

1.1 Major considerations in Electrical Machine Design

The basic components of all electromagnetic apparatus are the field and armature windings supported by dielectric or insulation, cooling system and mechanical parts. Therefore, the factors for consideration in the design are,

Magnetic circuit or the flux path:

Should establish required amount of flux using minimum MMF. The core losses should be less.

Electric circuit or windings:

Should ensure required EMF is induced with no complexity in winding arrangement. The copper losses should be less.

Insulation:

Should ensure trouble free separation of machine parts operating at different potential and confine the current in the prescribed paths.

Cooling system or ventilation:

Should ensure that the machine operates at the specified temperature.

Machine parts:

The art of successful design lies not only in resolving the conflict for space between iron, copper, insulation and coolant but also in optimization of cost of manufacturing, and operating and maintenance charges.

The factors, apart from the above, that requires consideration are

- a. Limitation in design (saturation, current density, insulation, temperature rise etc.,)
- b. Customer's needs
- c. National and international standards
- d. Convenience in production line and transportation

- e. Maintenance and repairs
- f. Environmental conditions etc.

Limitations in design:

The materials used for the machine and others such as cooling etc., imposes a limitation in design. The limitations stem from saturation of iron, current density in conductors, temperature, insulation, mechanical properties, efficiency, power factor etc.

- a. Saturation:** Higher flux density reduces the volume of iron but drives the iron to operate beyond knee of the magnetization curve or in the region of saturation. Saturation of iron poses a limitation on account of increased core loss and excessive excitation required to establish a desired value of flux. It also introduces harmonics.
- b. Current density:** Higher current density reduces the volume of copper but increases the losses and temperature.
- c. Temperature:** poses a limitation on account of possible damage to insulation and other materials.
- d. Insulation:** (which is both mechanically and electrically weak): poses a limitation on account of breakdown by excessive voltage gradient, mechanical forces or heat.
- e. Mechanical strength:** of the materials poses a limitation particularly in case of large and high speed machines.
- f. High efficiency:** and high power factor poses a limitation on account of higher capital cost. (A low value of efficiency and power factor on the other hand results in a high maintenance cost).
- g. Mechanical Commutation:** in dc motors or generators leads to poor commutation. Apart from the above factors Consumer, manufacturer or standard specifications may pose a limitation.