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**ENG 326 ASSIGNMENT**

**ELECTRICAL MACHINES**

1. [**How is Power factor correction done by using a synchronous motor?**](https://www.quora.com/Electrical-Engineering-How-is-Power-factor-correction-done-by-using-a-synchronous-motor)

Synchronous motor which is over excited is referred to as a synchronous condenser.
Over exciting means giving more current to its field winding (winding which produces the magnetic field). A synchronous condenser acts like a capacitor in terms that it decreases lagging power factor. A synchronous condenser produces reactive power as opposed to consuming in case of ordinary motor. Both transformers and induction motors draw lagging currents from the line. On light loads, the power drawn by induction motor has a large reactive component and the power factor has a low value.
The added current flowing to supply reactive power creates additional losses in the power system. Synchronous motors can be used to supply some of the reactive power required by induction motors. This improves the plant power factor and reduces the reactive current required from the grid.

1. [**What is meant by power factor when it come to synchronous motor?**](https://www.quora.com/What-is-meant-by-power-factor-when-it-come-to-synchronous-motor)

This means that the three phase current entering the stator winding has an angle difference (theta) with the voltage. The purpose of using synchronous motor is to use it in leading power factor by controlling the field current in rotor. The power factor of a synchronous motor is changed with a change in the excitation.

1. [**How do synchronous motors improve power factors?**](https://www.quora.com/How-do-synchronous-motors-improve-power-factors)

This type of ac motor (synchronous) in effect is used specially to act as a capacitor which function effectively in increasing the p.f. Of the system by injecting leading currents to offset the effect of inductive loads such as caused by the ac-induction motors (asynchronous) that are connected in the electrical circuits or networks whether in low voltage or high voltage installations. As the field of the synchronous motor can be altered or adjusted to work effectively in counter-acting the lagging currents of these ac-induction motors, then by the capacitive action of the synchronous motor once running, the power factor is increased to higher value thus improving the overall system p.f. Of a particular electrical network.

1. [**Why there is better power factor in synchronous motor as compared to that of an equivalent induction motor?**](https://www.quora.com/Why-there-is-better-power-factor-in-synchronous-motor-as-compared-to-that-of-an-equivalent-induction-motor)

A synchronous motor has better power factor as compared to that of an equivalent induction motor. This is mainly because stator supply is not required to produce magnetic field.

1. [**How can a power factor be controlled in synchronous motors?**](https://www.quora.com/How-can-a-power-factor-be-controlled-in-synchronous-motors)

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 leads, having a low lagging power factor. Normally, when the motor is utilized in this way to improve the factor, the synchronous motor is run without any mechanical load. The excitation is adjusted in such a manner that it works at a leading power factor. The synchronous motor is then referred to a synchronous condenser.



1. [**What happens when synchronous motor operates on no load?**](https://www.quora.com/What-happens-when-synchronous-motor-operates-on-no-load)

A synchronous motor running on no-load with leading power factor will act as synchronous condenser. This is not truly a no-load operation since the motor, while behaving as a condenser is actually feeding a part of reactive load of the system to which it is connected. The same motor when operated with lagging power factor on no-load will draw a reactive current from the system depending upon the system voltage. However, this does not mean that the motor can be operated on no-load regardless of the armature current that flows in the motor. The capacity of the motor to run as synchronous condenser or as synchronous motor, whether on load or no-load is dictated by its V-curve (Armature current vs. field current). If the rotor speed is made equal to that of the stator field and there is no load [torque](https://www.britannica.com/science/torque), these two magnetic fields will tend to align with each other.

1. [**Why is a synchronous motor not used for developing power factors?**](https://www.quora.com/Why-is-a-synchronous-motor-not-used-for-developing-power-factors)

The great feature of Synchronous Motor is its ability to operate at leading power factor when over-excited. A Synchronous Motor can be made to operate at unity and leading power factor by just increasing its excitation voltage i.e. by increasing the field current. This advantage of Synchronous Motor is used to improve the power factor. A Synchronous Motor when just used for improving the power factor is known as Synchronous Condenser. Synchronous Condenser is normally installed at the receiving end of a supply line when using capacitor bank is found uneconomical. It should always be kept in mind that an inductor consumed Reactive Power whereas a Capacitor is generator of Reactive Power. If at any point of Power System, the generation of reactive power is more than the consumption then voltage at that point will increase and vice-versa.

1. [**Why is the efficiency of the synchronous motor greater than the induction motor?**](https://www.quora.com/Why-is-the-efficiency-of-the-synchronous-motor-greater-than-the-induction-motor)

Efficiency is higher than 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. With induction motors, rotating magnetic field and rotor are not at the same speed, so eddy losses are present and those losses introduced by the slip are mainly responsible for reduced efficiency. In addition, with synchronous motor, the excitation is applied directly on the rotor field winding, while with induction motor, the power required for excitation is coming from the stator and induced on the rotor, so additional losses due to magnetization are present with the induction motor.

1. [**Why is a fixed power factor used in a motor?**](https://www.quora.com/Why-is-a-fixed-power-factor-used-in-a-motor)

Power factor of synchronous motors might be fixed. Usually such motors are huge and therefore their reactive power causes huge losses.

1. [**If a synchronous motor has a leading power factor, does this motor consume or supply reactive power? Does this motor consume or supply real po**](https://www.quora.com/If-a-synchronous-motor-has-a-leading-power-factor-does-this-motor-consume-or-supply-reactive-power-Does-this-motor-consume-or-supply-real-power)**wer?**

When ever a synchronous machine( either motor or generator) is being operated at leading power factor(PF), it always shed out its leading Reactive VARs( volta-ampere reactives) for such machine which is defficient with leading VARs( operating at lagging PF) and thus the VARs defficient machine will absorb that leading VARs supplied and tend to improve its lagging PF to unity. Now, when this machine is done with improvement of its PF from lagging to unity and still being fed with Leading VARs in excess, it will eventually start acting like a source of Leading VARs for some other Leading VARs defficient machines connected in the power system. Synchronous condensers( phase modifiers) are the best examples for this kind of practises. Phase modifier is nothing but an un loaded synchronous motor operated at leading PF and without load.

1. [**We use multiple MV synchronous AC motors from 350hp to 2000hp. What is a ballpark efficiency of these motors? I'm trying to estimate operation...**](https://www.quora.com/We-use-multiple-MV-synchronous-AC-motors-from-350hp-to-2000hp-What-is-a-ballpark-efficiency-of-these-motors-Im-trying-to-estimate-operation-costs)

Large synchronous motors have adjustable power factor. They can even have leading power factor. They are often set this way compensate for all the other induction motors. This can effect 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.

1. [**Why is the efficiency of a synchronous motor greater?**](https://www.quora.com/Why-is-the-efficiency-of-a-synchronous-motor-greater)

**Efficiency** is **higher** than 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. nduction motors are the “standard” industrial motors. More than 99% of motors used are induction motors. It is an induction motor if it runs less than the “synchronous” speed. If the synchronous speed, the induction motor would run at 1785 rpm. The reason is the power is “induced” on the rotor.

MV = High Efficiency +1~2%. While synchronous motors have higher efficiency and no slip, induction motors have good starting torque. The synchronous motor has no starting torque. Power factor is lagging in induction motor and unity in synchronous motor. Capex is lower for induction while Opex is lower for synchronous. The induction motor is easy to start whereas synchronous motor needs VSD, pony motor or damper bars. As a rule of thumb, sync motor is preferred for over 10 MW if slower than 12 pole. In case of 2-4 pole size, choose sync motor for powers greater than 20 MW. The induction motor is limited in size to about 30,000HP, less efficient, power factor is less than 1.0. The sync motor is common for larger machines. Thirty years ago, large machines were 5,000 HP, today they are 30,000 HP. In sync motors, rotor is magnetized to the stator. These motors need magnets such as permanent magnets on the rotor.

1. [**Which motor can operate at a high power factor?**](https://www.quora.com/Which-motor-can-operate-at-a-high-power-factor)

Synchronous motors are designed to operate at unity (1.0) power factor or 0.8 leading power factor. By varying the DC excitation of the motor, the power factor of the motor can be varied widely. Overexcited synchronous motors operate at leading power factor and provide reactive kVAR-like capacitors. This yields an improved power factor for the power-supply system. Because most utility companies bill their industrial customers on the basis of their kVAR use, rather than kW, an improved power factor provides large savings for the customer.

1. [**How is the power factor considered in an induction motor?**](https://www.quora.com/unanswered/How-is-the-power-factor-considered-in-an-induction-motor)

Power factor is a number which in very small length tells us about the efficiency of an AC machine like induction motor. As we know, in an inductive load current lags the voltage by a certain angle. Higher the lag, lesser will be the power factor. In case of DC current, voltage and current are in phase but in case of AC, at a given instant the current lags the voltage. As a result, the actual or active power to the machine is product of Voltage and cosine component of current. cosine of the angle between Voltage and Current is called power factor. If this factor is low, the line current will have to increase to transfer required power. This increase in current will cause Voltage drop and unnecessary heat loss thus decreasing efficiency.

1. [**How does a synchronous motor work as a power factor corrector?**](https://www.quora.com/How-does-a-synchronous-motor-work-as-a-power-factor-corrector)

[Synchronous motor](https://www.theengineeringknowledge.com/introduction-to-synchronous-motor/) is such a machine that can operate at unity, lagging and leading P.F but [induction motor](https://www.theengineeringknowledge.com/what-is-induction-motor/) operates only on lagging P.F. The synchronous motor P.F varies with a variation in field current. If it increases the value of P.F shifts from lagging (inductive) to unity and then becomes capacitive (leading). This feature of motor at working different P.Fs used in power system to improve the P.F.

When the motor operates for power factor correction then there is no load connected with it. It excited in such a way that it increases the power factor of the system means to make it leading. In this case, this motor is recognized as a **synchronous condenser.**In industries the induction motor is generally used, when induction motor is connected with a full load it has 0.8 lagging P.F. Due to variation of loads, the value of P.F of this motor decreases to 0.6 lagging, but this not good for appliances connected with the motor to operates at such low P.F. For the improvement of P.F synchronous motor (condenser) is connected in parallel with an induction motor for power factor improvement. In today’s post, we will discuss how synchronous motor installed in a system for power factor improvement. So let’s get started with *Synchronous Motor Power Correction.*

**Synchronous Motor Power Correction**

In the given figure, you can see that the output of the infinity bus bar (large power system) is connected with the industrial load by the transmission line.



There are 3 loads connected with it first 2 are induction motors having lagging P.F and 3rd is a synchronous motor that has unity, lagging and leading P.F.