FUEL ELEMENT'S CLADDINGS OF NUCLEAR REACTORS WITH CONSIDERING OF THE CREEP

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The economic effect of the nuclear power plants is limited by the opportunity of the long-term exploitation of fuel elements in reactor's core. Thus, the opportunity to propose the most precisely estimation of the operability of fuel element's cladding of nuclear reactors is one of the most important problem of the modern nuclear power engineering. High temperatures in nuclear reactor core and relatively high mechanical stresses from interactions with moving heat carriers lead to the conditions which auspicious to the creep. Taking this into account, wit is necessary to consider the creep to estimate the operability of rod fuel element's claddings of nuclear reactors.

We will use the schematization of the rod fuel element's cladding presented in the form of the thick-walled axisymmetric long-length cylinder loaded by the internal and external pressures and axial tensile force, which is established as the result of that pressures. We will use the particular variant of the creep theory with Kachanov-Rabotnov scalar damage parameter for the mathematical description of the creep in the material. The computer modelling of the state of the rod element's cladding of VVER-1000 nuclear reactor was realized with proposed schematization and mathematical model of the creep. As results of that computer modelling, we watched that the time before finishing of the latent damaging stage and forming the visual defect in the cladding of fuel rod have no dependences on the internal and external pressures, but have dependences on the absolute difference between internal and external pressures only. This conclusion corresponds with all-known phenomenological fact that the rates of creep and damage depends on invariant of the stress deviator only. Really, the invariant of stress deviator is zero for the all-round stretching or compressing and case of equal internal and external pressures acting on the fuel cladding corresponds to the state, which is closely to the all-round compressing.

Due to obtained results we can to tell that proposed schematisation of the fuel's cladding as the thick-walled long-length cylinder under internal and external pressures is unsuitable for the operability estimation of the fuel cladding of thermal nuclear reactors with light water as a heat carrier and as a neutron moderator, because internal and external pressures on fuel cladding in these reactors are comparable. It seems, that for these reactors it is necessary to consider the bending of fuel cladding in the flows of fluid heat carriers to estimate the operability limits. The bending consideration for the fuel cladding will be researched later. At the same time the proposed schematisation of fuel cladding can be suitable for fuel cladding of fast-breeder nuclear reactors with fluid metals as heat carriers, because the external pressure of fluid metal heat carriers on the cladding is significantly less than the internal pressure in the gaseous gap, which is between the fuel tablets and the cladding.