RestorATION the current flowing through the tube using the electric field strength measured at its inner surface

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The problem of restoration megampere current, flowing through the tube with a wall thickness significantly exceeding the thickness of the skin layer (estimated using the conductivity at room temperature), is being considered. To solve this problem we use the experimental data on the electric field intensity, measured on the inner surface of the tube [1]. Solution of a similar problem, presented in [2], is applicable for the case of a thin tubule (the wall thickness comparable with the thickness of the skin layer), and assuming that the thermal parameters of the tubule material do not change in time, the temperature remains constant. These assumptions are not right under the experimental conditions, described in the present work. Thus, the material of the tube is heated significantly during the passage of the current through it, for example, the outer layers of the tube are heated to temperatures near the melting point. As a result, all the thermophysical properties vary considerably, including conductivity, which affects the magnetic field and current density distribution through the thickness of the tube.

It is proposed to consider a thick tube as a series of nested thin tubules, for each the diffusion equation of the magnetic field by the Laplace transform is being solved; boundary conditions for the series of tubules are found in the condition that the current density and magnetic field on the conventional outer surface of the n-th tubule and the inner surface of the next, (n+1)-th tubule are equal. This method allows to take into account the nonuniform current distribution through the thickness of the tube, and at the same time we can track the process of substance heating through the layers and of changes in its conductivity.

The solution is found in the single-temperature approximation; smallness of the tube wall thickness in comparison with its radius allows to use a Cartesian coordinate system; since the problem is axially symmetric, the equations are solved in one-dimensional approximation.

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Bibliography

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