University of Al-Mustaqbal
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Magnetism

the practical aspect

Second Stage

Study of Magnetic Material Properties

Lec 6

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The objective of the experiment :

The purpose of this experiment is to study the magnetic properties of different materials (such as iron, steel, ferrite, and paramagnetic materials). The experiment aims to determine the behavior of materials in magnetic fields, measure magnetic hysteresis, evaluate permeability and retentivity, and classify materials into ferromagnetic, paramagnetic, and diamagnetic categories.

Equipment used in the experiment :

1. Solenoid (long coil)
2. DC power supply
3. Ammeter
4. Gaussmeter or Tesla meter
5. Iron core / steel core / ferrite core samples
6. Connecting wires
7. Magnetic field sensor
8. Variable resistor (Rheostat)
9. Soft iron U-core (optional)
10. Computer/software for plotting hysteresis curve (if available)

Theory of the Experiment:

Materials respond differently to magnetic fields depending on their atomic structure.

Types of Magnetic Materials:

- **Ferromagnetic materials** (Iron, Steel, Nickel)
  Strongly attracted to magnetic fields, exhibit hysteresis, high permeability.
- **Paramagnetic materials** (Aluminum, Magnesium)
  Weakly attracted to magnetic fields.
- **Diamagnetic materials** (Copper, Gold, Bismuth)
  Weakly repelled by magnetic fields.

Magnetic Properties Studied

1. **Magnetic Flux Density (B)**
   $B = H\mu$
   where:
   (μ) = permeability
   (H) = magnetic field intensity
2. **Permeability (μ)**
   Indicates how easily a material becomes magnetized.
3. **Coercivity (Hc)**
   The required reverse field to reduce magnetic flux to zero.
4. **Retentivity (Br)**
   The magnetic flux density retained after the external field is removed.
5. **Hysteresis Loop (B-H Curve)**
   Shows the magnetization and demagnetization cycle.

The method of work :

1. Place the solenoid and connect it to the DC power supply.
2. Insert the material sample (iron, ferrite, etc.) inside the solenoid.
3. Connect the ammeter to measure the current through the solenoid.
4. Use a gaussmeter to measure the magnetic flux density (B) at the end of the coil.
5. Gradually increase the current and record B at each step.
6. After reaching maximum current, gradually decrease it to zero and then reverse the polarity to obtain the full **hysteresis loop**.
7. Repeat the procedure for each material.
8. Plot B versus H to analyze magnetic properties.

Measurement Step	Current (A)	Magnetic Field H (A/m)	Flux Density B measured (T)	B theoretical = μH	Material Type
1	_____	_____	_____	_____	_____
2	_____	_____	_____	_____	_____
3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____

Discussion

1. Ferromagnetic materials are:

A. Strongly repelled
B. Weakly attracted
C. Strongly attracted
D. Not affected
E. Always non-magnetic

2. Diamagnetic materials:

A. Are strongly attracted
B. Are weakly repelled
C. Have high permeability
D. Show hysteresis
E. Become permanent magnets

3. The B-H curve represents:

A. Resistance vs Current
B. Voltage vs Time
C. Magnetic flux density vs field intensity
D. Temperature vs magnetism
E. Current vs capacitance

4. Retentivity refers to:

A. Force needed to magnetize the core
B. Remaining magnetism after removing field
C. Maximum current through solenoid
D. Voltage drop in coil
E. Coil resistance

5. Coercivity represents:

A. Heat produced
B. Force to fully magnetize
C. Reverse field required to demagnetize
D. Field required to saturate
E. Magnetic dipole moment

6. Which material is diamagnetic?

A. Iron
B. Nickel
C. Copper
D. Ferrite
E. Steel

7. The parameter μ refers to:

A. Voltage
B. Permeability
C. Resistance
D. Power
E. Frequency

8. Materials with high permeability:

A. Resist magnetization
B. Magnetize easily
C. Cannot magnetize
D. Are always diamagnetic
E. React chemically

9. Hysteresis loss occurs due to:

A. Heating
B. Magnetization cycle
C. Rust formation
D. Electrical short
E. Acoustic waves

10. The magnetic field inside a solenoid is proportional to:

A. Voltage
B. Number of turns × current
C. Coil resistance
D. Core mass
E. Air pressure

11. Which is used to measure magnetic flux density?

A. Ammeter
B. Voltmeter
C. Gaussmeter
D. Ohmmeter
E. Thermometer

12. Paramagnetic materials have:

A. Negative susceptibility
B. High coercivity
C. Slight positive susceptibility
D. No magnetic reaction
E. Very strong attraction

13. Saturation point refers to:

A. Current at zero
B. Maximum magnetization
C. No magnetic field
D. Heat loss
E. Resistance increase

14. The region where B increases linearly with H is called:

A. Saturation
B. Linear region
C. Dead zone
D. Reversal point
E. Leakage region

15. The hysteresis loop area represents:

A. Magnetic gain
B. Electromotive force
C. Hysteresis energy loss
D. Coil efficiency
E. Resistance change