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Title of the experiment: Hysteresis loop Tracer
(B-H loop experiment)

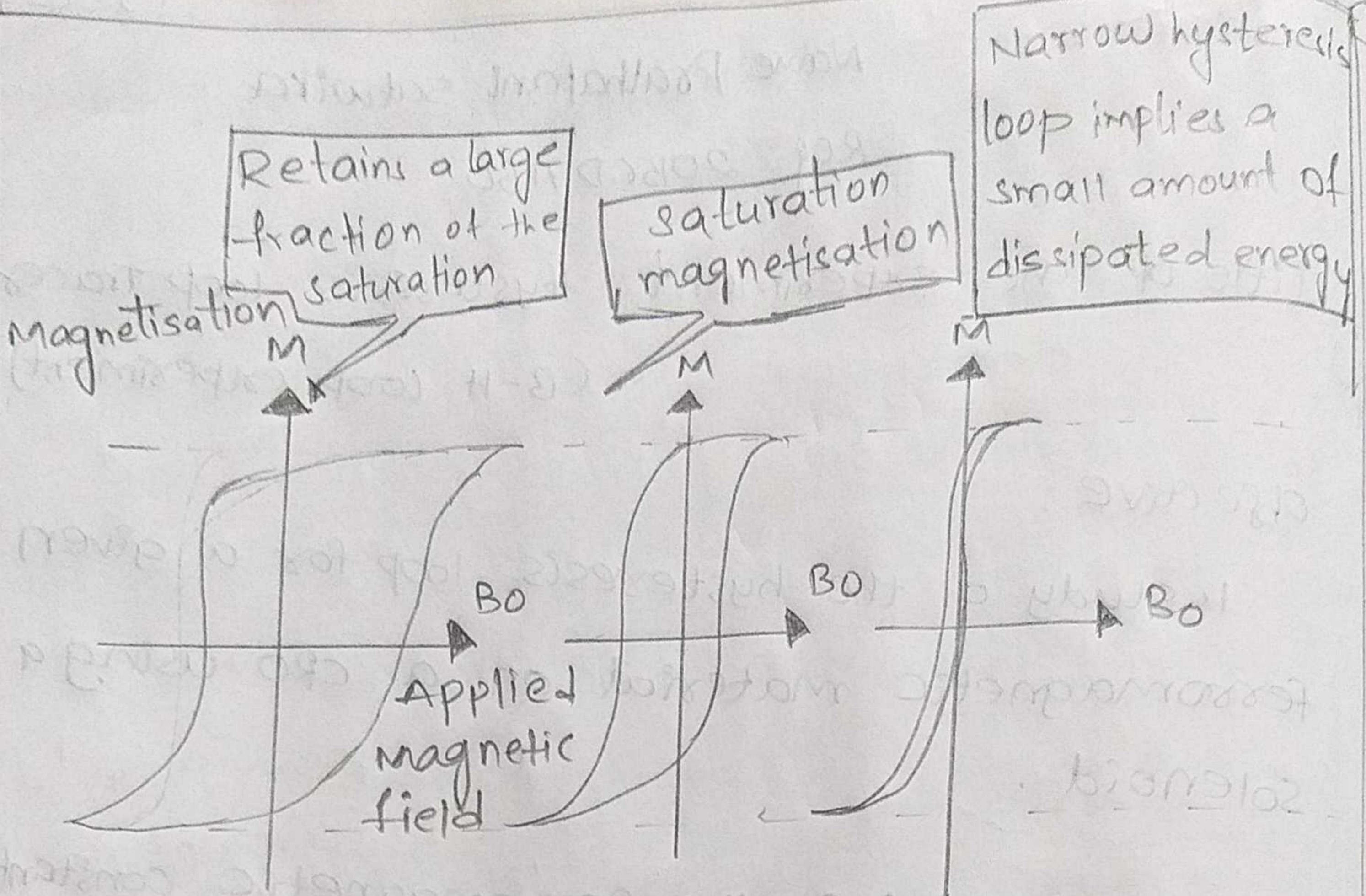
Objective:

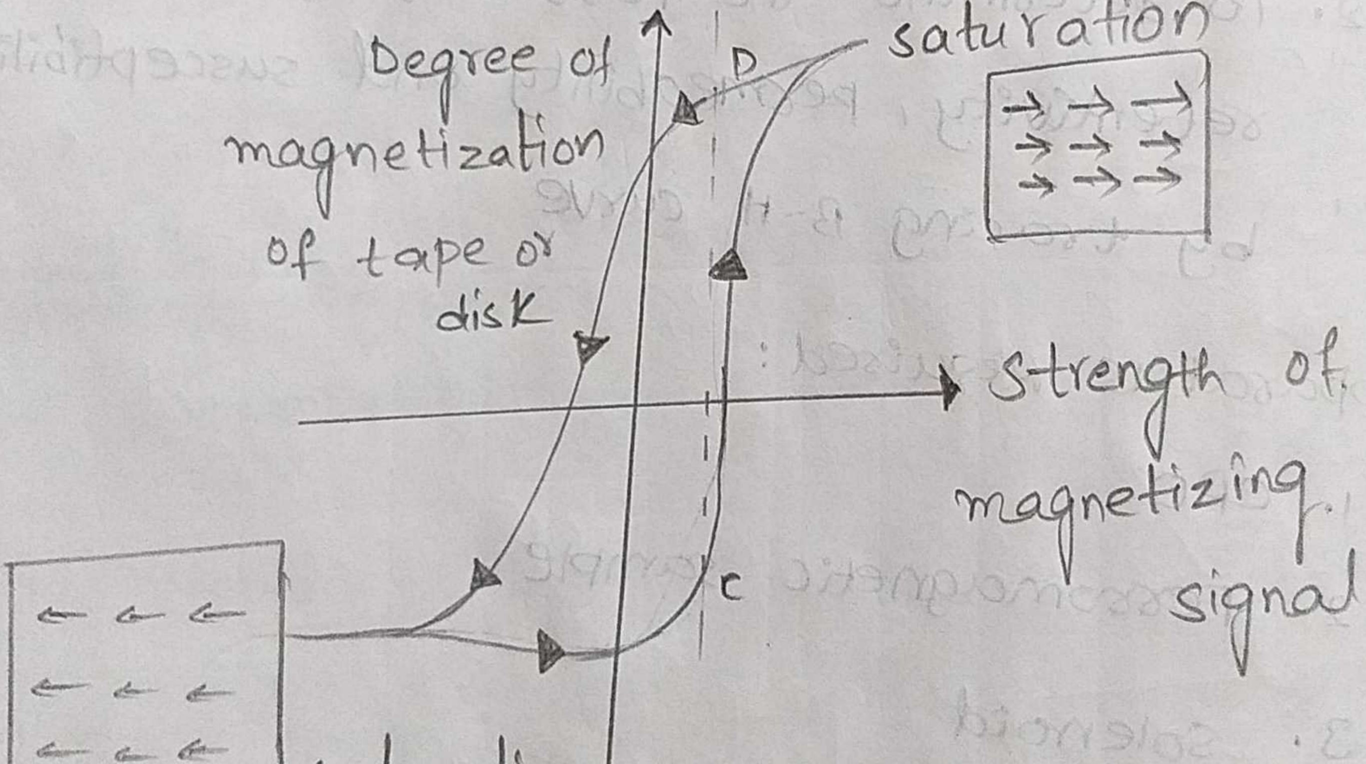
1. study of the hysteresis loop for a given ferromagnetic material on a CRO using a solenoid.

2. To determine the ferromagnetic constants: retentivity, permeability and susceptibility by tracing B-H curve

Apparatus Required:

1. CRO
2. Ferromagnetic sample
3. solenoid
4. Hysteresis loop tracer




Hysteresis loop.

Observations:-

Equipment diameter of pickup coil = 3.21 mm

$g_x$ = 100 (Total gain of both amplifier

$g_y$ = 1 (Gain of amplifier)

Sample = commercial Nickel (standard)

length of sample (c) = 39 mm

Diameter of sample (a) = 1.17 mm

cross sectional Area of sample (AS)

$= \pi = 1.074$

cross sectional Area of pickup coil = $\pi$ = (AC)

7.088

$\therefore$ Area ratio $= \frac{A_s}{A_C} = 0.1515$ or 0.133 mm

$\therefore$ Demagnetizing factor (N) $= \frac{c}{a}$

$= \frac{39}{1.17} = 33.33$

$= 0.0029$

Calibration:-

By Adjusting N & $\frac{A_s}{A_c}$ as given above the J-H loop width is too small. Thus both are adjusted to three times i.e. 0.399 (0.4) &

0.0087 respectively. This instrument is also calibrated internally i.e. Demagnetization = near about zero & Area Ratio = 0.4

Set magnetic field: (200) (rms)

$e_x = 80mm$ ; $e_x = 8.0V$

For area ratio of unity:

$$e_x = \frac{80}{0.4} = 200 \, mm \longrightarrow (1)$$

$$e_x = \frac{8}{0.4} = 20V \longrightarrow (2)$$

Now $G_o (rms) = \frac{H_a}{e_x}$

$H_a$ = rms value of magnetic field = 200

$$G_o (rms) = \frac{200}{200}$$

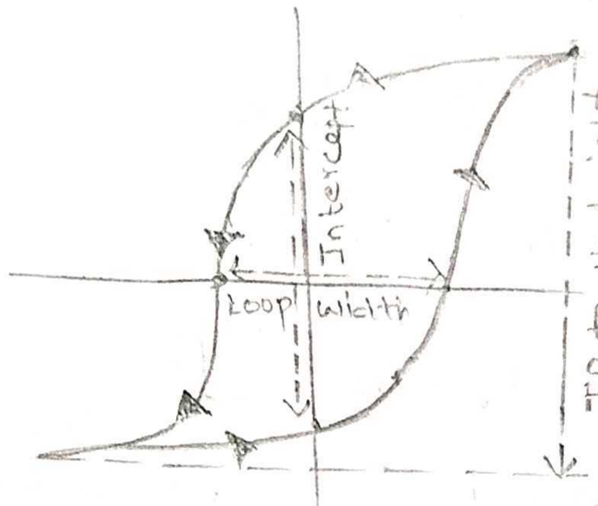
$$G_o (rms) = 1 \, G/mm$$

$G_o$ (Peak to peak) $= 1 \times 2\sqrt{2} = 2.828 \, G/mm \longrightarrow (3)$

$G_o (rms) = 200/20$

$G_o (rms) = 200/20 = 10 \, G/V$

$G_o$ (Peak to peak) $= 10 \times 2\sqrt{2} = 28.2 \, G/V \longrightarrow (4)$




## Calculation:

Loop width = 30 mm

= 10 mm (after dividing by the multiplying factor 3)

Tip to Tip Height = 3.6 V

Intercept = 2.8 V

1. Coercivity: $H_c = \dfrac{G_o e_x}{\left[\dfrac{A_s}{A_c} - N\right]}$

where;

$e_x = \frac{1}{2} \times$ Loop width $= \frac{1}{2} \times 10 = 5$ mm

$G_o = 2.820$ G/mm

$\dfrac{A_s}{A_c} = 0.133$ ; $N = 0.0029$

Now $H_c = \left[\dfrac{2.828 \times 5}{0.133 - 0.0029}\right]$

$H_c = 108.68$

2. Saturation magnetization:-

$$M_s = \frac{J_s}{4\pi}$$

$$J_s = \frac{G_0 \mu_0 g_x (e_y)_s}{g_y \left[\frac{A_s}{A_c} - N\right]}$$

where

$g_y = 1$ $\quad \mu_0 = 1$ $\quad N = 0.0029$

$g_x = 100$ $\quad \frac{A_s}{A_c} = 0.133$

$(e_y)_s = \frac{1}{2} \times$ Tip to tip height $= \frac{3.6}{2} = 1.8V$

$$J_s = \frac{28.2 \times 1 \times 100 \times 1.8}{1 \times [0.133 - 0.0029]}$$

$$J_s = 39016.14$$

Now,

$$M_s = \frac{39016.14}{4 \times 3.14} = 3.1\,k \text{ gauss}$$

3. Retentivity: $\quad M_r = \frac{J_r}{4\pi}$

where $\quad J_r = \frac{G_0 \mu_0 g_x (e_x)_r}{g_y \left[\frac{A_s}{A_c} - N\right]}$

$g_y = 1$

$g_x = 100$ $\quad \frac{A_g}{A_c} = 0.133$ $\quad (e_y)_r = \frac{1}{2} \times$ Intercept

$\mu_0 = 1$ $\quad N = 0.0029$ $\quad = \frac{2.8}{2} = 1.4V$

$$J_r = \frac{28.2 \times 1 \times 100 \times 1.4}{1 \times [0.133 - 0.0029]}$$

$$J_r = \frac{3948}{0.1301} = 30,345.8$$

$$M_r = \frac{30345.8}{4 \times 3.14} = 2.4 \text{ k gauss.}$$

Table:-

| Sample | Loop width | Tip to Tip height | Intercept |
|---|---|---|---|
| Soft Iron | 1.4 cm | 6.4 | 3.6 |
| Hard steel | 3.2 cm | 3.4 | 2 |
| Nickel | 4 cm | 1.2 | 0.6 |

Results:-

| sample | coercivity | saturation magnetization | Retentivity |
|---|---|---|---|
| Commercial Nickel | 43.474 Oe | 1 K Gauss | 517.7 Gauss |
| Hard steel | 34.77 Oe | 2 k Gauss | 1724.9 Gauss |
| Soft Iron | 15.21 Oe | 5.5 K Gauss | 1035.4 Gauss |