Power Systems Lab

Experiment 5
Laboratory Report

Syed Alisamar Husain, 17BEE012
B.Tech Electrical Engg, 8th Semester

March 26, 2021

Department of Electrical Engineering
Jamia Millia Islamia, New Delhi

Experiment 5

1 Objective

To construct the V-curve for a synchronous motor with varying field excitation from leading to lagging power factor assuming suitable open-circuit characteristics.

Let the given problem be as follows:

2 Theoretical Background

V-curve is a plot of the **stator current versus field current** for different constant loads. The graph plotted between the armature current I_a and field current I_f at no load the curve is obtained known as V-Curve. Since the shape of these curves is similar to the letter V, thus they are called the V-curve of a synchronous motor.

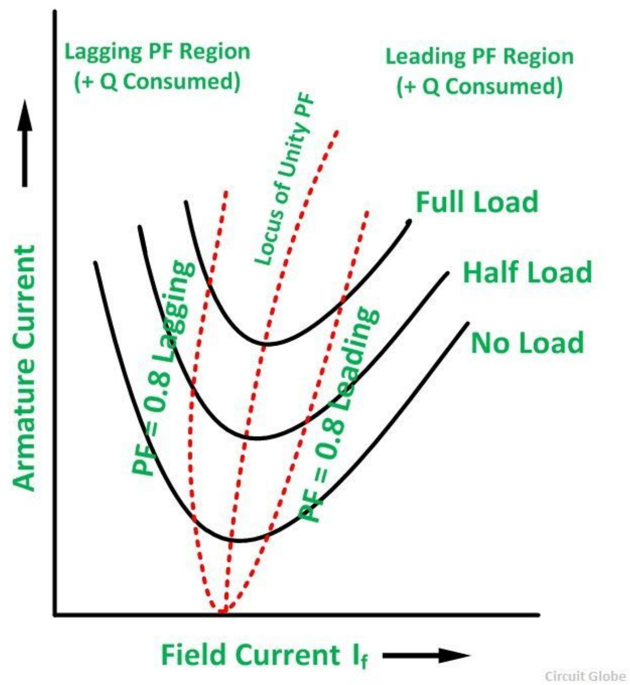

Figure 1: V-Curves of a Synchronous Motor

2.1 Plotting a V-Curve

The power factor of the synchronous motor can be controlled by varying the field current I_f. The armature current I_a changes with the change in the field current I_f.

Let us assume that the motor is running at no load. If the field current is increased from this small value, the armature current I_a decreases until the armature current becomes minimum. At this minimum point, the motor is operating at a unity power factor. The motor operates at a lagging power factor until it reaches up to this point of operation.

If now, the field current is increased further, the armature current increases and the motor starts operating as a leading power factor. The graph drawn between armature current and field current is known as the V curve. If this procedure is repeated for various increased loads, a family of curves is obtained.

2.2 Unity Power Factor Compounding Curve

The point at which the unity power factor occurs is at the point where the armature current is minimum. **The curve connecting the lowest points of all the V curves for various power levels is called the Unity Power Factor Compounding Curve.** The compounding curves for 0.8 power factor lagging and 0.8 power factor leading are shown in the figure above by a red dotted line.

The loci of constant power factor points on the V curves are called Compounding Curves. It shows the manner in which the field current should be varied in order to maintain a constant power factor under changing load. Points on the right and left of the unity power factor corresponds to the over-excitation and leading current and under excitation and lagging current respectively.

3 Implementation

```
% To construct the V-curve for a synchronous motor with varying
% field excitation from leading to lagging power factor

% 17BEE012 - Alisamar Husain

If = (38:1:58) / 10;  % Field currents from 3.8 A to 5.8 A
Ia = zeros(1,21);     % Armature currents to be calculated

Xs = 2.5;             % Synchronous reactance

Vp = 210;
delta1 = -12 * (pi/180);

Ea1 = 200 * (cos(delta1) + 1j*sin(delta1));

% Calculate armature current for each value
for i = (1:21)
    Ea2= 45.5 * If(i);

    delta2 = asin( (Ea1/Ea2) * sin(delta1) );
    Ea2 = Ea2 * (cos(delta2) + 1j*sin(delta2));

    Ia(i) = (Vp - Ea2) / (1j * Xs);
end

figure(1);
plot(If, abs(Ia), 'Color', 'k', 'LineWidth', 2.0);
xlabel('Field Current');
ylabel('Armature Current');
grid on;
```

4 Observations

The following graph for the V-Curve of Synchronous Motor was obtained. **Unity power factor** was obtained at 4.9 A of Field current where the Armature current was close to 15.8 A.

4.1 Graphs and Plots

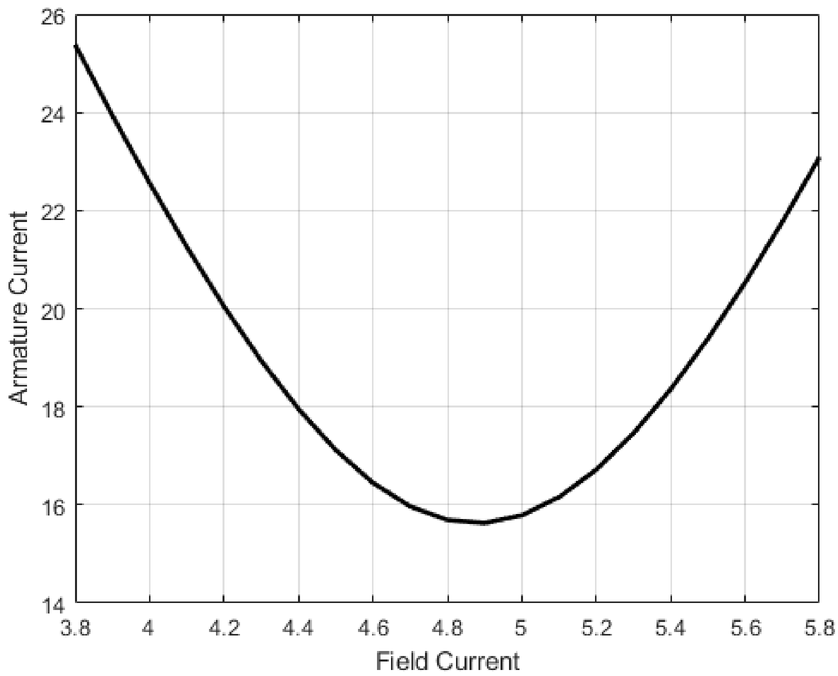

Figure 2: V-Curve of a Synchronous Motor

5 Result

The V-curve graph was plotted between the armature current I_a and field current I_f for a synchronous motor.