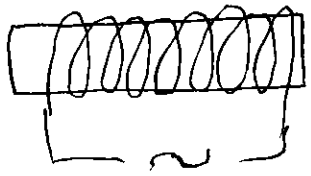
Hysteresis loss

Consider a magnetic material of length l across which a coil of area of cross section A, no of turns N and carrying a.c current is wound



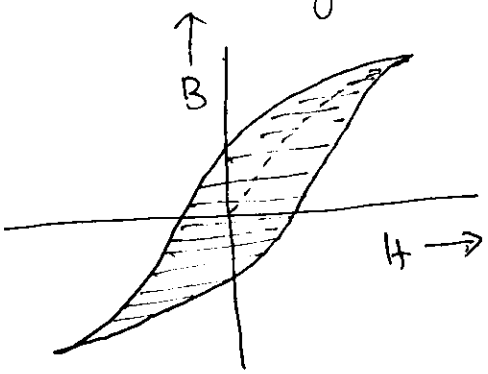
If at any instant current is i and magnetic flux density is B then flux

$$\Phi_B = NBA \quad \text{——} (1)$$

and magnetising field

$$H = \frac{Ni}{l}$$

$$\Rightarrow i = \frac{Hl}{N} \quad \text{——} (2)$$



As current changes, the magnetic flux Φ_B also changes producing an induced emf e given by

$$e = -\frac{d\Phi_B}{dt} = -\frac{d}{dt}(NBA)$$

$$e = -NA\frac{dB}{dt} \quad \text{——} (3)$$

According to lenz's law work dW' will have to be done against changing current in time dt

$$dW' = ei\,dt = +NA\frac{dB}{dt}\cdot\frac{Hl}{N}\cdot dt$$

$$dW' = H\,dB\cdot Al$$

$\therefore$ work done per unit volume is

$$dW = \frac{dW'}{V} = \frac{H\,dB\,A\cdot l}{Al}$$

$$dW = H\,dB$$

$\therefore$ As field changes from B_1 to B_2

$$W = \int_{B_1}^{B_2} H\,dB$$

on a complete cycle B

$$W = \oint H\,dB$$

$\therefore$ work done is measured by area of B-H loop

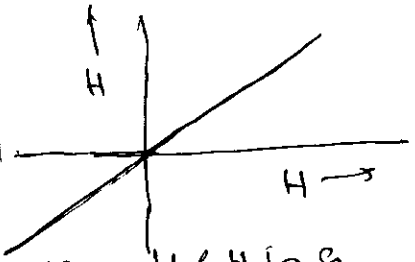
PTO

Also $B = \mu_0[H + M]$

$\Rightarrow dB = \mu_0[dH + dM]$

$\Rightarrow H\,dB = \mu_0 H\,dH + \mu_0 H\,dM$

$\therefore \oint H\,dB = \mu_0 \oint H\,dH + \mu_0 \oint H\,dM$



But $\oint H\,dH = 0$ $\therefore$ curve between H & H is a straight line and loop area is zero