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NASA TECH BRIEF

Goddard Space Flight Center

Hexapole Magnet Field Analysis

The problem:

The measurement of a hexapole magnet field by the use of Hall effect magnetometers or flip coils is inaccurate because their size is large compared to the magnet gap.

The solution:

A method was developed in which the field of the hexapole magnet is analyzed by rotating the magnet about a wire loop of rectangular shape placed inside the pole tips and measuring the induced loop voltage with a wave analyzer. The quantitative characteristics of the field are then determined from this voltage induced at various harmonics of the rotation frequency.

How it's done:

The technique requires an analyzer, a loop, and the magnet. The two components of the magnetic field are determined from the following expressions:

$$B_r = \Sigma B_n (r/r_o)^{n-1} \cos n\theta$$

$$B\theta = -\Sigma B_n (r/r_o)^{n-1} \sin n\theta$$

where r_o is the radius of the magnet.

For a symmetric hexapole magnet, B_n has non-zero values at n = 3, 9, 15. . ., with n = 3 producing the dominant term. The magnitude of B_n is determined by rotating the magnet about its axis and measuring the voltage induced in a rectangular pickup loop placed so that it is bisected by the magnet axis. In this arrangement, various harmonics of rotation frequency can readily be separated by the wave analyzer. Furthermore, the harmonic number of the B_n can be unambiguously identified by measuring the rotation period with an electronic counter.

The voltage induced at the n'th harmonic is related to B_n by the expression:

$$V_n(t) = 2Lr_o \omega B_n (D/2r_o)^n \cos n\omega t$$

where L is the length of the loop, D its width measured between the centers of the wire, t is time, and ω is the angular frequency at which the magnet is rotated.

Applications for this technique are also useful in the design of hexapole magnets. For example, the effect of different pole tip shapes on the field can be measured, and the effect of different designs on the maximum field strength can be determined.

Note:

Requests for further information may be directed to:

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No patent action is contemplated by NASA.

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