ESTIMATING THE FUNDAMENTAL FREQUENCIES OF THE THICK-WALL CLADDING OF CYLINDRICAL FUEL ELEMENTS OF NUCLEAR REACTORS

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It is well-known that a core of nuclear reactors is under the significantly non-stationary external impacting factors produced from the moving high-pressured and high-temperature heat carrier. These factors can significantly limiting the durability of important for efficiency and safety core structures such as the fuel assemblies and the claddings of fuel elements inside theirs first of all. Damages in the cladding of fuel elements are occurred due to inertia forces generated by the non-stationary external impacting factors produced from the moving high-pressured and high-temperature heat carrier. To estimate these inertia forces it is necessary to know the fundamental frequencies of the cladding, corresponded to the different form of the vibrations. Thus, it is of current interests the theme of this research deals with estimating the fundamental frequencies, corresponding to the plane axial-symmetrical strain, of the cladding of nuclear fuel elements of nuclear reactors.

There are a lot of method for estimating the fundamental frequencies, but it is proposed to use the finite differences technique, because it is will be necessary to solve further the dynamic problem of the theory of elasticity by using the method of lines, which is considered as one of perspective approach now, although this method is well-known. Differential equation, representing the non-stationary stress-strain state of the thick-walled cylindrical cladding, is obtained from the general equations of the dynamic theory of elasticity, represented in the cylindrical coordinates, considering with the well-known assumptions of plane strain state. This approach leads to the partial differential equation with second order on radial coordinate and on the time. By using the well-known Fourier approach, this partial differential equation is reduced to the ordinal differential equation of second order on radial coordinate for the function of forms. To find the fundamental frequencies of the cladding the obtained differential equation for the function of forms is considered with the boundary conditions corresponded to the surfaces of cladding free from the loadings. Using the well-known finite differences technique, the discretization of the differential equation considering the boundary conditions for the function of forms is obtained in the matrix form relatively the nodal values of the function of forms. As the conditions of existing the non-zero solution for the function of forms the characteristic equation for finding the fundamental frequencies are obtained. This characteristic equation with large matrix size, corresponding to the necessary large number of grid nodes, can be solved numerically only. In further, on the basis of the proposed approach using the finite differences the numerical computer simulations of the fundamental frequencies of the cladding of fuel elements will be accomplished for the nuclear reactor VVER-1000 and VVER-440 type, widely used in Ukrainian power industry.