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Electrical/Electronics Engineering

Electrical Machines II

ANSWERS TO POWER FACTOR CORRECTION AND SYNCHRONOUS MOTORS

1. The power factor of a synchronous motor is changed with a change in the excitation. When the excitation of the motor is increased, the power factor changes from lagging to unity and then to a leading power factor. This property of the motor is utilized to improve the power factor of the loads, having a low lagging power factor. Normally, when the motor is utilized in this way to improve the factor, the synchronous motor is to run without any mechanical load.
2. That means that the three phase current entering the stator winding has an angle difference with the voltage.

The purpose of using synchronous motors is to use it in leading power factor by controlling the field current in the rotor.

3. An over-excited synchronous motor has a leading power factor. This makes it useful for power correction in industrial loads. Both transformers and induction motors draw lagging (magnetizing) currents from the line. This improves the plant power factor and reduces the reactive current required from the grid.
4. A synchronous motor has better power factor as compared to that of an equivalent induction motor. This is mainly because
 - Synchronous motor has no slip
 - Stator supply is not required to produce magnetic field

- Mechanical load on the rotor remains constant
 - Synchronous motor has large air gap
5. Synchronous motors are used for the power factor correction. Now, since the set up of the magnetic flux (which can be considered as the reactive power component) inside the motor is done by the dc excitation provided on the rotor terminals, the power factor can also be controlled by controlling the dc excitation.
 6. A synchronous motor running on no-load with leading power factor will act as synchronous condenser. The same motor when operated with lagging power factor no-load will draw a reactive current from the system depending upon the system voltage.
 7. Like an induction machine, an under excited synchronous machine too will consume reactive power; a properly excited synchronous machine neither consumes nor produces reactive power; An over excited synchronous machine can produce reactive power.
 8. Efficiency is higher than that of an induction motor of the same output and voltage rating because there are neither losses related to slip nor the additional losses due to magnetizing current.

With synchronous motors, there is no difference of speed between air gap rotating magnetic field and rotor.

9. Power factor of induction motor depends on load and speed, power factor of an synchronous motor might be fixed, usually such motor are huge and therefore their reactive power causes huge losses.
10. The real power is nothing to do with it. The real power will be proportional to the mechanical load. If the motor is uncoupled it will be (close to) zero, regardless of the reactive situation. If the load is consuming power, the motor will take it from the supply to pass on. If the load is supplying power the converse will apply.
11. Large synchronous motors have adjustable power factor. They can even have leading power factor. They are often set this way to

compensate for all other induction motors. This can affect the efficiency of the motor depending on load. With the system tuned to near unity the entire distribution system benefits. It is a good way to go. There is not just one type of synchronous motor but they most often do better than standard induction motors.

12. Synchronous motor always rotates with synchronous speed, irrespective of the lading conditions. So, the effective output is not reduced, compared to induction motor. So more efficiency is observed in this case. Also, the operating power factor is constant in synchronous motors. It is also a doubly excited machine, unlike induction motor.
13. Synchronous machines have separate DC excitation which reduces machine's excitation dependency on main supply, hence better PF. Where as induction motor have no such provisions, hence low PF.
14. Power factor is a number which in very small length tells us about the efficiency of an AC machine like an induction motor. As we know, in an inductive load current lags the voltage by a certain angle. Higher the lag, the lesser the power factor will be. Cosine of the angle between voltage and current is called Power factor.
15. An over-excited synchronous motor has a leading power factor. This makes it useful for power factor correction of industrial loads. Both transformers and induction motors draw lagging (magnetizing) current from the line. This improves the plant power factor and reduces the reactive current required from the grid.