PHY F214 PHYSICS LAB-11 REPORT SEM-1 2017-2018

EXP NO. – 1   EXP NAME – Hysteresis loop for a ferromagnetic material (M-B curve)

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AIM:

1. To study the magnetization (M) of a ferromagnetic material due to an applied magnetic field B and plot the hysteresis curve
2. To calculate the retentivity and the coercivity of the material of the rod.

APPARATUS:

Two solenoid coils S and C, ferromagnetic specimen rod, reversible key (R), ammeter, magnetometer, battery, rheostat and transformer.

PRINCIPLE USED:

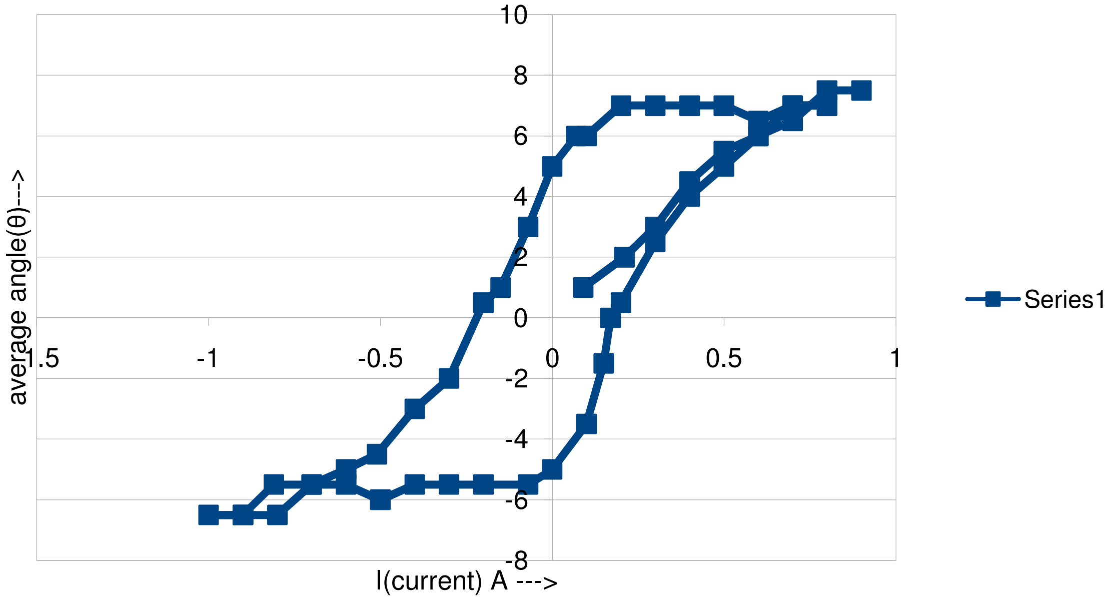
A ferromagnetic material has certain domains inside it with specific magnetic moments aligned in random directions so that when it is subjected to an external magnetic field all the domains get aligned in the direction of the external magnetic field and the material gets magnetised. This external magnetic field is created by a solenoid. We then measure the magnetic field of the rod by measuring the angle that the needle deflects from the original position. Thus we record the current flowing through the solenoid and the deflection angle.

OBSERVATION AND PROCEDURE:

First we align the dial of the magnetometer such that the 0 position is along the axis of the solenoid. Then we move the whole system until the arrow coincides with the 0. During all this the rod should be taken out and the no current should be flowing. We then demagnetise the rod. We are using two solenoids in order to cancel the effect of the magnetic field of each other at the position of the magnetometer. So that we are able to exactly calculate the magnetic field produced by only the rod due to the magnetization. We move the compensating solenoid until the pointer aligns with the zero while passing the current. Then after this we switch off the current and put the demagnetized rod back inside the solenoid. We then start varying the current starting from 0 and note down the corresponding average angle of deflection on the two sides. We increase the current and then bring it back to zero and after that we increase the current in reverse direction and keep on doing this until one complete cycle has finished.

I(A)	θ1	θ2	average theta
0.09	2	0	1
0.21	3	1	2
0.3	4	2	3
0.4	5	4	4.5
0.5	6	5	5.5
0.6	7	5	6
0.7	8	6	7
0.8	8	6	7
0.7	8	6	7
0.6	8	5	6.5
0.5	8	6	7
0.4	8	6	7
0.3	8	6	7
0.2	8	6	7
0.1	7	5	6
0.07	7	5	6
0	6	4	5
-0.07	2	4	3
-0.15	0	2	1
-0.2	0	1	0.5
-0.3	-3	-1	-2
-0.4	-2	-4	-3
-0.51	-4	-5	-4.5
-0.6	-4	-6	-5
-0.7	-5	-6	-5.5
-0.81	-5	-6	-5.5
-0.9	-6	-7	-6.5
-1	-6	-7	-6.5
-0.9	-6	-7	-6.5
-0.8	-6	-7	-6.5
-0.7	-5	-6	-5.5
-0.6	-5	-6	-5.5
-0.5	-5	-7	-6
-0.4	-5	-6	-5.5

-0.3	-5	-6	-5.5
-0.2	-5	-6	-5.5
-0.07	-5	-6	-5.5
0	-4	-6	-5
0.1	-3	-4	-3.5
0.15	-1	-2	-1.5
0.17	0	0	0
0.2	1	0	0.5
0.3	3	2	2.5
0.4	5	3	4
0.5	6	4	5
0.6	7	5	6
0.7	7	6	6.5
0.8	7	8	7.5
0.9	7	8	7.5



HYSTERESIS CURVE

The curve shows the hysteresis as we apply the external magnetic field the ferromagnetic material gets magnetized in the direction of the external magnetic field. The ferromagnetic substance contains various domains containing a particular magnetic dipole moment which is aligned in random directions. On the application of the external magnetic field the magnetic dipole moments in some domains get aligned in the direction of the external field. Thus the substance produces a significant amount of magnetic field in the direction of the external applied field. As we increase the magnitude of the field more and more domains get aligned and so we see an increase in the graph from 0 to a saturation level initially. After a certain point even if we increase the applied field then also the magnetization doesn't increase as in that situation all the domains have already been aligned. Next when we slowly bring the current back to 0 the curve does not follow the same path. Even when the current reaches 0 the magnetization is retained by the ferromagnetic substance this is the property of these types of substances called retentivity.

Then in order to make the magnetization back to 0 we have to apply a reverse magnetic field in the opposite direction until it reaches 0 this value of the magnetic field is called the coercivity of the material. Further when we keep on increasing the current in the reverse direction the magnetization starts increasing in the opposite direction as is seen and again it reaches a saturation in the negative direction. And like this we again decrease the current in the after reaching a maximum negative until it reaches the same positive saturation point and the curve continues on like this.

Hysterisis curve is the property of the material used.

The saturation current is 0.8 A and -0.9 A

Retentivity =

Coercivity =

INFERENCE:

1. The ferromagnetic substance have the capacity to retain magnetization.
2. The magnetization increases upto a certain level after which it becomes saturated.
3. The magnetization is a result of the alignment of the various domains in the direction of the applied magnetic field.
4. We have to apply an opposite current in order to demagnetize the rod which is called it's coercitvity.

POSSIBLE ERRORS:

1. There can be an error in making the axis of the solenoid to be perfectly perpendicular to the horizontal magnetic field.
2. There can be manual error while measuring the deflection angle.

3. There is error as the applied magnetic field is not perfectly uniform it changes as the solenoid is not an infinite solenoid so there may be errors due to that also.
4. There can also be a small error in the equipment which can be taken into experimental error.
5. There can be a slight error if the rod is not demagnetised completely which will be due to manual error.
6. We should change the current in one direction only we should not take it back and forth. There should be a continuous unidirectional change in current as this might lead to irregularities in the hysteresis curve.