SNS COLLEGE OF ENGINEERING

Kurumbapalayam (Po), Coimbatore – 641 107

An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME : 19EE407 ELECTRICAL MACHINES AND DRIVES

II YEAR / 04 SEMESTER MECH

Unit 2 – ELECTRICAL MOTORS

Synchronous Motor

What is a Synchronous Motor?

- A synchronous motor (short for synchronous electric motor) is an AC motor where the rotation of the rotor (or shaft) is synchronized with the frequency of the supply current.
- That is, the rotation period of the rotor is equal to the rotating field of the machine it is inside of.

Introduction

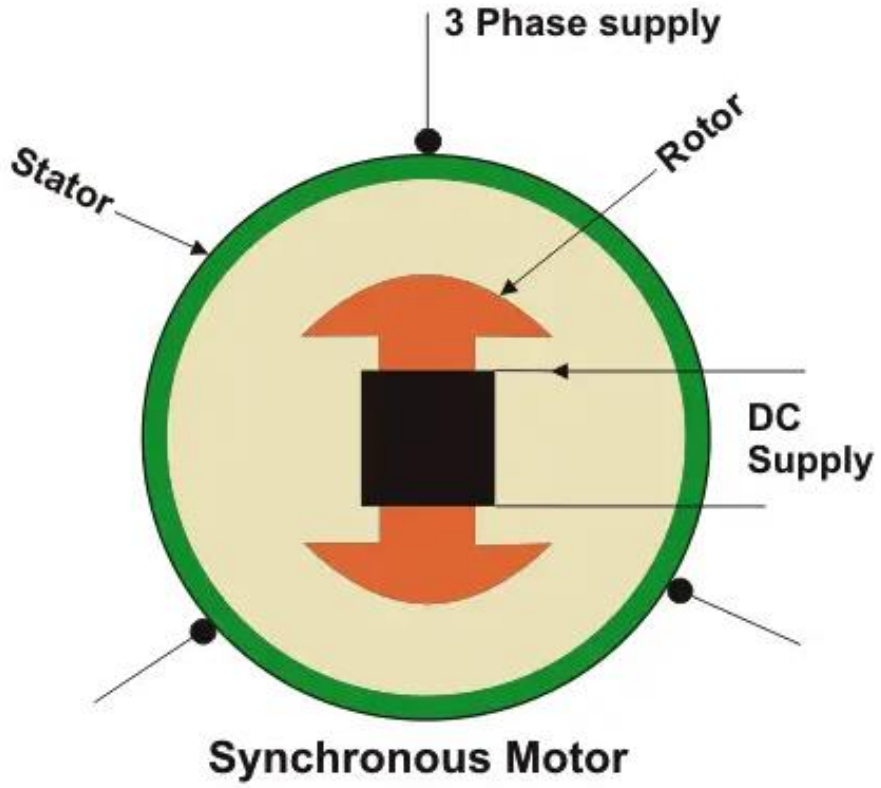
- The most common type of 3 phase motors is synchronous motors and induction motors.
- When three-phase electric conductors are placed in certain geometrical positions (i.e. in a certain angle from one another) – an electrical field is generated.
- The rotating magnetic field rotates at a certain speed known as the synchronous speed.
- If an electromagnet is present in this rotating magnetic field, the electromagnet is magnetically locked with this rotating magnetic field and rotates at the same speed as the rotating field.

- This is where the term synchronous motor comes from, as the speed of the rotor of the motor is the same as the rotating magnetic field.

- It is a fixed speed motor because it has only one speed, which is synchronous speed. This speed is synchronised with the supply frequency. The synchronous speed is given by:

$$N_s = \frac{120f}{p}$$

Construction of Synchronous Motor



- Usually, its construction is almost similar to that of a 3 phase induction motor, except the fact that here we supply DC to the rotor

Main Features of Synchronous Motors

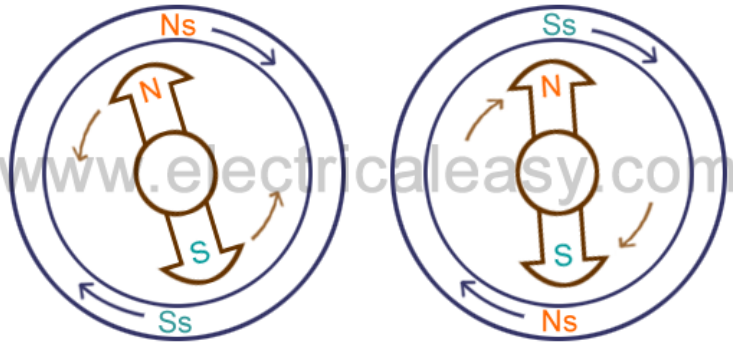
- Synchronous motors are inherently not self starting. They require some external means to bring their speed close to synchronous speed to before they are synchronized.

- The speed of operation of is in synchronism with the supply frequency and hence for constant supply frequency they behave as constant speed motor irrespective of load condition

- This motor has the unique characteristics of operating under any electrical power factor. This makes it being used in electrical power factor improvement.

Principle of Operation of Synchronous Motor

- Synchronous motors are a doubly excited machine, i.e., two electrical inputs are provided to it. Its stator winding connected with three-phase, and DC to the rotor winding.
- The 3 phase stator winding carrying 3 phase currents produces 3 phase rotating magnetic flux. The rotor carrying DC supply also produces a constant flux.
- At a particular instant rotor and stator poles might be of the same polarity (N-N or S-S) causing a repulsive force on the rotor and the very next instant it will be N-S causing attractive force.



- But due to the inertia of the rotor, it is unable to rotate in any direction due to that attractive or repulsive forces, and the rotor remains in standstill condition. Hence a synchronous motor is not self-starting.
- Here we use some mechanical means which initially rotates the rotor in the same direction as the magnetic field to speed very close to synchronous speed. On achieving synchronous speed, magnetic locking occurs, and the synchronous motor continues to rotate even after the removal of external mechanical means.

Methods of Starting of Synchronous Motor

- **Motor starting with an external prime Mover**: Synchronous motors are mechanically coupled with another motor. It could be either 3 phase induction motor or a DC shunt motor.
- Here, we do not apply DC excitation initially. It rotates at speed very close to its synchronous speed, and then we give the DC excitation. After some time when magnetic locking takes place supply to the external motor is cut off.
- **Damper winding In this case**, the synchronous motor is of salient pole type, the additional winding is placed in the rotor pole face. Initially, when the rotor is not rotating, the relative speed between damper winding and rotating air gap flux is large and an emf is induced in it which produces the required starting torque.
- As speed approaches synchronous speed, emf and torque are reduced and finally when magnetic locking takes place; torque also reduces to zero.
- Hence, in this case, the synchronous motor first runs as three phase induction motor using additional winding and finally it is synchronized with the frequency.

Applications of Synchronous Motors

- A synchronous motor having no load connected to its shaft is used for power factor improvement. Owing to its characteristics to behave at any electrical power factor, it is used in power systems in situations where static capacitors are expensive.
- Synchronous motor finds applications where operating speed is less (around 500 rpm) and high power is required. For power requirements from 35 kW to 2500 KW, the size, weight and cost of the corresponding three-phase induction motor are very high. Hence these motors are preferably used. Ex- Reciprocating pump, compressor, rolling mills etc.

Mechanical Characteristics

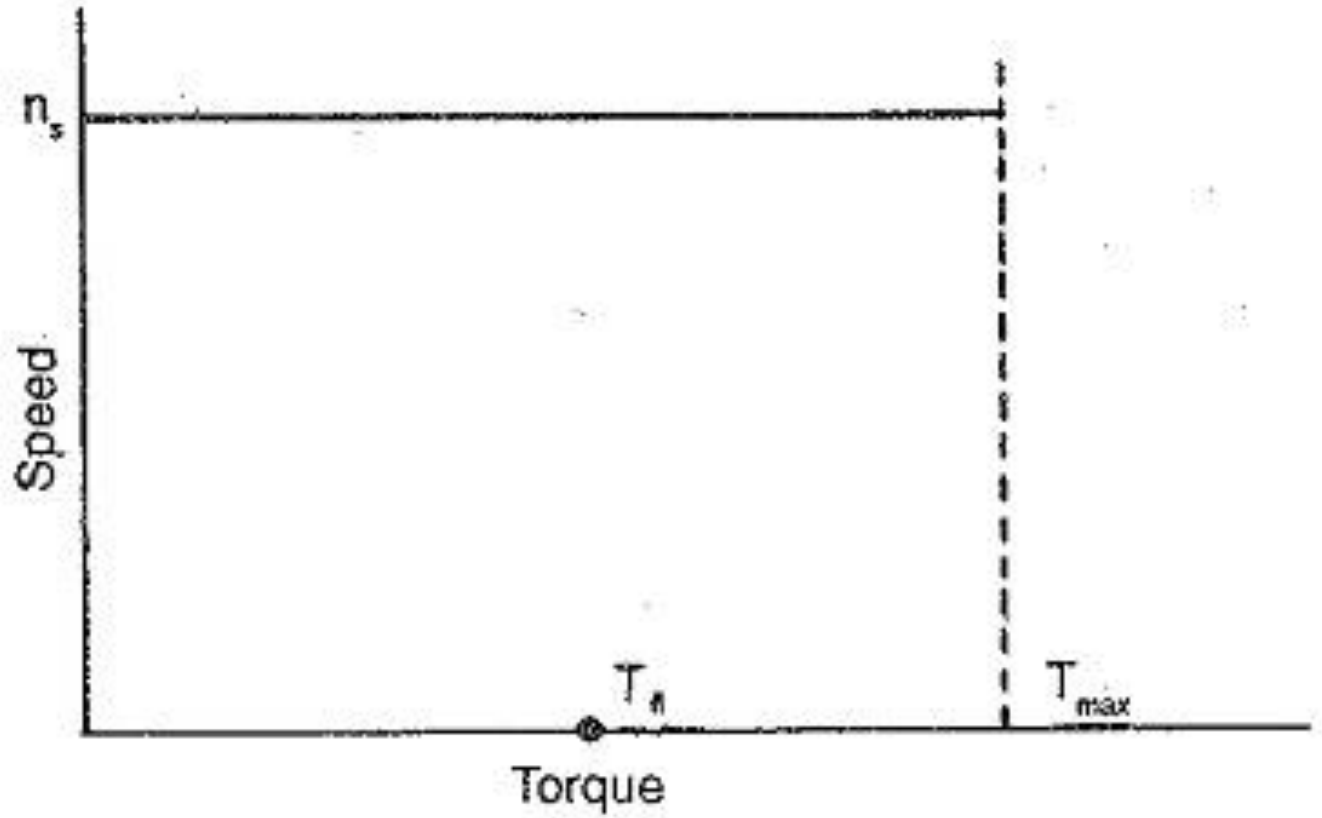


Fig. 1.34(a) *Speed torque characteristic of a synchronous motor*