Fast boundary element methods for the simulation of electric eddy current fields, their heat production and cooling

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Abstract: For the layout of high energy electrical devices in industry, an efficient boundary element method has been developed in strong cooperation with an international firm.

As an example we model an electric transformer which is driven by an alternating current of 50 Hertz producing the driving energy. We compute the electric field and the eddy current density in the device by solving the Maxwell equations. Appropriate boundary potentials are employed and corresponding boundary integral equations are formulated in combination with domain decomposition. These equations are approximated by a Galerkin boundary element method which results in a very large system of linear equations with about 10^6 DOFs. For their numerical solution we apply a fast iterative method based on algebraic cross approximation. The eddy currents produce a large amount of heat which needs to be taken care of by a cooling flow. The corresponding heat problem will be solved again by a fast boundary element method whereas the cooling flow can be simplified by making use of Prantl's boundary layer approximation.