ELECTRICAL ENGINEERING MATERIALS

Unit V : Special Purpose Materials

Topic: Materials Used in the Fabrication of a Transformer

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

By Sunil Saharan

Short Answer Questions

Q.1 Name the material used for the transformer core and give the reasons for choosing it.

Ans. The core is made of C.R.G.O. (cold rolled grain oriented) silicon steel laminations, about 0.23 to 0.35 mm thick. Small and high-frequency transformers use silicon steel or ferrites.

Reasons:

1. High permeability, so the flux passes easily with a small magnetising current.
2. Grain orientation gives very low hysteresis loss along the direction of flux.
3. Silicon increases resistivity, and thin insulated laminations break the paths of eddy currents, so eddy current loss is small.
4. The flux in a transformer flows in one fixed direction, so grain-oriented steel can be used.

Q.2 Write the materials used for the windings of a transformer. Compare copper and aluminium for this use.

Ans. Windings are made of copper or aluminium. Small transformers use round enamelled wire and large transformers use rectangular copper strip.

Basis	Copper	Aluminium
Resistivity	Lower	Higher (about 1.6 times the area needed)
Weight	Heavier	Much lighter
Cost	Higher	Lower
Strength	Higher	Lower
Joining	Easy to solder and weld	Difficult to solder
Use	Most transformers	Some distribution transformers

Q.3 Write the insulating materials used in a transformer and the place where each is used.

Ans. The insulating materials are as given below.

Where	Material	Reason
On the winding wire	Enamel (small); paper or cotton tape (large)	Thin film, good dielectric strength

Between windings and layers	Oil-impregnated paper, press-board, varnished cloth	High dielectric strength; Class A (105 °C) in oil
Between core, windings and clamps	Press-board, Bakelite, epoxy	Strong, resists oil and heat
Between laminations	Thin varnish or oxide coating	Stops eddy current flow between sheets
Dry-type transformers	Epoxy resin, glass fibre, mica, silicone	Heat resistant, no oil needed
Insulating and cooling medium	Mineral oil	High dielectric strength; circulates to cool

Q.4 Write the materials of the tank, bushings, breather and gaskets of a transformer, with reasons.

Part	Material	Reason
Tank and conservator	Mild steel (welded sheet), oil-resistant paint	Strong, cheap, easy to weld; can be corrugated or finned for cooling
Bushings	Porcelain with copper or brass rod	High dielectric and mechanical strength; weather proof; shed shape keeps surface dry
Breather	Silica gel crystals	Absorbs moisture of incoming air, keeps oil dry
Gaskets and seals	Cork or oil-resistant synthetic rubber	Prevent oil leakage
Core clamps and frame	Mild steel channels and bolts (bolts insulated)	Hold the core tight and bear the forces
Terminals	Copper or brass	Good conductivity, easy to join

Remember: Transformer bushings are made of porcelain.

Long Answer Question

Q.5 Write the various engineering materials necessary for the fabrication of a transformer along with their part names. Also explain the reasons for using these materials for that particular application.

Ans. A transformer is made of the following parts. Each part uses the material that suits its job.

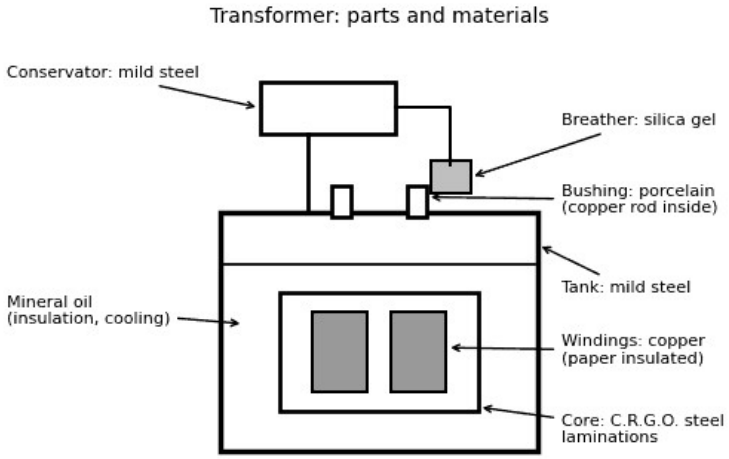


Fig. 1 Parts of an oil-filled transformer and their materials

Part	Material	Reason
Core	C.R.G.O. silicon steel laminations	High permeability; low hysteresis loss; silicon and lamination reduce eddy loss
Windings	Copper (or aluminium)	Low resistivity, ductile, strong, easy to solder
Winding insulation	Enamel, paper, cotton tape	High dielectric strength
Spacers and cylinders	Press-board, Bakelite, epoxy	Strong and insulating; resist oil and heat
Insulating and cooling medium	Mineral oil	High dielectric strength; low viscosity so it cools; high flash point
Tank and conservator	Mild steel	Strong, cheap, easy to weld
Bushings	Porcelain with copper rod	Insulating, strong, weather proof
Breather	Silica gel	Absorbs moisture
Gaskets	Cork or synthetic rubber	Prevent leakage
Clamps and frame	Mild steel	Mechanical strength

Dry-type transformers:

Epoxy resin, glass fibre, mica and silicone replace the oil and paper insulation. They stand higher temperature (Class F or H).

Note: Thicknesses and the choice of material differ between makers and ratings. They are textbook values and are not given in the syllabus.

Points to Remember (for MCQ and True/False)

1. Transformer bushings are made of porcelain.
2. The transformer core is made of C.R.G.O. silicon steel laminations.

3. Winding conductor of a transformer: copper (or aluminium).
4. Transformer oil is used for insulation and cooling.
5. High-frequency transformer cores are made from ferrites.
6. Silica gel in the breather absorbs moisture.
7. The tank and conservator are made of mild steel.