THREE PHASE SQUIRREL CAGE INDUCTION MOTORS

Salient features

- Rugged cast iron frames
- Fitted with specially designed cooling fins and dynamically balanced rotors for smooth and vibration free performance
- Wound with higher thermal grade super enameled copper wires.
- Pumps are vacuum impregnated with selected resins, followed by a backing cycle for dielectric properties for moisture and environmental protection
- Efficiency, power factor and slip are better than other counterparts

Product specification

<table>
<thead>
<tr>
<th>S.No.</th>
<th>PARAMETER</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Range</td>
<td>0.8 kw to 315 kw</td>
</tr>
<tr>
<td>2.</td>
<td>Voltage</td>
<td>415 + 10%</td>
</tr>
<tr>
<td>3.</td>
<td>Frequency</td>
<td>50 Hz + 5%</td>
</tr>
<tr>
<td>4.</td>
<td>Combined variation</td>
<td>10%</td>
</tr>
<tr>
<td>5.</td>
<td>Insulation</td>
<td>Class F</td>
</tr>
</tbody>
</table>
6. S Mounting  Horizontal foot mounting (B3) as per ISI 1231
7. Ambient  50°C
8. Degree of protection  IP55 as per IS:4691
9. Duty  S1
10. Enclosure  Totally enclosed fan cooled

**ELECTRIC MOTORS**

**Application:**

Widely used for agriculture, rice/flour mills, air compressors and industries.

**Features:**

- Higher efficiency and power factor
- Rugged construction with high quality raw materials
- Wide voltage range motor design
- High grade enameled copper wire with varnish impregnated winding
- Virtually Nil maintenance cost

**Products specification**

**Class A**

- Horizontal foot mounted squirrel cage induction motors with standard shaft extension to suit 415 Volts +10%, 50 cycles +3%, 3 phase AC supply continuous rated as per IS :325/1978 and IS:7538

<table>
<thead>
<tr>
<th>KW</th>
<th>HP</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2 – 22.0</td>
<td>3.0 – 30.0</td>
<td>1440 – 960</td>
</tr>
</tbody>
</table>
ELECTRIC MOTOR

- An electric motor is an electromechanical device that converts electrical energy to mechanical energy.

- The mechanical energy can be used to perform work such as rotating a pump impeller, fan, blower, driving a compressor, lifting materials etc.

INDUCTION MOTORS (AC MOTOR)

- ASYNCHRONOUS
  - PHASE
  - SLIP RING INDUCTION MOTOR
  - SQUIRREL CAGE INDUCTION MOTOR
  - 1 φ induction motor
  - 3 φ induction motor

- SYNCHRONOUS
  - ACCORDING TO THE PHASE
  - 3 φ induction motor
THREE PHASE SQUIRREL CAGE INDUCTION MOTORS

A **Squirrel Cage Motor** is the rotating part used in the most common form of AC Induction Motor. An Electrical Motor with a squirrel cage rotor is termed a **Squirrel Cage Motor**.
CONSTRUCTION OF SQUIRREL CAGE INDUCTION MOTOR

Any Induction Motor has a Stator and a Rotor. The Construction of Stator for any induction motor is almost the same. But the Rotor Construction Differs with respect to the type which is specified above.

FRAME OR YOKE

- It gives complete support and protection.
- Frame with fins for cooling purpose
- It is made up of cast iron
- Machined in vertical turret lathe (internal boring, facing)
- Eye-bolt fitted on the frame for transit purpose

STATOR CORE
Stator stampings are made up of silicon steel.

Stator core is stacked by using stampings and pressed by hydraulic pressing machine.

Aluminum ribs are used to rivet the stator core.

To reduce hysteresis loss, silicon (about 3-5%) is added to the high grade steel.

Eddy current loss is reduced by building the stator core by stacking a number of thin silicon steel stampings.

Semi-closed slots are provided in the inner portion of the stampings.
Stamping thickness – 0.5 mm

Types of stamping – 1. Open type
2. Closed type
3. Semi Closed

Stampings are grouped according to
- Grade
- Dia
- Types of slots
- Number of slots

Stampings are arranged by using mandrels.

Aluminium ribs are used to rivet the stator stampings.

STATOR WINDING

Motors windings depends upon,
Application, Size, Speed, Frequency and Phase.

**Windings are of three types**

- Lap winding – both AC & DC motors
- concentric winding - AC motors
- wave winding - DC motors
- Enamel is used for insulating the windings
- **PVC is used for insulating the windings in the submersible (high HP motors) motors.**
INSULATION

• If there is no insulation short circuit occurs between the conductors. So insulation must be there.

• The insulating material is used as a protection cover.

<table>
<thead>
<tr>
<th>Material</th>
<th>Class</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minolex</td>
<td>F</td>
<td>180(^\circ)C</td>
</tr>
<tr>
<td>Leathorid</td>
<td>A</td>
<td>90(^\circ)C</td>
</tr>
</tbody>
</table>

VARNISHING PROCESS

• Varnishing is done for insulation purpose.
After assembling the stator windings the stators are placed in winding stand.

The winding stand is kept inside the vacuum impregnated chamber.

The chamber is suctioned to remove air, moisture content and then varnish is filled in the chamber. (stator fully immersed)

The high pressures rotate the varnish and flow inside the winding.

After 20 min the stator is removed from the chamber and kept in oven for 4-9 hrs at 120°C.

It prevents rust and improves insulation.

The winding stand contains winding it is placed inside the impregnated chamber.

The chamber is filled with varnish the gate valve is closed.

The high pressures rotate the varnish and flow inside the winding.

The process takes place for 20 minutes.

**ROTOR DIE CASTING PROCESS**
**ROTOR CORE**

- Rotor core is made up of silicon steel by die-casting process.
- Rotor core is assembled by stacking rotor stampings and punched into shapes pressed by using mandrels.
- Closed slots of either circular or rectangular shapes are provided in the stamping.
- After the core is stacked the shaft is inserted at the centre and firmly fitted by the key-way.
- Then the assembly is put in the die-casting machine where forced and pressured molten aluminum through the slots to form rotor bars and end rings and fins arrangement.
- Rotors bars are slightly inclined to the shaft axis due to the skew provided in the rotor stampings.
Skew helps to run motor quietly by reducing magnetic hum and reduces the magnetic locking tendency of the rotor.

Copper or brass bars are driven through the slots manually and the ends on both sides are then welded or silver soldered together to form end rings.

It is used for high HP motors

**ROTOR SHAFT**

- Rotor shaft is made up of mild steel.
- The shaft is machined and step turned in lathe and knurling is made in thread rolling machine to give a grip and tight fitting to the rotor.

**Rotor Balancing:**

- The weight of the rotor should be equal in all sides at all parts is called rotor balancing.
- There are two methods of rotor balancing by,
  - Material adding (Rotor pin)
  - Material removal- Submersible rotors (balancing ring)
- Balancing results in uniform air gap between stator and rotor
- After the rotor core is ready the shaft is inserted in to the rotor.

**The purpose of balancing**
One of the most important applications of vibration analysis is the solution of balancing problems. An unbalanced propeller, rotor or driveshaft will cause vibration and stress in the rotating part and in its supporting structure. Balancing of a rotating part is therefore highly advisable in order to accomplish one or more of the following:

- Increase quality of ride.
- Minimize vibration.
- Minimize audible and signal noises.
- Minimize structural stresses.
- Minimize operator annoyance and fatigue.
- Increase bearing life.
- Minimize power loss.

**REASONS FOR HAVING SKEWED ROTOR**

1. It helps in reduction of magnetic hum, thus keeping the motor quiet,

2. It also helps to avoid “Cogging”, i.e. locking tendency of the rotor. The tendency of rotor teeth remaining under the stator teeth due to the direct magnetic attraction between the two,

3. Increase in effective ratio of transformation between stator & rotor,

4. Increased rotor resistance due to comparatively lengthier rotor conductor bars, &
5. Increased slip for a given torque

Rotor balancing is used to maintain uniform air gap between stator and rotor.

BEARINGS AND END COVER

▶ The rotor is seated in ball bearings on both sides.
▶ It helps the moving parts to rotate smoothly without friction.
▶ End covers provide support to the rotor assembly.
▶ Two end covers are fixed on both sides with suitable bearings

TESTING OF MOTORS

▶ **INSULATION TEST** – This test is carried out by using megger by connecting one end to body and other end to one end of the phase. The pointer denotes the insulation resistance.

▶ **NO-LOAD TEST** – It is carried out to find the no-load input current and no-load power factor, phase angle.
► FULL LOAD TEST – It is carried out to find the full-load current and full load power factor, phase angle.

► BLOCKED ROTOR TEST – This test aimed at find the following blocked rotor input current/phase, blocked rotor input power factor, and phase angle.

LOSSES

Types of Losses:

► Electrical loss (copper loss),

► Magnetic loss,

► Mechanical loss.

Electrical loss

► It is due to ohmic resistance in stator windings.

► Windings are normally made of copper and so it is called as copper loss.

► As the copper loss varies on load conditions it is also called variable loss.
Magnetic loss

► Hysteresis loss – As the stator core is made of silicon steel/iron, magnetic loss are also called as core or iron loss.

► Due to flux reversals hysteresis loss takes place

► As silicon is added to the steel the loss is reduced to the maximum.

► Eddy current loss

$$(\text{Eddy current})^2 \times \text{resistance of the stator core}$$

► The amount eddy emf induced in the core is proportional to the flux density and the frequency of flux reversals.

MECHANICAL LOSS

► Friction loss:

This loss occurs between two solid parts of the machine i.e., friction in bearings. This loss is directly proportional to speed of the motor.

► Air-friction or Windage loss:

This loss occurs between rotating solid parts of the machine and the air around the surface of the motor.

MERITS AND DEMERITS

Merits

➢ Simple and rugged construction
ROTATING MACHINERY DIVISION (RMD)

- Low cost and reliability.
- Requires minimum maintenance,
- High efficiency

**Demerits**

- Low starting torque
- Speed decreases with increase in load
- Speed control in 3 phase induction motors with auxiliary speed controllers is costly (10 times the motor)
ROTATING MACHINERY DIVISION (RMD)