Connection, Rotational direction test and load characteristics Of Synchronous Motor

Object: The object of this experiment is to run the synchronous machine as a synchronous motor and determine the load characteristic IL = f (M) at cos φ = 1.

Theory: The synchronous machine is operated as a motor if a constant speed is required. If the stator winding of the synchronous motor is connected to the three – phase mains, the stator rotating field immediately reaches the synchronous speed. Due to its inertia, the rotor cannot follow the rotating field immediately from standstill. It must be started up in the vicinity of the speed of rotating field (synchronous speed) and then pulls up to the required speed itself. In operation as a motor, the synchronous machine requires a starting aid with which it is driven close to its rated speed in order to run then independently at the speed of rotating field with the excitation switched on. The excitation must be set to zero first and then increased slowly until the motor breaks out.

A measure of the load of the synchronous motor is the (load angle φ), as shown in Figure (47). Overloading of the synchronous motor must be avoided because otherwise it falls "out of step" and comes to a standstill; in addition it would overheat at standstill. It may only be loaded between no – load and pull – out torque. The rotor remains behind the stator rotary field by the load angle depending on the load. On exceeding the load angle the pull – out torque is reached and the motor comes to a standstill.

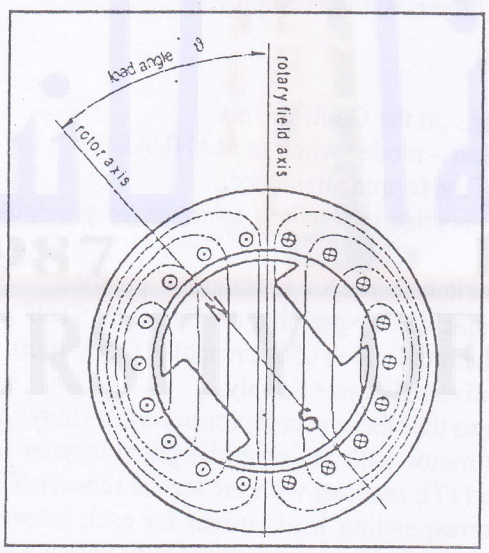

Figure (47)
Load angle of synchronous motor

Necessary equipments:

1. Synchronous Machine (Type 2711).
2. Brake Unit (Type 2719).
3. Control Unit (Type 2730).
4. Universal Power Supply (Type 2740).
5. Power factor meter (10 A).
6. 2 Ammeters, range (0 – 5 A).

Procedure:

Run I:

1. Push the experimental machine onto the Brake Unit and couple it to the braking machine.
2. Adjust the adapter feet so that the experimental machine and the braking machine are collinear (on one axis). Fix the experimental machine by pulling the clamping lever towards the braking machine.
3. Connect the circuit shown in Figure (48).
4. Connect the machine stator winding in star circuit to the 400 V mains.
5. Set the excitation of the Universal Power Supply to the left stop (0 volt).
6. Switch *ON* the Control Unit.
7. Switch *ON* the Universal Power Supply; Speed, torque and direction of rotation are displayed.
8. Note the direction of rotation on the display. The machine should rotate to the right (CW); otherwise switch *OFF* the Universal Power Supply and interchange two of the three mains leads and Switch *ON* the Universal Power Supply again.
9. Record the speed (no – load speed) and the direction of rotation in the following table:

Speed / rpm	Direction of Rotation	CW(Clock Wise)	CCW(Counter Clock Wise)

10. Switch *OFF* the Universal Power Supply.

Run II:

Make the following settings on the Control Unit:

1. Switch the operation – mode switch to MANUAL.
2. Note the setting of the torque attenuator.
3. Set the speed – preselection switch to range of previously recorded speed (1800 rpm).
4. Set the set point switch INT/EXT to "internal" position.
5. Start the braking machine by pressing the START / STOP key.
6. Set the speed to the rated speed of the machine (1500 rpm).
7. Switch *ON* the Universal Power Supply.
8. Set the excitation so that the power factor becomes Unity ($\cos\varphi = 1$).
9. Slowly brake the motor with the set point potentiometer to the torque values recorded in Table (17); readjust with the torque reducer if necessary. Measure and record the corresponding load current for each torque value in the table. The power factor must be kept constant at Unity with the excitation during the run.

10. To finish the experiment, set the excitation to (ZERO) first then switch *OFF* the Universal Power Supply and then the Control Unit.

Table (17)

Load characteristics of the Synchronous motor at Unity power factor

M / Nm	0 (Pf = 1)	0.4	0.8	1.2	1.6	2.0	2.4	·2.8	3.2
IL/A									

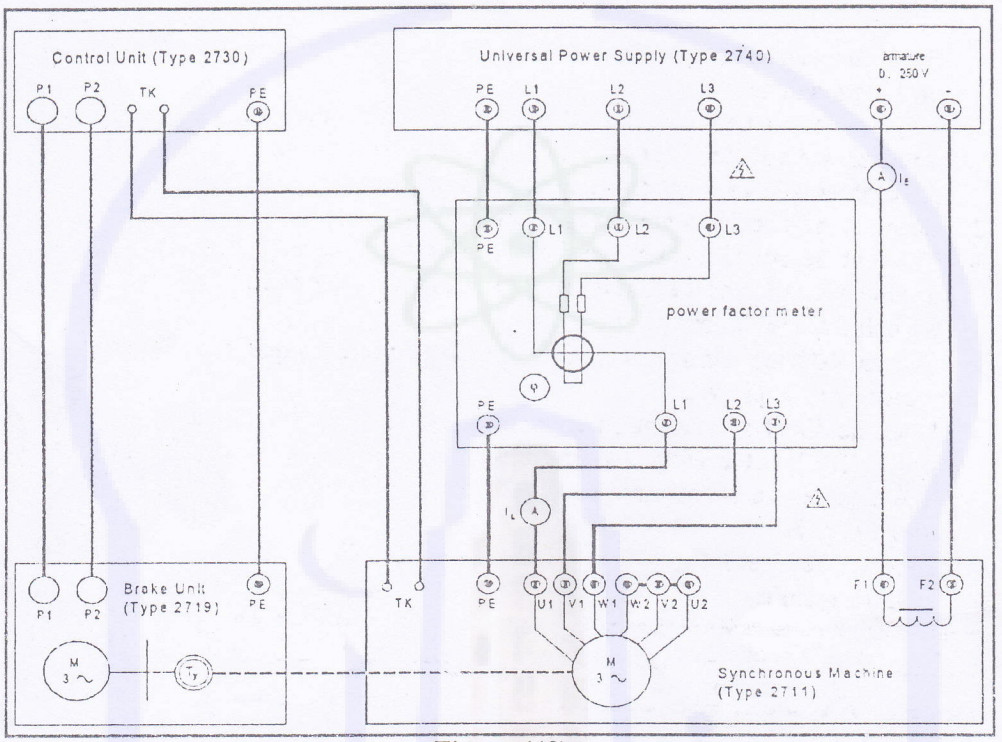

Figure (48)

Connection circuit diagram for determining the load characteristics Of the Synchronous Motor

Notes:

- If the synchronous motor does not start up, the excitation must be increased slowly until the motor has reached the given value on the rating plate.
- For an accurate setting of speed and torque, the voltage values can be measured additionally with a voltmeter at the jacks provided.
- The excitation must be increased before the machine falls out of step.
- Carry out the measurements with out delays if possible. If the machine heats up too much, the measuring results will deviate and the machine must cool down.

Report & Discussion:

1. Draw the load characteristics listed in Table (17). What do you learn from the load characteristic?
2. Why the synchronous motor requires special starting aids?