NASA TECH BRIEF
Marshall Space Flight Center

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Alternating Current Losses in Superconducting Coils

A superconducting material wound into a coil, will not carry as large a current as tests on shorter lengths would suggest. At present, superconductors are clad in copper to prevent current reducing instabilities. This is an expensive and bulky solution. In order to find a more efficient remedy a study was begun, and a report published, on the nature of these instabilities. The report deals primarily with the technique of exciting the coils with an alternating current. A measurement of the heat dissipated should lead to a better understanding of the mechanism involved in the degradation of the coil.

First examined was the relationship between coil loss and frequency. The conductor used was a composite of Nb, Nb_3-Sn and Cu in the form of a tape wound into a pancake coil. It was found that dividing the coil losses by the current squared (I^2) and the tape length squared helped correlate the data. (However, there is no theoretical basis for this correlation.) The figure is a sample of the results. Finally, the heat loss in the coil was investigated as a function of the magnetic field H. In a normal conductor the heat loss would be proportional to $I^2 R$ (R=Resistance). But in the case of a superconductor, the magnetic flux can penetrate the conductor to produce eddy currents in the interior of the conductor as well as on its surface; thus the heat loss will be proportional to I^3 or more exactly $(H_{peak})^3$ When measured, the heat loss in low fields was proportional to $(H_{peak})^3$ as expected, but it was found that in high fields (over 1000 gauss) the heat loss is proportional to $(H_{peak})^{3.5}$.

Coil Loss vs Frequency

Notes:

1. This information may be of interest to manufacturers of superconducting magnets, motors, and generators.
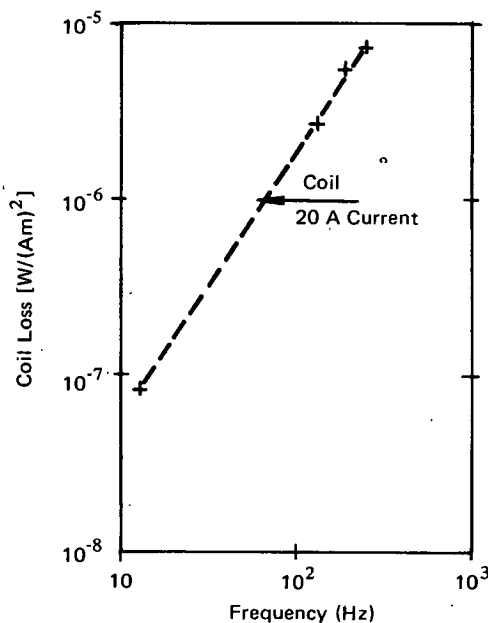
2. Requests for further information may be directed to:
   Technology Utilization Officer
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No patent action is contemplated by NASA.

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