LAB-6 B-H CURVE

7.1 Introduction

The B-H curve is the curve characteristic of the magnetic properties of a material or element or alloy. It tells you how the material responds to an external magnetic field, and is a critical piece of information when designing magnetic circuits.

7.2 Objective

7.2.1 Educational:

A precise knowledge of various magnetic parameters of ferromagnetic substances and the ability to determine them accurately are important aspects of magnetic studies. These not only have academic significance but are also indispensable for both the manufacturers and users of magnetic materials. The characteristics which are usually used to define the quality of the substance are coercivity, retentivity, saturation magnetization and hysteresis loss. Understanding the magnetic behavior of materials by measuring the hysteresis curve and calculation of magnetic properties namely, remnant magnetization, coercive field and magnetic moment per atom.

7.2.2 Experimental:

To determine the energy loss per unit volume of a given magnetic material per cycle by tracing the Hysteresis loop.

7.3 Prelab Preparation:

7.3.1 Reading:

Variation of flux density due to the gradual alignment of the magnetic domains (atoms, that behave like tiny magnets) within the magnetic circuit material. Study about the B-H curves of different magnetic materials, such as iron, steel, etc.

7.3.2 Written:

Keep the worksheet ready with required write up, Formulae, Tabular columns and theoretical values.

7.4 Equipment needed

1. The Hysteresis Loop tracer used in this experiment is HLT-111.
2. Diameter of the pick-up coil – 3.21 mm
3. Gx = 100

4. Gy = 1Sample Used: Thin cylindrical rod made of Commercial Nickel

7.5 Formula

Calculation of Energy Loss:

The energy loss per unit volume per cycle is given by:

$$E_L = (\frac{N_1}{N_2})(\frac{R_2}{R_1})(\frac{C}{AL}) * S_v * S_h * \text{Area of Loop}$$

N_1 = No. of turns in primary coil
N_2= No. of turns in secondary
R_1 = Variable Resistance between terminals in Ohms
R_2 = Fixed Resistance in Ohms
C = Capacitance in Farads
A = Area of cross-section of Specimen in m^2
L = Length of Specimen in m
S_V = Vertical Sensitivity
S_H = Horizontal Sensitivity

7.6 Background

Consider a magnetic material being subjected to a cycle of magnetization. The graph intensity of magnetization (B) vs. magnetizing field (H)gives a closed curve called B-H loop. The intensity of magnetization B does not become zero when the magnetizing field H is reduced to zero. Thus the intensity of magnetization B at every stage lags behind the applied field H.This property is called magnetic hysteresis. The B-H loop is called hysteresis loop. The shape and area of the loop are different for different materials.

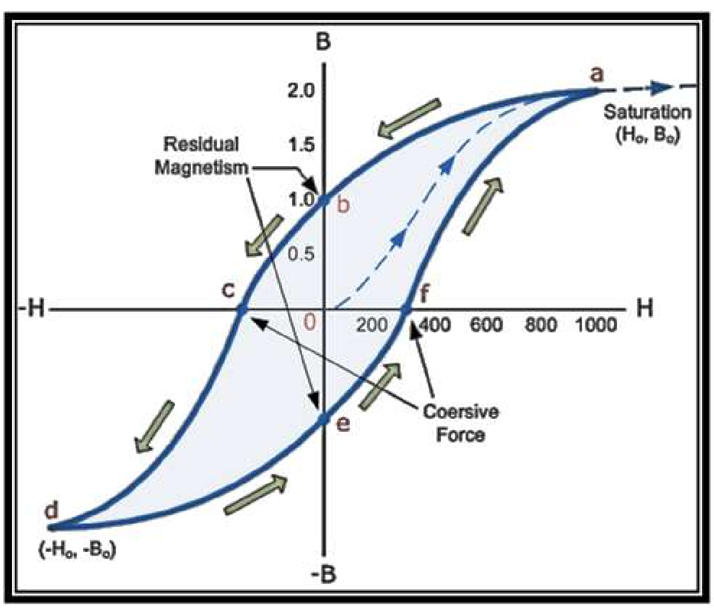

Figure 7.1: B-H CURVE

Let's assume that we have an electromagnetic coil with a high field strength due to the current flowing through it, and that the ferromagnetic core material has reached its saturation point, maximum flux density. If we now open a switch and remove the magnetizing current flowing through the coil, we would expect the magnetic field around the coil to disappear as the magnetic flux reduced to zero.

However, the magnetic flux does not completely disappear as the electromagnetic core material still retains some of its magnetism even when the current has stopped flowing in the coil. This ability for a coil to retain some of its magnetism within the core after the magnetization process has stopped is called Retentivity or remanence, while the amount of flux density still remaining in the core is called Residual Magnetism, BR.

The reason for this that some of the tiny molecular magnets do not return to a completely random pattern and still point in the direction of the original magnetizing field giving them a sort of "memory". Some ferromagnetic materials have a high retentivity (magnetically hard) making them excellent for producing permanent magnets.

While other ferromagnetic materials have low retentivity (magnetically soft) making them ideal for use in electromagnets, solenoids or relays. One way to reduce this residual flux density to zero is by reversing the direction of the current flowing through the coil, thereby making the value of H, the magnetic field strength negative. This effect is called a Coercive Force, HC.

If this reverse current is increased further the flux density will also increase in the reverse direction until the ferromagnetic core reaches saturation again but in the reverse direction from before. Reducing the magnetising current, i once again to zero will produce a similar amount of residual magnetism but in the reverse direction.

Then by constantly changing the direction of the magnetizing current through the coil from a positive direction to a negative direction, as would be the case in an AC supply, a Magnetic Hysteresis loop of the ferromagnetic core can be produced.

7.7 Procedure

1. Power on the device.
2. Slowly vary the applied magnetic field using magnetic field slider. B-H graph corresponding to
3. the field will be plotted, whenever the slider is stopped.
4. Note down the values of Horizontal Sensitivity and Vertical Sensitivity.
5. Tabulate the loop width, the tip-to-tip height and positive intercept to negative intercept distance for each magnetic field and plot it on graph.
6. Determine the area of the loop from the graph.
7. Repeat the experiment for different values of Resistance R1

7.8 Observation

S No	Resistance R_1 in $Ohms$	Horizontal Sensitivity S_H	Vertical SensitivityS_v	Area of loop in m^2	Energy Loss
1					
2					
3					
4					
5					

7.9 Results

The energy loss per unit volume of a given magnetic material per cycle is . . . .

7.10 Viva Voce

1. Mention different magnetic materials based on their magnetization.
2. What are hard and soft magnetic materials
3. Define retentivity.
4. Define coercivity.
5. Explain hysteresis loss associated with magnetic materials.
6. What are the units of magnetization?

7.11 Further Probing Experiments

Q_1:Draw the B-H curve for different material?
Q_2:Calculate the coercivity and Retentivity of given Ferro magnetic material.