Analysis & Probability/Algebra: Disk Drive Engineer

Hewlett-Packard Company

Job Description: Design digital magnetic recording systems for use in hard disk drives.

Problem:

A magnetic recording engineer wants to determine the minimum write current (I_w) he can use to drive a head to write magnetic transitions (bits of information) onto a disk in a disk drive.

The head cannot get any closer than 25 nanometers (1 nanometer = 1×10^{-9} meters) to the surface of the disk. The magnetic field at the head gap (H_g) is roughly equal to product of the number of windings on the head (N) times the write current (expressed in amps), divided by the distance of the gap (G).

$Hg = (N \times I_w) \div G$

The magnetic field is expressed in a couple of terms, Oersteds (Oe) and Amp•Turns/Meters. One Orested is equal to 80•πAmp•Turns/Meter.

The head has 48 turns (or windings,N) and the gap distance,G, is 1 micrometer (1×10^{-6} meters or 1 µm). From previous modeling, he knows that the magnetic field decreases with distance away from the gap, such that it is roughly one half of H_g when the head is 25 nanometers away from the disk. He knows there is a demagnetizing field (H_d) that occurs inside the disk during the write process.

This field opposes the field from the head. Previous calculations showed that H_d is 500 Oersteds. The net field for writing (H_x) must be greater than the coercivity (H_c) of the media plus the demagnetizing field. The coercivity of the media has been measured at 2000 Oersteds.

What is the minimum write current?

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See problem for details.

Solution:

$H_x > H_c + H_d$
H_x = net field for writing
H_c = coercivity of media
H_d = Demagnetizing field

$H_c + H_d = 2000 \text{ Oe} + 500 \text{ Oe}$

$= 2500 \text{ Oe}$

$H_x = 0.5 H_g$

Therefore, $H_g = 2 \cdot H_x > 5000 \text{ Oe}$

1 Oe = 80 • π Amp • Turns / Meter, abbreviated (A • T) / m

Therefore, $H_g > 5000 \text{ Oe } (80 \cdot \pi) (A \cdot T)/m$

$H_g > 1.26 \cdot 10^6 \; A \cdot T/m$

$H_g = (I_w \cdot N)/G$

$I_w = H_g \cdot G/N = (1.2^6 \cdot 10^6 \; A \cdot T/m)(1 \cdot 10^{-6} \; m) / 48 \; T$

$I_w > 0.026$ Amps or $26 \cdot 10^{-3}$ Amps (26 milliamps)