SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME: 19EEB210 / Electrical Machines and Drives

II YEAR / IV SEMESTER

Unit II – ELECTRICAL MOTORS

Topic : SYNCHRONOUS MOTOR

SYNCHRONOUS MOTOR

- A synchronous motor is a type of AC motor whose rotor rotates at the same speed as the rotating magnetic field.
- The stator's magnetic field revolves at a speed that depends on the supply frequency known as synchronous speed.
- The rotor of the synchronous motor is synchronized with the frequency of the supplied current.
- It does not rely on the induced rotor current instead the rotor has either permanent magnets or field windings that are energized using an external source.
- Synchronous speed depends on the supply frequency and the number of poles in the rotor. Synchronous speed is given by

$$\mathbf{NS = 120f \div p}$$

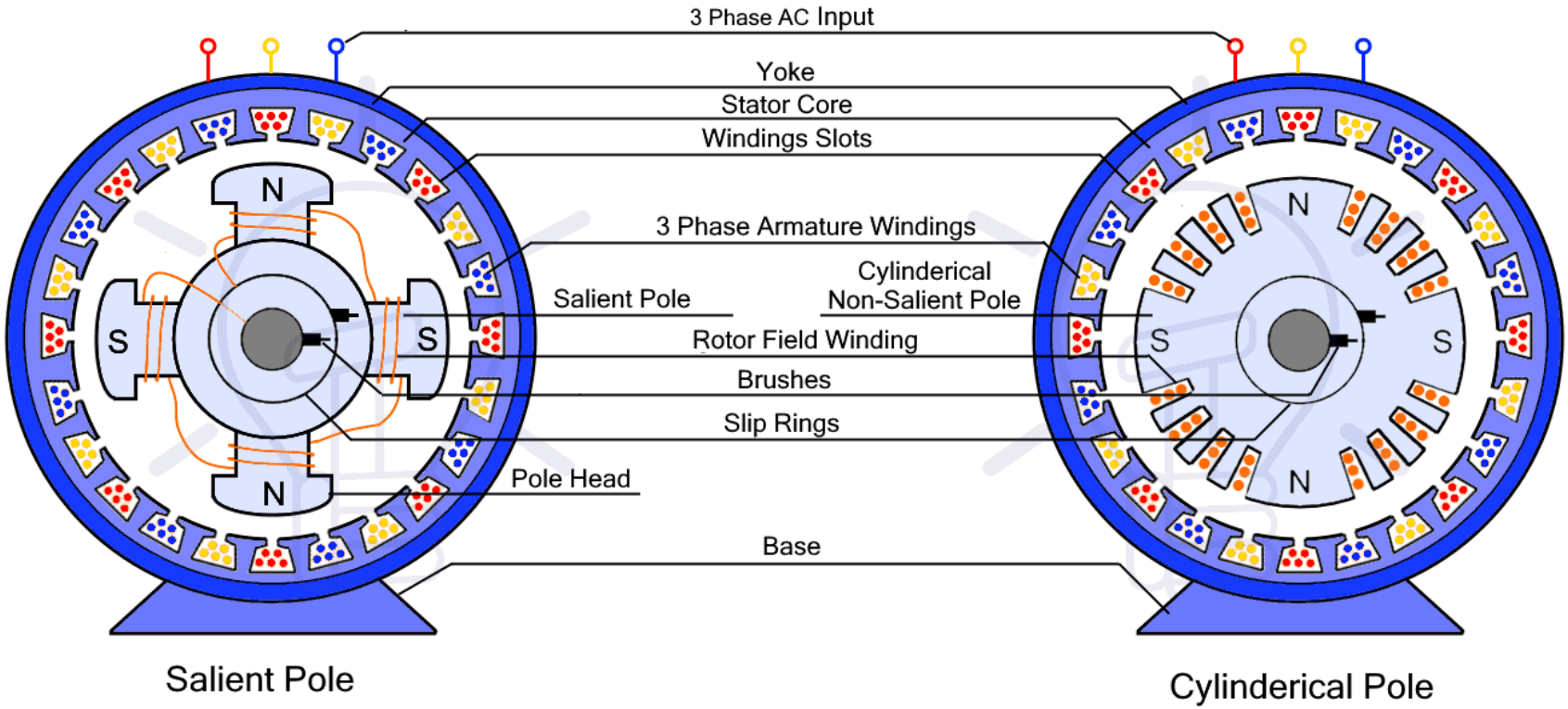
where,

NS = Synchronous speed (RPM)

f = Frequency of supply current

p = No. of poles

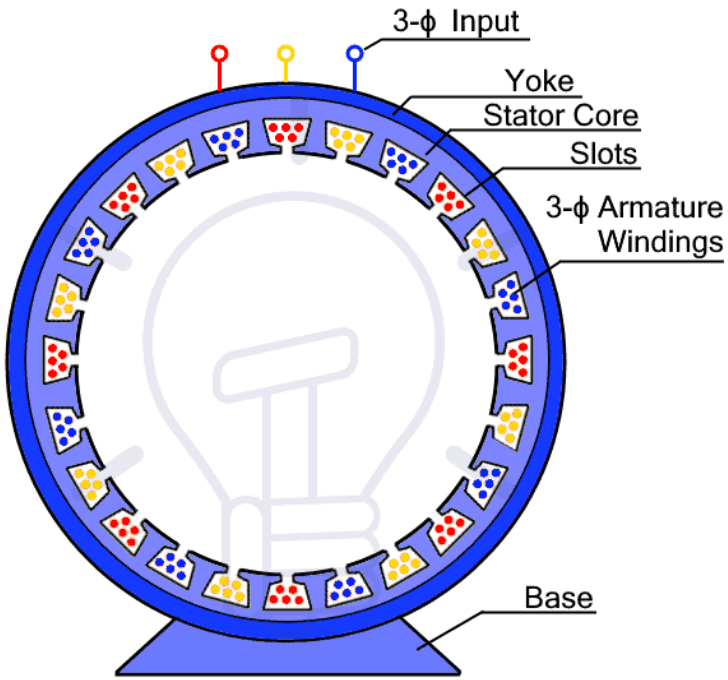
SYNCHRONOUS MOTOR



Construction of Synchronous Motor

STATOR

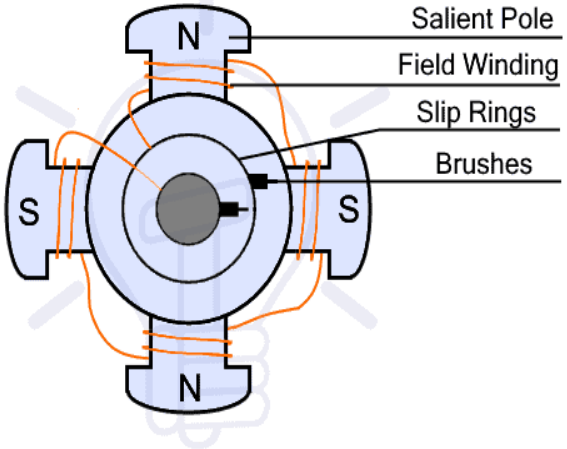
- The stator is the stationary part of the motor. Just like an induction motor, the stator core is made of thin laminated sheets of steel or cast iron of good magnetic quality to reduce hysteresis and Eddy current loss.
- The core has axial slots for holding the three-phase alternating stator field winding called armature winding.
- The stator's armature winding is supplied with 3-phase power through its input terminal. It is responsible for generating the rotating magnetic field (RMF).



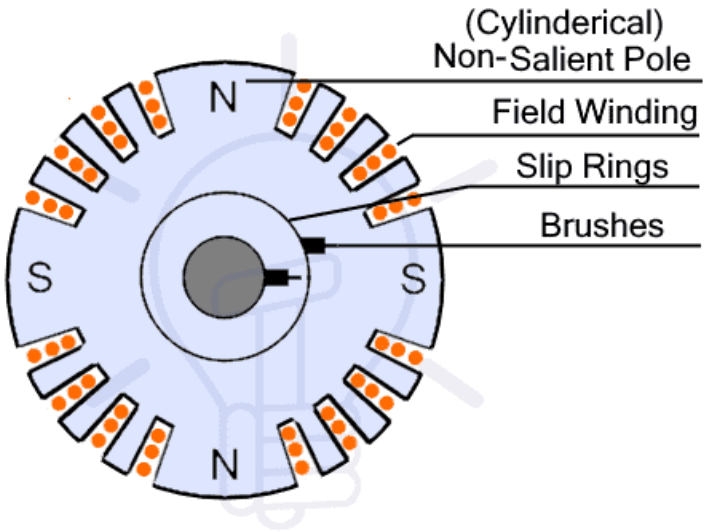
Synchronous Motor Stator

ROTOR

- The rotor is the rotating part of the synchronous motor. It has a cylindrical shape and holds the field winding.
- It is responsible for generating the magnetic field or poles.
- It is energized using slip rings and brush assembly using a DC source.



Salient Pole Rotor

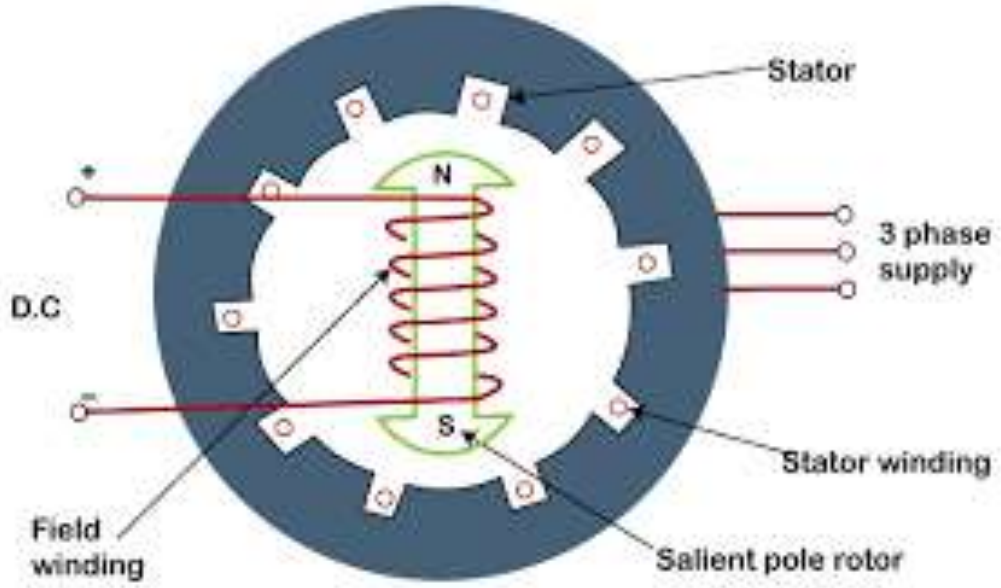


Non-Salient (Cylinderical) Pole Rotor

WORKING

•Synchronous motor works on the principle of magnetic locking between the stator RMF (rotating magnetic field) and the rotor magnetic field. As we know, opposite poles attract each other, therefore the RMF poles attract the opposite rotor poles generating a rotating motion.

•A synchronous motor is a doubly excited machine i.e. it requires AC and DC supply for both parts stator as well as rotor to achieve synchronism



WORKING

•A three-phase AC is supplied to the stator's windings to generate RMF. The stator is designed to have the same number of poles as the rotor.

•These poles rotate at the speed that is in sync with the input frequency f is called synchronous speed. It is given by NS = 120f / p

•A DC supply is provided to the rotor's windings to generate a fixed magnetic field.

• As the DC source supplies constant current, the rotor's magnetic field does not vary. Magnetic poles are generated at the opposite ends of the rotor.

• The rotor's poles interact with the RMF of the stator and rotate at the same speed as it attains the synchronous speed.

•If the rotor rotates at the same speed as the stator RMF, there is no load torque. The rotor and stator poles align with each other.

• If a mechanical load is applied, the rotor starts oscillating about its new equilibrium position, this phenomenon is known as 'hunting

CHARACTERISTICS

- The synchronous motor is inherently not self-starting. The rotor needs to be brought up to the synchronous speed by any means to synchronize with the supply frequency.
- Its speed only varies with the frequency of the input supply. VFD is used to control the speed of the synchronous motor.
- Its speed is independent of the load. Therefore synchronous motor is not affected by any variation in the load.
- The Increase in load increase the torque. A synchronous motor will stall if the torque increase beyond the breakdown torque.
- Synchronous motor either run at synchronous speed or does not run at all.
- Synchronous motor can run in both leading as well as lagging power factors. Therefore they are used for power factor Improvement in industries.

APPLICATIONS

- Synchronous motors were primarily used in constant speed applications. But, with the development of solid-state variable frequency drives like inverters and cyclo converters has allowed their use in variable speed applications also.
- The synchronous motors are particularly used for low speed (below 300 RPM) applications because at low speed, the power factor can be adjusted to unity and hence the efficiency is high.
- An over-excited synchronous motor (called synchronous condenser) can used to improve the overall power factor of the plant while carrying their rated load.
- Since a synchronous motor behaves like a variable inductor or a variable capacitor, used to improve the voltage regulation of transmission lines.
- Power electronic converters generating very low frequency enable us to use the synchronous motors for ultra-low speed applications such as to drive crushers, rotary kilns and variable-speed ball mills, etc.
- Some industrial applications of synchronous motors are such as high power and high speed compressors, blowers, mainline traction, induced and forced draft fans, servo drives, etc.

ADVANTAGES

- It has a constant operating speed called synchronous speed that only depends on supply frequency and does not vary with any change in load.
- It can operate in lagging, unity and leading power factor by increasing the field excitation. Thus making it useful for power factor improvement.
- It has a relatively higher efficiency above 90% as compared to the induction motor.
- They are more cost-effective at a lower speed than an induction motor.

DISADVANTAGES

- Synchronous Motors are inherently not self-starting and require other means to provide near synchronous starting speed.
- It stalls if the load exceeds beyond breakdown limit.
- It requires an external DC source for its rotor field excitation
- Its speed cannot be varied unless the VFD variable frequency drive is used to very its supply frequency.
- Hunting occurs in synchronous motor with sudden application of load.
- It requires frequent maintenance due to slip rings and brushes.
- Synchronous motors are generally more complicated and costlier than induction motors.

KEEP
LEARNING.

Thank u

SEE YOU IN NEXT CLASS