Indian Institute of Technology Hyderabad (IITH)

Electrical Machines Laboratory, Department of Electrical Engineering

Experiment-5: V and Inverted V Curves of Synchronous Motor

1. Objective

The objective of this experiment is to study the following characteristics of a synchronous motor.

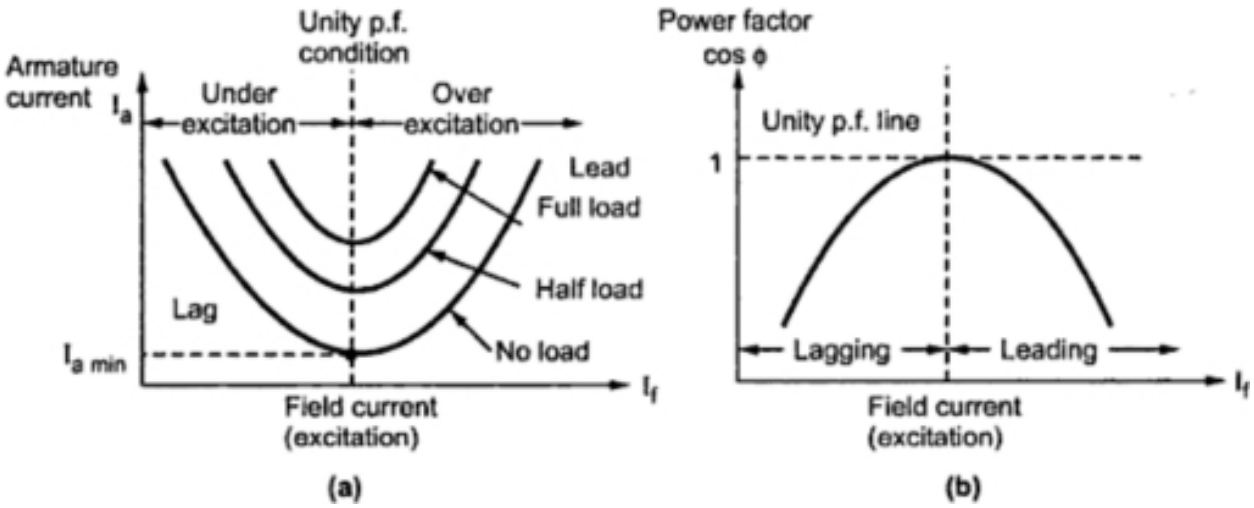
- Variation of armature current against variation in field current.
- Variation of power factor against variation in field current.

2. Introduction to V and Inverted V Curves

A synchronous motor is doubly exited machine, its armature winding is energized from an AC source and its field winding from the DC source. Total air gap flux is the resultant of the two fluxes produced by the AC and DC excitation. The DC excitation which operates the motor at unity power factor is called the nominal or normal excitation.

If the field current is made less than nominal excitation (under excitation) then the deficiency in air gap flux is made up by the armature MMF. So the armature (stator) winding draws a magnetizing current or lagging VA from the AC source and as a result motor operates in lagging power factor. Similarly, if the field current is made more than the nominal excitation (over exited) motor operates in leading power factor.

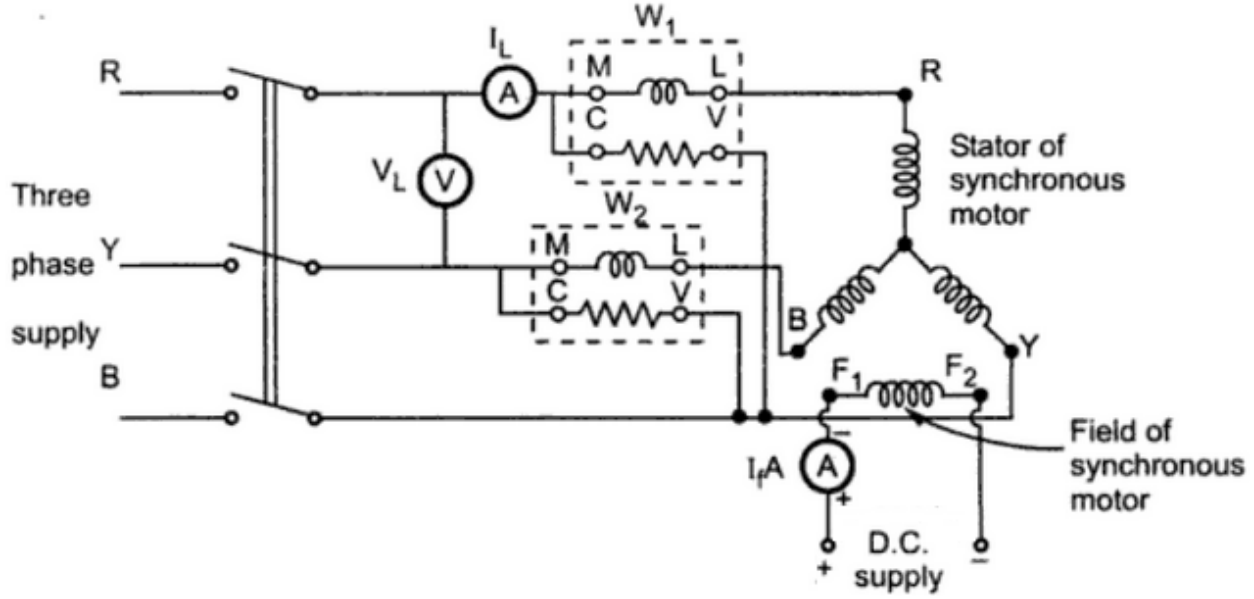
If we draw the variation of armature current and power factor vs field current the curves appear as V and inverted V respectively. The feature of synchronous motor that operates in leading power factor when over excited is utilized in power factor correction applications. Synchronous machines have parabolic type characteristics. The following figure shows the variation of armature current and power factor with field current at no load, half load and full load conditions.



3. Circuit Arrangement & Experiment Procedure

The circuit arrangement for conducting the experiment is shown as follows, where the armature current is measured by the line ammeter and power factor by Two-wattmeter method. The field current is measured by the DC ammeter in the field circuit.

- Connections are made as shown in the circuit diagram.
- Variable three phase supply is increased gradually to rated value, and then the field current is increased till unity power factor is observed.
- Now by varying the field current above and below the nominal excitation corresponding armature current and power factor readings are recoded.
- Plot these obtained armature current and power factor readings against field current to obtain V and inverted V curves.



4. Results

V Curve: I_f vs. I_a

S. No.	Field current (I_f)	Armature current (I_a)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

Inverted V Curve: I_f vs. $cos\phi$

S. No.	Field current (I_f)	W_1	W_2	Power factor $(\cos\phi)$
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

$$\cos\phi = \cos\left\{\tan^{-1}\left[\frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right]\right\}$$

5. Conclusions

- Draw the plots of V and inverted V curves.
- Identify the ranges of field current for which the synchronous motor behaves as an inductor and a capacitor, respectively.
- Comment on the operation of synchronous motor as a synchronous condenser.
- Comment on the applications of synchronous motor based on the observations you made through the experiment.

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