ELECTRICAL ENGINEERING MATERIALS

Unit IV : Magnetic Materials

Topic: Hard Magnetic Materials

Important Questions with Answers (3rd Semester, Electrical Engg.)

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Short Answer Questions

Q.1 Explain the properties of cobalt steel.

Ans. Cobalt steel is steel with a large amount of cobalt (generally about 15 to 35%) and small amounts of tungsten or chromium. It is a hard magnetic material.

Properties:

1. Higher coercivity and higher retentivity than tungsten and chromium steels.
2. Higher energy product, so a smaller magnet gives the same field.
3. More stable: it holds its magnetism better against heat, shocks and stray fields.
4. Costlier than tungsten and chromium steel.

Applications:

Permanent magnets for motors, magnetos, loudspeakers, speedometers and good-quality instruments.

Q.2 Write the properties of chromium steel.

Ans. Chromium steel is steel with about 3 to 6% chromium and about 1% carbon.

Properties:

1. Good coercivity and good retentivity.
2. Cheap and easy to harden by quenching in oil or water.
3. Easily machined into shape before hardening.
4. Its magnetic properties are less than those of cobalt steel.

Applications:

Permanent magnets of meters and measuring instruments, magnetos and small motors.

Q.3 State the properties and applications of hard ferrites.

Ans. Hard ferrites are ceramic materials, mainly barium ferrite and strontium ferrite. They are made by pressing iron oxide with barium or strontium oxide and sintering.

Properties:

1. High coercivity, so they resist demagnetisation well.
2. Moderate retentivity, lower than Alnico.
3. Very high electrical resistivity, so there is no eddy current problem.
4. Light, cheap and do not rust.
5. Hard and brittle.

Applications:

1. Small DC motors and loudspeakers.

2. Fridge door magnets, toys and holding magnets.
3. Magnetic separators, sensors and microwave devices.

Q.4 Name any two hard magnetic materials. Write the properties of hard magnetic materials and the uses of permanent magnets.

Ans. Two hard magnetic materials are cobalt steel and Alnico. Others are tungsten steel, chromium steel and hard ferrites.

Properties of hard magnetic materials:

1. High retentivity.
2. High coercivity.
3. Wide hysteresis loop with a large area (so not used for AC cores).
4. High energy product.
5. Stable magnetism against heat, shocks and stray fields.
6. Usually hard and brittle.

Uses of permanent magnets:

Loudspeakers and microphones, small DC motors and generators, meters and measuring instruments, magnetos, fridge door magnets, magnetic separators and compass needles.

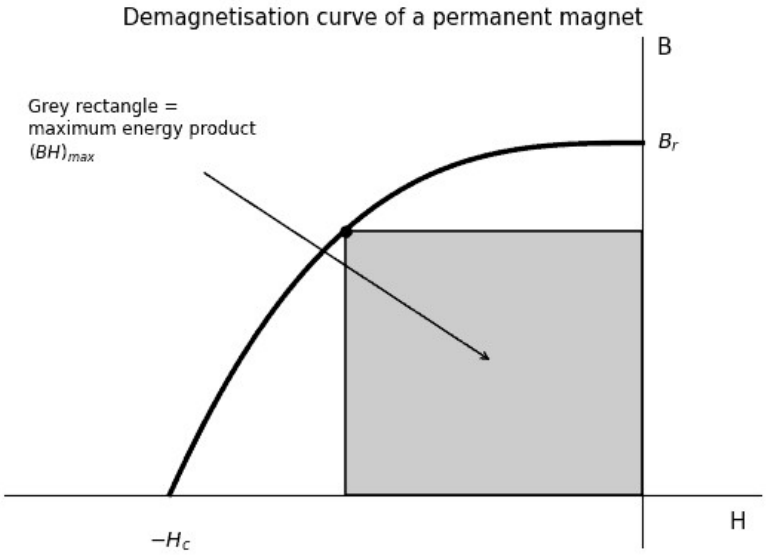


Fig. 1 Demagnetisation curve of a permanent magnet

Remember: The area of the largest rectangle under the demagnetisation curve is the maximum energy product (BH)max. A better magnet material has a larger (BH)max.

Q.5 Write short notes on tungsten steel.

Ans. Tungsten steel is steel (iron with about 0.7% carbon) with about 5 to 6% tungsten.

Properties:

1. Good retentivity and fair coercivity.
2. Cheap and easy to harden by quenching.
3. Its magnetism weakens gradually with time, heat and vibration.

Applications:

Older permanent magnets of instruments, magnetos and small motors, and simple magnets for toys and compass needles.

Q.6 Write short notes on Alnico (Alcomax).

Ans. Alnico is an alloy of aluminium, nickel and cobalt, with iron and sometimes copper. Improved grades are sold under names such as Alcomax.

Properties:

1. Very high retentivity and high coercivity.
2. Very high energy product, much better than the steels.
3. Good stability, even at higher temperatures.
4. Very hard and brittle: made by casting or sintering and finished only by grinding.
5. Costly because of nickel and cobalt.

Applications:

Loudspeakers, microphones, DC motors and small generators, meters, magnetos, sensors and holding magnets.

Long Answer Question

Q.7 Discuss hard magnetic materials (tungsten steel, chromium steel, cobalt steel, Alnico and hard ferrites) with their properties and applications.

Ans. Hard magnetic materials are ferromagnetic materials that are difficult to magnetise and difficult to demagnetise. They have high retentivity, high coercivity and a wide hysteresis loop, and they keep their magnetism for a very long time. They are used for making permanent magnets.

Material	Properties	Applications
Tungsten steel	Steel with about 5 to 6% tungsten; cheap; magnetism weakens with time	Simple magnets, older instruments
Chromium steel	Steel with about 3 to 6% chromium; cheap; easily machined	Meters, magnetos
Cobalt steel	Higher coercivity and retentivity; stable; costly	Motors, loudspeakers, instruments
Alnico (Alcomax)	Very high energy product; stable; brittle; costly	Loudspeakers, motors, meters, sensors
Hard ferrites	High coercivity, cheap, light, high resistivity; brittle	Small motors, fridge magnets, toys

Note: Compositions and values are approximate textbook values and are not given in the syllabus.

Points to Remember (for MCQ and True/False)

1. Hard magnetic materials are used for making permanent magnets (True).

2. Alnico is used for making permanent magnets.
3. Tungsten steel and Alcomax are hard magnetic materials; iron is soft.
4. Hard ferrites are used in small motors, loudspeakers and fridge magnets.
5. Hard magnetic materials have high retentivity and high coercivity.
6. Cobalt steel is better and more stable than tungsten and chromium steel.
7. Two hard magnetic materials: cobalt steel, Alnico (also tungsten steel, chromium steel, hard ferrites).