RAMA UNIVERSITY

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FACULTY OF ENGINEERING & TECHNOLOGY

Electrical Machine-ii

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EFFECT OF CHANGES IN FIELD EXCITATION ON SYNCHRONOUS MOTOR PERFORMANCE

As increasing the strength of the magnets will increase the magnetic attraction, and thereby cause the rotor magnets to have a closer alignment with the corresponding opposite poles of the rotating magnetic poles of the stator. This will obviously result in a smaller power angle. When the shaft load is assumed to be constant, the steady-state value of Ef sinδ must also be constant. An increase in Ef will cause a transient increase in Ef sin , and the rotor will accelerate. As the rotor changes its angular position, δ decreases until Ef sinδ has the same steady-state value as before, at which time the rotor is again operating at synchronous speed, as it should run only at the synchronous speed. This change in angular position of the rotor magnets relative to the poles of rotating magnetic field of the stator occurs in a fraction of a second. The effect of changes in field excitation on armature current, power angle, and power factor of a synchronous motor operating with a constant shaft load, from a constant voltage, constant frequency supply, is illustrated in Fig:2.32. For a constant shaft load,

$$E_{f1}\sin\delta_1 = E_{f2}\sin\delta_2 = E_{f3}\sin\delta_3 = E_f\sin\delta$$

This is shown in Fig. show where the locus of the tip of the Ef phasor is a straight line parallel to the VT phasor. Similarly, for a constant shaft load,

$$I_{a1}\cos\phi_{i1} = I_{a2}\cos\phi_{i2} = I_{a3}\cos\phi_{i3} = I_a\cos\phi_i$$

This is also shown in Fig. , where the locus of the tip of the Ia phasor is a line perpendicular to the VT phasor.

Note that increasing the excitation from Ef1 to Ef3 in Fig: caused the phase angle of the current phasor with respect to the terminal voltage VT (and hence the power factor) to go from lagging to leading. The value of field excitation that results in unity power factor is called normal excitation. Excitation greater than normal is called over excitation, and excitation less than normal is called under excitation. Furthermore, as indicated in Fig: 2.32, when operating in the overexcited mode, |Ef | > |VT |. In fact a synchronous motor operating under over excitation condition is sometimes called a synchronous condenser.

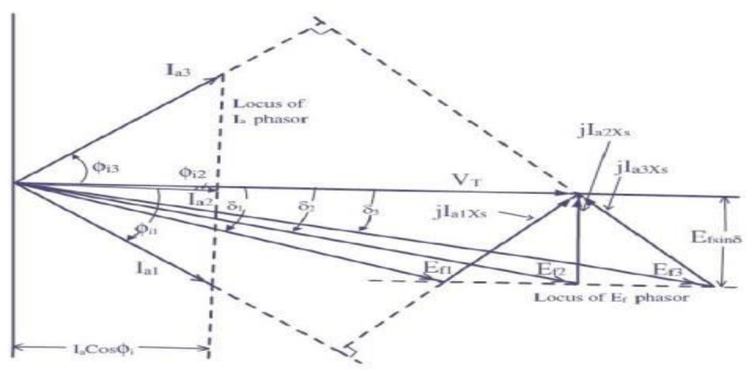
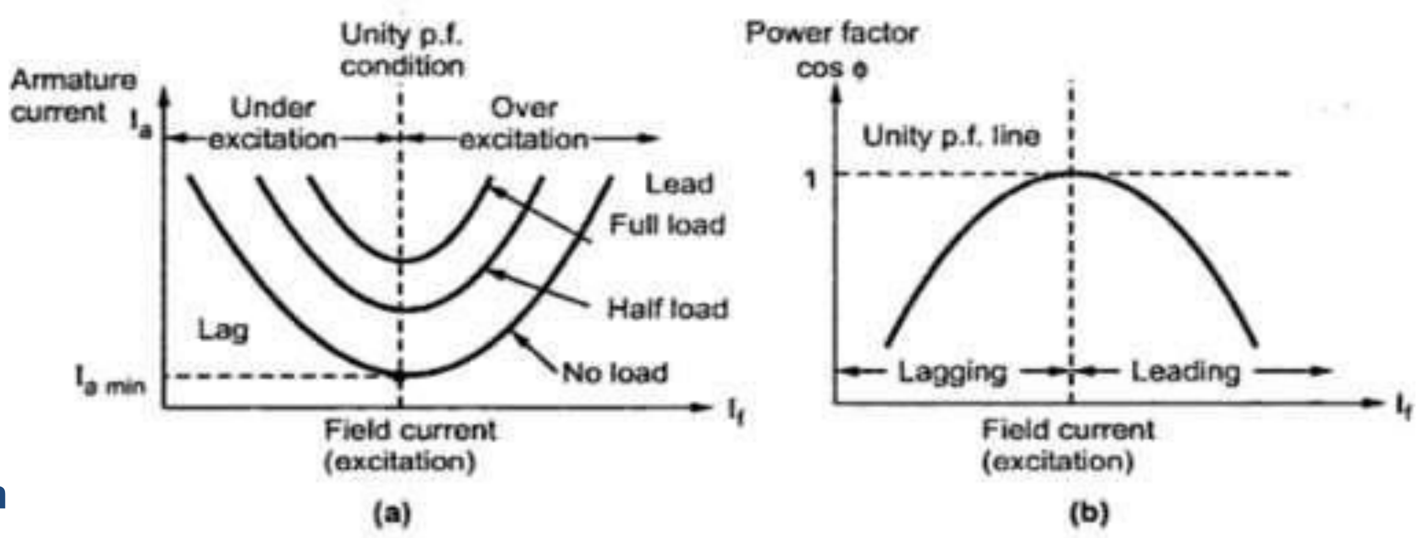


Fig:

V AND INVERTED V CURVES OF SYNCHRONOUS MOTOR

- When the excitation of a three phase synchronous motor taking constant power P from constant voltage supply main is varied, the power factor of the motor changes.
- The power drawn by a 3 phase synchronous motor is given by, $P=VI\cos\varphi$.
- Since input power P and supply voltage V are constant, decrease in power factor causes increase in armature current and vice-versa.
- Hence variation in excitation or in field current causes the variation in armature current and curves drawn between armature current and field current for different power inputs are known as "V – curves".
- On the other hand ,if the power factor ($\cos\varphi$) is plotted against the field current, the graph looks like an inverted V.
- The following figures shows the experimental setup to obtain V curves. The three phase supply is given to stator.
- The two wattmeter method is used to measure the input power.
- Here the rheostat is used in the field circuit to adjust the excitation to operate the motor under variable excitation.

V and Inverted V curve



conclusion

V curve

V curve is the graph showing the relation of armature current as a function of field current in synchronous machines keeping the load constant. The purpose of the curve is to show the variation in the magnitude of the armature current as the excitation voltage of the machine is varied.

Inverted V curve

The Inverted V Curve is a graph showing the relation of power factor as a function of field current