Experiment - 4 (V and Inverted V Curves of Synchronous Motor)

Machines Lab (EE3500)

EE19BTECH11041

① Aim:

To study below characteristics of Synchronous Motor.

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

② Theory:

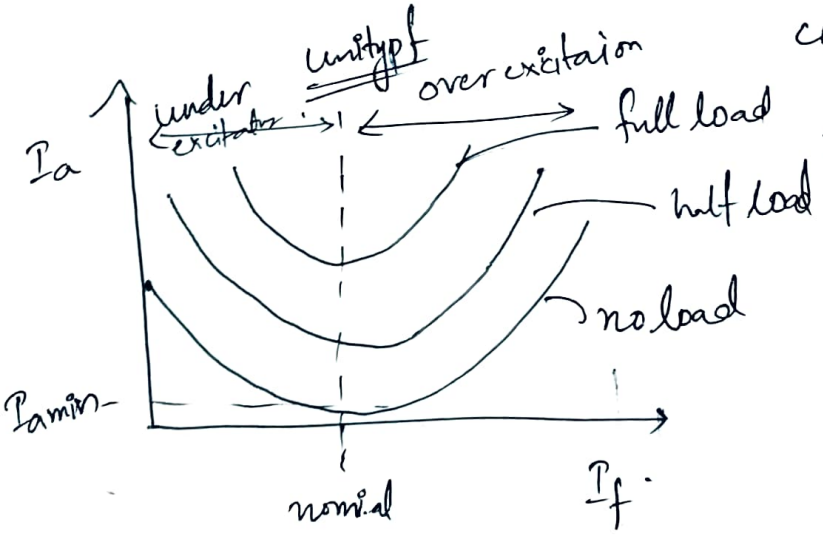
A Synchronous motor is doubly exited machine, its armature winding is energized from an AC Source and its field winding from DC Source. Total air gap flux is the resultant of the two fluxes. The D.C excitation at which motor operates at unity powerfactor is called nominal or normal excitation.

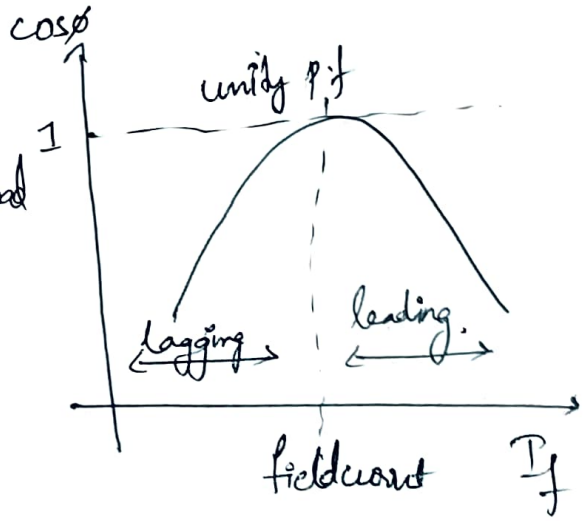
If the field current is made less than nominal excitation. (Under excitation) then the deficiency in air gap flux is made up by the armature MMF. So the stator winding draws a magnetizing current or lagging VA from the A.C Source. and as a result motor operates at

(2) Theory

lagging power factor. Similarly, if the field current is made more than the normal excitation (over excited) 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 correcting 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.

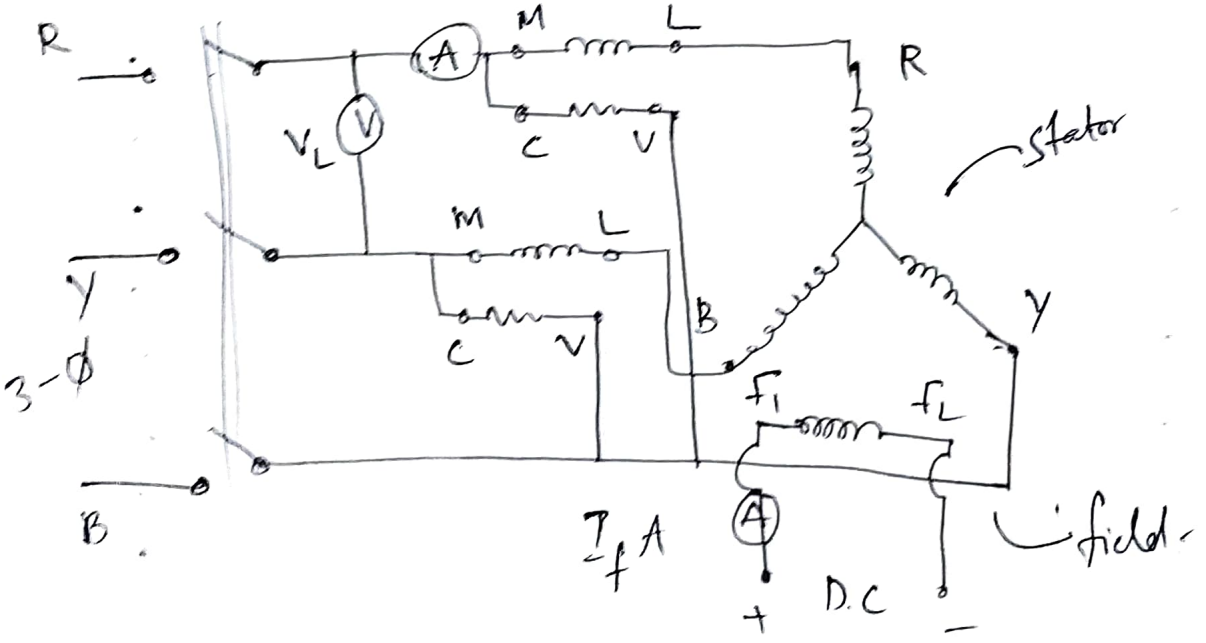




(3) Procedure:

The Circuit arrangement for conducting the experiment is shown as follows, where the armature current is measured by 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 gradually increased to rated value and then 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 are recorded and plotted.



(4) Results

V Curve : I_f Vs I_a

S.No	Field Current (I_f)	Armature Current (I_a)
1	0.18A	4.15A
2	0.25A	3.56A
3	0.32	3.01
4	0.39	2.43
5	0.46	1.87
6	0.54	1.2
7	0.59	0.82
8	0.62	0.63
9	0.68	0.44
10	0.7	0.46
11	0.75	0.72
12	0.8	1.01
13	0.87	1.54
14	0.88	1.65
15	0.93	2
16	1.0	2.6
17	1.03	2.82
18	1.08	3.2
19	1.15	3.8
20		

Inverted V Curve (I_f vs $\cos\phi$)

S.No	field Current(I_f)	W_1	W_2	Power factor($\cos\phi$)
1	0.18	-588	1163	0.186
2	0.25	-486	1028	0.202
3	0.32	-383	890	0.224
4	0.39	-283	755	0.253
5	0.46	-168	615	0.313
6	0.54	-40	466	0.437
7	0.59	+35	370	0.572
8	0.62	83	322	0.699
9	0.68	182	230	0.98
10	0.7	206	206	1 (UPF)
11	0.75	293	115	0.797
12	0.8	366	53	0.611
13	0.87	477	-53	0.419
14	0.88	517	-86	0.381
15	0.93	585	-163	0.309
16	1.0	653	-203	0.290
17	1.03	771	-229	0.298
18	1.08	839	-295	0.266
19	1.15	854	-405	0.201

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

(5) Conclusions:

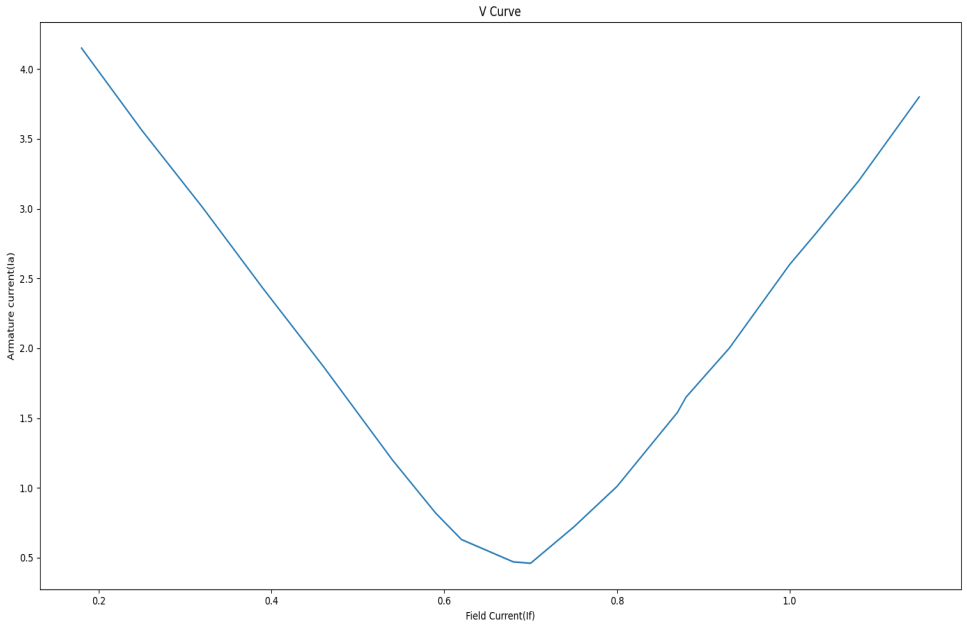
(2) If $I_f > 0.7A \Rightarrow$ leading $\Rightarrow$ Capacitive.

$I_f < 0.7A \Rightarrow$ lagging $\Rightarrow$ Inductive.

(3) A Synchronous motor with no mechanical load is Synchronous condenser. Generally its in overexcited mode.

(4) over-excited Synchronous motor are used as power-factor correction in industrial loads. we can also control reactive power here and make fans too.

V-Curve:



Inverted V-Curve: