TORSIONAL FATIGUE OF STEAM TURBINE ROTOR AS A RESULT OF GENERATOR FAULTS

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The world-wide experience of long-term exploitation of steam turbines makes it possible to conclude that the main reason of failures and disastrous breakdowns of turbine rotors is the accumulation of fatigue damage caused by theirs torsional vibrations. Such vibrations are exited as a result of generator faults as, for instance, the generator short circuit or the switching the generator on the network system with a coarse synchronization. Both faults lead to the short-term surge of the reactive torsional electromagnetic moment acting from the side of generator upon the turbine rotor.

The steam turbine is a complex mechanical system which consists of high pressure, middle pressure and low pressure stages with different temperature and load conditions. The three-dimensional finite-element model of a turbine-generator rotor model consisted of 50 thousand elements was developed and used for the investigations.

The estimation of torsional fatigue damage of rotor under the action of short-term reactive moment was performed based on the finite-element model and experimental data of fatigue properties of rotor steel at torsion with account for the influence of the temperature, asymmetry of loading and scale effect. The linear theory of damage summation (the hypothesis of Palmgren and Miner) was used in calculations of fatigue damage of rotor. The different variants of loading were investigated. The amplitude and duration of the reactive torsional moment as well as the level of damping were varied in a wide range. It may be concluded from the results of calculations that in most cases of loading the essential fatigue damage of rotor takes place. As a result of one cycle of a generator short circuit the relative fatigue damage of rotor may reach up to 0.04.

As a result of extreme insufficiency of information on the static and dynamic strength of turbines rotors, as well as on the parameters of reactive torsional moment in service conditions the forecasting of rotors damage development caused by the torsional vibrations at present time can not be recognized as sufficiently reliable. In connection with this it is necessary to equip turbines by modern means of control not only for the transverse but also for the torsional vibrations of rotors. In this case the accuracy of the torsional fatigue damage estimation may be substantially increased.