ELECTRICAL ENGINEERING MATERIALS

Unit V : Special Purpose Materials

Topic: Materials Used in the Fabrication of Motors and Generators

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

By Sunil Saharan

Short Answer Questions

Q.1 Write the material used for the stator and rotor core of an induction motor. Why is the core laminated?

Ans. The stator and rotor cores are made of silicon steel laminations (non-oriented, about 0.35 to 0.5 mm thick), each coated with a thin insulating layer and punched with slots.

Reasons:

1. High permeability, so the flux is strong with a small magnetising current.
2. Narrow hysteresis loop, so hysteresis loss is small.
3. Silicon increases resistivity.
4. Lamination breaks the paths of eddy currents, so eddy current loss is reduced.
5. The flux direction keeps changing in a rotating machine, so non-oriented steel is used, not C.R.G.O.

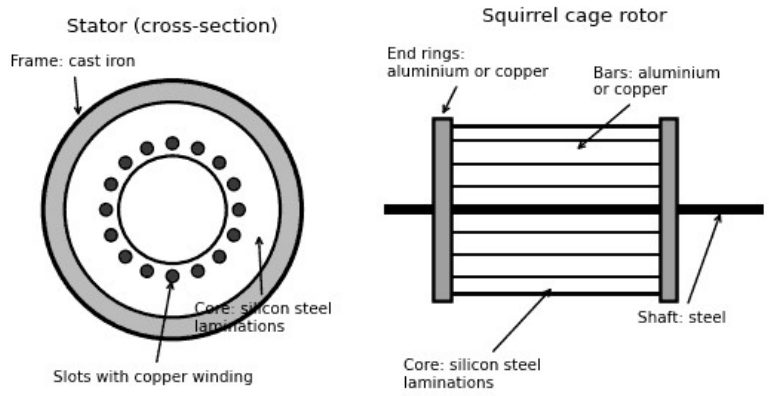


Fig. 1 Stator and squirrel cage rotor of an induction motor

Q.2 Write the materials used for the windings and winding insulation of a motor.

Ans. The winding is made of copper wire (round or rectangular) with enamel insulation, because copper has low resistivity, is ductile and strong, and is easy to wind and solder. Aluminium is used in some small or low-cost motors.

Insulation:

1. Enamel on the wire (polyester or polyurethane).
2. Slot liners and layer insulation: paper, presspaper, polyester film, mica or glass cloth.
3. Slot wedges: Bakelite, epoxy-glass or bakelised wood.

4. Impregnation with varnish or resin by dipping and baking.
5. Insulation class: Class B or F for most motors.

Q.3 Write the materials used for the rotor bars, end rings, shaft and bearings of an induction motor, with reasons.

Part	Material	Reason
Rotor bars and end rings	Aluminium (die-cast) or copper	Low resistivity; aluminium is light, cheap and cast in one piece; copper has lower resistivity and gives higher efficiency
Shaft	Carbon steel or alloy steel	High tensile strength and toughness; carries torque
Bearings	Hardened chromium steel (ball or roller); bronze or white metal in sleeve bearings	Hard, wear resistant, low friction
Frame	Cast iron, welded steel or aluminium alloy	Strong, cheap, damps vibration
End shields	Cast iron or aluminium alloy	Hold bearings accurately; easily cast
Fan	Aluminium, plastic or cast iron	Light and strong

Q.4 Write the materials used for brushes, slip rings and commutator, with reasons.

Ans. The materials are given below.

Part	Material	Reason
Brushes	Carbon (graphite)	Soft and self-lubricating; good conductor; does not weld to the ring; cheap
Slip rings	Brass, bronze or steel	Smooth, hard, good conductor
Commutator segments	Hard drawn copper	High conductivity, hard and wear resistant
Insulation between segments	Mica (micanite)	High dielectric strength, stands heat and arcing
Brush holder and springs	Brass holder; steel or phosphor bronze spring	Conducting, springy

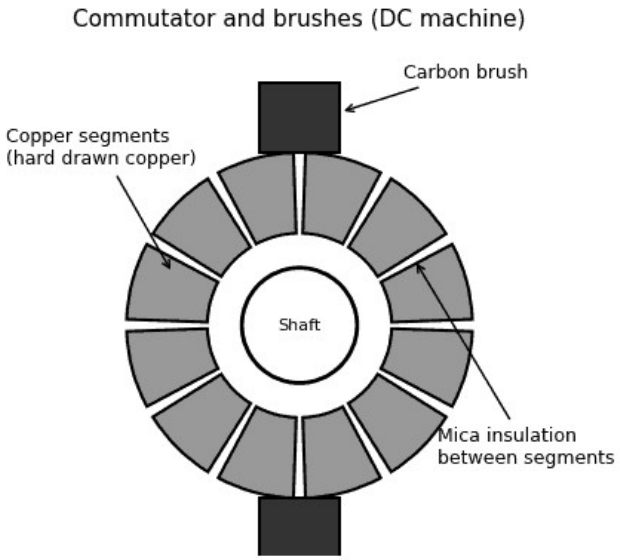


Fig. 2 Commutator and carbon brushes of a DC machine

Remember: Brushes of slip-ring induction motors and DC machines are made of carbon. The commutator is made of copper. The statement that DC machine brushes are made of bronze is False.

Long Answer Questions

Q.5 Explain the various engineering materials necessary for the fabrication of an induction motor.

Ans. A three-phase induction motor has a stator and a rotor. Each part is made of the material that suits its job.

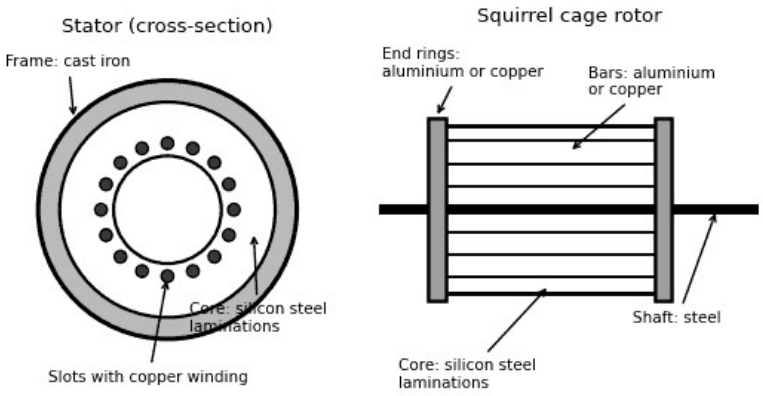


Fig. 3 Stator and squirrel cage rotor of an induction motor

Part	Material	Reason
Stator frame	Cast iron or welded steel	Strong, cheap, damps vibration
Stator and rotor core	Silicon steel laminations	Low hysteresis and eddy loss

Stator winding	Copper (enamelled)	Low resistivity
Winding insulation	Enamel, paper, mica, varnish	Dielectric strength, heat resistance (Class B or F)
Rotor bars and end rings	Aluminium (or copper)	Low resistivity, light, easy casting
Shaft	Carbon steel	Strength and toughness
Bearings	Hardened chromium steel	Wear resistance
End shields	Cast iron or aluminium	Strong, easy to cast
Slip rings (slip-ring type)	Brass or bronze	Smooth, good conductor
Brushes (slip-ring type)	Carbon	Self-lubricating
Terminal box	Cast iron or aluminium with Bakelite block and brass terminals	Strong, insulating, conducting

Q.6 Explain the various engineering materials for the fabrication of a DC motor and generator.

Ans. A DC machine has the same parts as above, with a field system and a commutator. The materials of a generator are almost the same as those of a motor.

Part	Material	Reason
Yoke (frame)	Cast steel (cast iron for small machines)	Carries flux and gives support; cast steel has higher permeability
Field poles and pole shoes	Laminated silicon steel (or cast steel)	High permeability, low eddy loss
Field winding	Copper (enamelled)	Low resistivity
Armature core	Silicon steel laminations	Low hysteresis and eddy loss
Armature winding	Copper with Class B or F insulation	Low resistivity, strength
Commutator segments	Hard drawn copper	High conductivity, wear resistant
Segment insulation	Mica (micanite)	Withstands heat and arcing
Brushes	Carbon or graphite	Self-lubricating, good conductor
Shaft and bearings	Carbon steel; hardened chromium steel	Strength; wear resistance

Alternator (generator) differences:

1. Stator core: silicon steel laminations; stator winding: copper with mica or glass-epoxy insulation.
2. Rotor: forged or cast steel (high-speed type) or laminated steel poles; field winding of copper fed through slip rings with carbon brushes.

3. Large generators use mica-based insulation with epoxy or silicone resin (Class F or H).

Note: The choice of material changes with the size and type of machine. Thicknesses and details are textbook values and are not given in the syllabus.

Points to Remember (for MCQ and True/False)

1. Brushes of a slip-ring induction motor are made of carbon.
2. The commutator of a DC motor is made of copper.
3. Brushes of a DC machine are not made of bronze (True/False answer: False).
4. Laminating the stator core reduces eddy current losses.
5. Squirrel cage rotor bars and end rings: aluminium or copper.
6. Mica is used between the commutator segments.
7. Stator and rotor cores are made of silicon steel laminations.
8. Generator materials are almost the same as motor materials.