EXPERIMENT 11

STARTING METHODS OF SYNCHRONOUS MACHINE

EQUIPMENT

* 3 Phase Synchronous Motor.
* Knife Switch.
* PMDC Motor as a prime mover.
* Variable DC Supply.
* AC and DC Voltmeter and Ammeter.
* Variable Resistor.

INTRODUCTION

Three basic approaches can be used to safely start a synchronous motor:

**1.** Reduce the speed of the stator magnetic field to a low enough value that the rotor can accelerate and two magnetic fields lock in during one half-cycle of field rotation. This can be achieved by reducing the frequency of the applied electric power (which used to be difficult but can be done now).

**2.** Use an external prime mover to accelerate the synchronous motor up to synchronous speed, go through the paralleling procedure, and bring the machine on the line as a generator. Next, turning off the prime mover will make the synchronous machine a motor.

**3.** Use damper windings or Amortisseur windings.

We will use 2ndand 3rdmethod in the lab to start the synchronous motor.

* Method 1- Using Damper Winding

The torque acting on a synchronous machine is counter-clockwise and then clockwise during one electrical cycle, and the average torque is zero. The motor will vibrate heavily and finally overheats. So, a synchronous machine cannot be started by direct applying the two supplies i.e. 3-phase supply to Armature winding and DC supply to field winding. So, for this purpose synchronous machines are always provided with Damper winding also known as Amortisseur winding. Damper windings are special bars laid into notches carved in the rotor face and then shorted out on each end by a large shorting ring.



* Method 2- Using Prime Mover

To use an external prime mover to accelerate the rotor of synchronous motor near to its synchronous speed and then supply the rotor as well as stator. Care should be taken to ensure that the direction of rotation of the rotor as well as that of the rotating magnetic field of the stator is the same. This method is usually followed in the laboratory- the synchronous machine is started as a generator and is then connected to the supply mains by following the synchronization or paralleling procedure. Then the power supply to the prime mover is disconnected so that the synchronous machine will continue to operate as a motor.



OBJECTIVE

Learn how to start a synchronous motor. And why we need these methods to start synchronous motor.

APPLICATION

**Synchronous motors** are normally used in **applications** in which a constant and precise speed is required. Typical **applications** of these low power **motors** are positioning **machines**. They are also used in robot actuators. **Synchronous motors** are also used in ball mills, watches, record players, and turntables.

These **machines** are commonly **used** in analog electric clocks, timers and other devices where correct time is required. In higher power industrial sizes, the **synchronous motor** provides two important functions.

PROCEDURE

(A) Method 1- Using Damper Winding

1. Connect circuit as shown in Figure 11.2

2. First, main filed winding is short circuited.

3. Reduced voltage approximately 70V AC with is applied across stator terminals. The motor starts up.

4. When it reaches a steady state speed a weak dc excitation i.e. 50V is applied by removing the short circuit on the main filed winding. If excitation is sufficient, the machine will be pulled into synchronism.

5. Full supply voltage is applied across stator terminals.

6. The motor may be operated at any desired P.F by changing the D.C excitation.

(B) Method 2- Using Prime Mover

1. Connect circuit as shown in Figure 11.3

2. Apply 3-phase supply to armature circuit.

3. Rotate the armature with help of prime mover at rated speed.

4. Apply field excitation.

5. Vary field excitation until machine runs at constant speed. At that instant machine interlocks electrically.

ISSUE

Did not know how to make connections because it’s too complex.

CONCLUSION

**Synchronous** motors have the unique ability to run at different power factors. As load on the **motor** increases, the armature (stator) current Ia increases regardless of excitation. For under and over excited **motor**, the power factor (p.f.) tends to approach unity with increase in load.

POST LAB QUESTIONS

* Write down different parameters to define the synchronous machine rating.

The **ratings** of **synchronous generators** for large power systems extend up to about 2,000 megavolt-amperes. Smaller power systems use **generators** of lower **rating** (e.g., 50 megavolt-amperes and up) since it is usually not desirable to have more than 10 percent of the total required system generation in one **machine**.

* What do you mean by rated value i.e. rated voltage, rated current, rated power, rated speed etc.

**Rated Voltage**

The **rated voltage is** the **value** of **voltage** used to designate the switchgear and to which **is** related its operating performance. The **rated voltage** indicates the upper limit of the highest **voltage** of systems for which the switchgear **is** intended.

**Rated Current**

The **current** that an electrical device can carry, under specified conditions, without resulting in overheating or mechanical overstress.

**Rated Power**

**Rated power** means the maximum brake **power output** (horsepower and kilowatt) of an engine as specified by an engine manufacturer.

**Rated Speed**

The **rated speed** is the **speed** at which the motor will first produce its maximum designed power output, and “maximum **speed**,” the fastest the motor can spin while producing that same amount of power./:m] ]The reduction ratio should be applied on the RPM while your load is attached to the motor.

3. What is the difference between induction machine and synchronous machine? What happens when field circuit of synchronous motor is disconnected?

A three-phase **synchronous motor** is a doubly excited **machine**, whereas an **induction motor** is a single excited **machine**. The armature winding of the **synchronous motor** is energized from an AC source and its field winding from a DC source. The stator winding of **Induction Motor** is energized from an AC source.

Now if the field is disconnected (considering open circuit) while the motor is running, the interlocking will be lost and the motor will eventually come to halt.

Also there can be an induced voltage in the field windings (if the field is open circuited) because of the relative motion between the rotor conductors and the stator magnetic field.