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ABSTRACT

Doctoral dissertation

Field-circuit analysis of abnormal operating states of turbogenerator

The doctoral dissertation consists of eight chapters and a list of references.

The first chapter provides an overview of research issues occurring in analysis of abnormal operating states of turbogenerator and the aim, scope and scientific thesis of the dissertation. The aim of the doctoral thesis is the study of electromagnetic and electromechanical phenomena occurring in modern turbogenerator during abnormal operating states. Selected states are the following loss of field, accidental off-line turbogenerator energizing, faulty synchronization and double field ground in the excitation winding. The scientific thesis is formulated as *field-circuit analyses of abnormal operating states of turbogenerator allow to describe the electromagnetic phenomena and their effects in both the stator and rotor and consequently indicate the most vulnerable construction elements in the machine.*

The second chapter shows the turbogenerator models used during calculation process. There are described the models utilized to research of magneto static field, steady state AC magnetic field and transient states. Furthermore extended model for research of double field ground in the excitation winding is described in details.

The third chapter deals with verification of turbogenerator models based on field and field-circuit methods. Measured and calculated static characteristics (such as no-load and short circuit curves) are compared each others. Beside that measured and calculated reactances and time constants are compared as well. Good accuracy of determined electromagnetic parameters describing synchronous machines in transient states allow to utilize build field-circuit turbogenerator model to research the turbogenerator behavior during abnormal operating states.

In the fourth chapter are presented the computation results of loss of field. Based on the results, it is possible to utilize the magnetic flux as a criterion for detecting this abnormal state. This method is significantly faster than the widely applicable criterion of changing the position of impedance vector seen from the armature winding. The analysis of electromagnetic phenomena during acceptable asynchronous work (M=0,4 M_N) shows that there is lack of the risks of turbogenerator construction elements damages as a results of huge electrodynamics forces and heat.

The fifth chapter contains the calculation results of accidental off-line turbogenerator energizing. The physical phenomena existing in rotor are studied. Based on the results, the most vulnerable construction elements to damage are indicated.

The sixth chapter concerns the analysis of faulty synchronization. The conditions of the occurrences of highest electromagnetic torques and stator currents are studied. Achieved results indicate that computed electromagnetic torque from faulty synchronization with inverse phase sequence should be taken to mechanical computation to determine the mechanical stresses.

In the seventh chapter are presented the computation results of double field ground in the excitation winding. Field-circuit analyze of electromagnetic phenomena indicate the risk of huge short-circuit current exceeding 25 I_{FN} and can melt the rotor steel. Double ground faults in excitation winding distort the magnetic field in gap causing the distortion of electromotive force (increase of third harmonic) and stator current (increase of second harmonic). Second harmonic of stator current can be a diagnostic pattern to detect this abnormal operating state.

The eighth chapter contains the summary of the dissertation and general conclusions.

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