A SHAPE OPTIMISATION OF COOLING FINS IN ELECTRICAL TRANSFORMER TANK USING GA ALGORITHM

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ABSTRACT

The effective and long-term operation of electrical transformers strongly depends on the cooling conditions. To increase the heat dissipation from the naturally air-cooled unit, the tanks are equipped with fins that are positioned to have the same distances, thicknesses and heights between coils. Based on the validated coupled numerical simulations of the three-phase transformer performance [1], it was shown that such a configuration is not optimal. Hence, the aim of this research was to optimise the geometrical dimensions of the transformer tank fins.

In most of papers, the authors focus on the global optimisation to achieve a lower cost, a reduced size and a better operating performance. In consequence, the objective function is computed using only global parameters that characterise the analysed device [2,3]. For example, the typical simplifications include the constant losses generated in the core and coils, constant material properties, constant cooling conditions, radiation omission.

In contrary to those approaches, in the present work, the objective function was computed using a CFD analysis that included a 3-D model of transformer top tank wall and the volume of the surrounding air. The model is a part of the coupled CFD and electromagnetic approaches described in detail in [1]. It was also assumed that the mass and the total dimensions of the tank did not increased.

The fin optimisation computations can be summarised in the following way: an in-house code generated parameters composing a chromosome in each generation. Then using the optimised parameters, geometry generator was executed in serial mode to build geometries and meshes of the entire generation. In the next step, the parallel CFD solvers were run (the tasks were also executed in parallel mode) to speed up the solution of the formulated problem. As a result, a set of fitness functions was determined for each individual. In the last step, the functions were estimated and the new parameters were generated starting the next generation.

The final configuration of the top finned wall of the tank is different in comparison to the original device. The obtained results show a noticeable drop of the operating winding temperature. This means that both coil and core losses were also reduced. In addition, a thermal class of the windings can also be lowered reducing the overall cost of the device.

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