DEVELOPMENT OF MODEL OF POLY PARAMETRIC DESIGN OF ELECTROMECHANICAL ENERGY CONVERTERS

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The work is devoted to polyparametric design of electromechanical energy converters. Parametric design (parameterization) is modeling using the parameters of the model elements, its links and the functional interaction of these elements and the relationships between these parameters. Parameterization allows for a relatively short time to calculate various designs and layouts and at the same time minimize the number of fundamental errors in the design.

Designing a future structure taking into account several variables (adjustable or non-adjustable) is a complicated type of parametric design and is a polyparametric design. This design is significantly different from conventional 2D drafting or 3D modeling. The ideas of polyparametric design appeared at the early stages of CAD development, and are successfully implemented using computer technology. The most common programs for polyparametric design are as follows: KOMPAS 3D, Creo Parametric (ProEngineer), Autodesk (AutoCAD), SolidWorks (SolidWorks Simulation, SolidWorks Electrical), ANSYS, COMSOL Multiphysics, MATLAB.

As the initial indicator of the polyparametric model of the turbogenerator (TG), we take the total power (P_s) of the TG, and as a parametric indicator, the current density (j_1) in the stator winding:

$$j_1 = \sqrt{\frac{\gamma \cdot C_p \cdot \vartheta \cdot (q_k/q_{c1})}{l \cdot k_f}} \qquad (1)$$

γ – electrical conductivity of copper, m/Om·mm^2; C_p – specific heat capacity of copper, (kW·s)/(m^3·°C); υ – speed of movement of the cooling medium in the hollow conductors of the stator winding, m/s; l – length of the cooled section of the stator winding rod, m; q_k/q_{c1} – ratio of the cross-section of the cooling channels in the stator winding to the cross-section of copper in the stator winding, p.u.; k_f – coefficient of increase in losses (current displacement coefficient), p.u.

Therefore, the TG polyparametric design model will determine the value of its apparent power (kVA):

$$P_S = \sqrt{3} \cdot U_N \cdot a_1 \cdot q_{a1} \cdot \sqrt{\frac{\gamma \cdot C_p \cdot \vartheta \cdot (q_k/q_{c1})}{l \cdot k_f}} \cdot 10^{-3} \qquad (2)$$

U_N – stator winding voltage, kV; a_1 – number of parallel branches in the phase, o.u.; q_{a1} – cross-section of copper of all rods of the stator winding, mm^2;

In general, a mathematical model of the simplest polyparametric design of a TG can be defined as a multicomponent dependence $P_S = f(U_N, a_1, q_{a1}, j_1)$, while each component can be represented by a dependent and independent function (adjustable or non-adjustable parameter).

Hence, the recommended current density in the stator winding largely depends on the TG cooling system and is in the range of 3...4 A/mm^2 – for indirect cooling, and 6...11 A/mm^2 – for direct cooling of the stator winding.