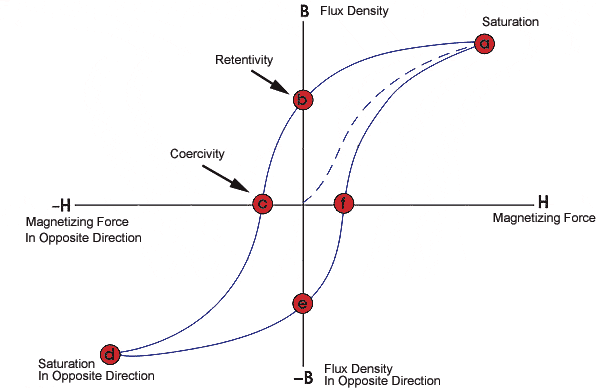
**9. B-H Curve**

**Objective:** To draw the hysteresis curve (B-H curve) of a given sample of ferromagnetic material and to determine retentivity, coercivity and hysteresis loss.

**Apparatus Required:** CRO, ferromagnetic specimen, solenoid, hysteresis loop tracer.

**Theory and Formula used:**

When a ferromagnetic material is magnetized in one direction, it will not relax back to zero magnetization when the imposed magnetizing field is removed. It must be driven back to zero by a field in the opposite direction. The lack of retraceability of the magnetization curve is the property called hysteresis and it is related to the existence of magnetic domains in the material. Once the magnetic domains are reoriented, it takes some energy to turn them back again. A hysteresis loop shows the relationship between the induced magnetic flux density (B) and the magnetizing force (H). It is often referred to as the B-H loop. An example hysteresis loop is shown below in Figure 1.

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**Figure1: A typical hysteresis loop.**

The loop is generated by measuring the magnetic flux density (B) of a ferromagnetic material while the magnetic field (H) is changed. A ferromagnetic material that has never been previously magnetized or has been thoroughly demagnetized will follow the dashed line as H is increased. At point "a" almost all of the magnetic domains are aligned and an additional increase in the magnetizing force will produce very little increase in B. The material has reached the point of magnetic saturation. When H is reduced to zero, the curve will move from point "a" to point "b." At this point, it can be seen that B remains non-zero in the material even though H is zero. This is referred to as the point of retentivity on the graph and indicates the remanence or level of residual magnetism in the material. (Some of the magnetic domains remain aligned but some have lost their alignment.) As H is reversed, the curve moves to point "c", where B becomes zero. This is called the point of coercivity on the curve. (The reversed magnetizing force has flipped enough of the domains so that the net flux within the material is zero.) The force required to remove the residual magnetism from the material is called the coercive force or coercivity of the material.

As the magnetizing force is increased in the negative direction, the material will again become magnetically saturated but in the opposite direction (point "d"). Reducing H to zero brings the curve to point "e." It will have a level of residual magnetism equal to that achieved in the other direction. Increasing H back in the positive direction will return B to zero. Notice that the curve did not return to the origin of the graph because some force is required to remove the residual magnetism. The curve will take a different path from point "f" back to the saturation point where it with complete the loop.

From the hysteresis loop, a number of primary magnetic properties of a material can be determined:

1. Retentivity - A measure of the residual flux density corresponding to the saturation induction of a magnetic material. In other words, it is a material's ability to retain a certain amount of residual magnetic field when the magnetizing force is removed after achieving saturation. (The value of B at point “b” on the hysteresis curve.)

2. Coercivity - The amount of reverse magnetic field which must be applied to a magnetic material to make the magnetic flux return to zero. (The value of H at point “c” on the hysteresis curve.)

3. Hysteresis Loss: The energy loss per cycle per unit volume is called hysteresis loss and is given by 1/4π (Area of B-H curve).

**Procedure:**

**1.** Take sample holder and insert a ferromagnetic specimen (sample) in the lower side hole of the holder.

**2.** Insert this sample holder in the solenoid.

**3.** Before switch ‘On’ the Hysteresis Loop Tracer, connect din connector cable of solenoid to the Input of the tracer.

**4.** Connect solenoid three pin connector to the tracer solenoid socket.

**5.** Connect ‘Y’ terminal of Hysteresis Loop Tracer to CRO ‘Y’ terminal with the help of crocodile cable and other terminal of cable to the ‘E’ terminal of Hysteresis Loop Tracer.

**6.** Similarly connect ‘X’ terminal of Hysteresis Loop Tracer to CRO ‘X’ terminal with the help of crocodile cable and other terminal of cable to the ‘E’ terminal of Hysteresis Loop Tracer.

**Note :** Here +ive terminal of both crocodile cable should be connected to ‘Y’ and ‘X’ terminals respectively of Hysteresis Loop Tracer and –ive terminal of both crocodile cable should be connected to ‘E’ terminal to Hysteresis Loop Tracer.

**7.** Keep CRO in ‘XY’ mode.

**8.** Rotate H-Balance, Phase and DC Balance knobs of Hysteresis Loop Tracer fully anticlockwise.

**9.** Keep knob of Hysteresis Loop Tracer always in ‘B’ position.

**10.** Switch ‘On’ the Hysteresis Loop Tracer and CRO.

**Note :** First of all adjust the Hysteresis Loop Tracer, than switch ‘On’ the CRO.

**11.** By the Area Ratio and Demagnetize knob of the Hysteresis Loop Tracer, we can adjust the shape of the curve.

**12.** Adjust the magnetic field intensity with the help of Magnetic Field knob of the tracer.

**13.** Now the Hysteresis Loop of the taken sample will display on CRO.

**14.** Plot the Hysteresis Loop from CRO and tabulate the magnetic field reading from display.

**15.** Here magnetic field in Gauss, will displays on LCD in accordance to the intensity of magnetic field.

**Observations:**

**Given,**

**Total gain of both amplifiers, gx = 100, gy = 1**

**Diameter of the sample: 1.20 mm (2r1); Diameter of the pickup coil = 3.26 mm (2r2)**

**Area ratio [ As/Ac ] = r12/r22 = 0.135; Demagnetizing factor (N) = 0.0033 ; G0 = 34.18 G/V**

**Observation table:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No. | Magnetic Field (Gauss) | Observed Loop width  (**W**)  (in Volts) | Tip to tip height  (**T**)  (in Volts) | Positive intercept to negative intercept distance  (**Y**)  (in Volts) |
| **1** |  |  |  |  |
| **2** |  |  |  |  |
| **3** |  |  |  |  |

**Calculations:**

***Note: All the calculations should be done at the highest applied field to ensure that the sample has saturated.***

**1.** ActualLoop width = (Observed Loop width)/3 =**W/3=** -----------V

(Since, the area ratio for the given sample is so small the signal ex was enhanced by multiplying area ratio and demagnetization by three. The finally obtained value of the loop width is divided by this same factor, 3, to give the correct value of coercivity.)

**2.** Intercept =**Y/2**= --------------------- V

**3.** Tip to tip height = **T**------------ V

**(a) Coercivity (Hc)**  **ex** = 1/2 x Actual Loop width = ---------------V

=........................................................Gauss

**(b) Hysteresis loss per unit volume per cycle (Loss)**

**A** = Area of B-H curve in V2

Loss =…………………………ergs/cycle/cm3

**(c) Retentivity:** = Intercept = ...............V



= ..................................... Gauss

**(d) Saturation Magnetic flux density:**

tH = Tip to tip height х 0.5................... V



**Result:**

1. B-H curve for the given ferromagnetic material is traced.
2. The calculated value of
3. Coercivity is ...................................Gauss.
4. Retentivity is ....................................Gauss.
5. Hysteresis Loss per unit volume per cycle is ............................ ergs/cycle/cm3.
6. Saturation Magnetic flux density is ..........................Gauss.

**Precautions and sources of error:**

1. Handle CRO carefully.
2. The positions of X and Y amplifiers should not be disturbed after adjusting it once in the whole experiment.
3. Variations in the supply voltage will affect the tracing of the curve on the paper.