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Application of spectral tuning on the dynamic model of the reactor VVER 1000 support cylinder

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Abstract

The paper deals with the optimization of parameters of the dynamic model of the reactor VVER 1000 support cylinder. Within the model of the whole reactor, support cylinder appears to be a significant subsystem for its modal properties having dominant influence on the behaviour of the reactor as a whole. Relative sensitivities of eigenfrequencies to a change of the discrete parameters of the model were determined. Obtained values were applied in the following spectral tuning process of the (selected) discrete parameters. Since the past calculations have shown that spectral tuning by the changes of mass parameters is not effective, the presented paper demonstrates what results are achieved when the set of the tuning parameters is extended by the geometric parameters. Tuning itself is then formulated as an optimization problem with inequalities.

Keywords: reactor VVER 1000, support cylinder, spectral tuning

1. Introduction

The tuning of the dynamic model was based on the values of eigenfrequencies that were computed on the FEM model, and could also be identified on the dynamic model. The computation model, that has been developed in Cosmos/M programming code, contains support cylinder with core barrel housing. The eigenfrequencies obtained by modal analysis of this model represent the objective values for the eigenfrequencies of the tuned dynamic model of the support cylinder.

The tuning of the discrete parameters of the dynamic model of the support cylinder body is the first step of identification of the parameters of the complete VVER 1000 reactor model. It was necessary to use identical boundary conditions for both models so that modal properties of the support cylinder would not be influenced by any other factor. In case of this model, it means that all stiffness parameters, including the gland flange stiffness, the bearing support stiffness and the stiffness of the toroidal pipes, were not considered. The only stiffness element which was considered was the contact stiffness of the support cylinder with the flange of the pressure vessel.

As the past calculations [3] showed, spectral tuning carried out only by changes of mass parameters has not appeared to be effective. Therefore it was necessary to add some other parameters for a new tuning process. It was found reasonable that geometric parameters (thickness of the support cylinder wall and its diameter) could be the suitable ones to extend the set of tuning parameters. The fact that the total weight of the new dynamic model should be approximately the same as the weight of the FEM model is also taken into account. This requirement is represented by two inequality constraints. Further, the changes of all discrete pa-

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