Experiment no. 2

NO LOAD AND LOAD TEST ON A DC SHUNT GENERATOR

AIM:

1) To plot the open circuit characteristics (O.C.C) of a DC shunt generator and to determine its critical resistance.
2) To find the residual magnetism in field.
3) To plot the external characteristics of a DC shunt generator by loading the generator.

INTRODUCTION:

In this experiment we aim to conduct a No-Load test on a DC Generator to determine its open circuit characteristics followed by a Load test on a DC shunt Generator to determine its external load characteristics. The DC Generator as we know can be either separately excited or self excited in shunt. While in the No-Load Test we shall be exciting the Armature independently the Load test as the name suggests shall be carried out in shunt.

THEORY:

Performance characteristics of a DC machine are sensitive to the mode of excitation. To an extent the mode of excitation depends on the field winding as well. For instance in shunt excitation the field winding has high resistance owing to the large number of thin wire turns. Here shunt excitation is carried out and since the armature voltage of a DC m/c remains more or less constant we control the field current (it is pretty small around 1.5 to 2 Amps) via a series resistance connected to the field winding externally. While when the number of turns is small and the wire thick series mode of excitation is used.

The Open circuit characteristics or the OCC are in actual the magnetization characteristics of the m/c. In practice we should be comparing the flux and the mmf. Now the field current can give us a measure of the mmf while the EMF E_a can give us a measure of the flux so long as the speed remains constant. So the OCC must be conducted at constant (and rated) speed. The OCC should be conducted with the Armature separately excited so that the field winding does not affect the measurement. As is apparent from the simplified circuit of a DC m/c Terminal voltage = E_a at ‘0’ armature current. It is important to increase I_f gradually and only in the forward direction. This is so because iron has residual magnetism (retentivity) and although we are interested in Hysteresis one should first increase It to the limit and then decrease it back to ‘0’, local increase & decrease will give rise to unwanted local hysteresis loop. It is interesting to note that the same procedure when carried out at a speed different from the rated speed will be a mere proportional translation of the original curve.

Practical Generators are almost always excited from their own armature terminals. Such a circuit when used in shunt, also called shunt Generator, has an inbuilt positive feedback. If the armature is brought to rated speed with the filed current set to ‘0’ the initial armature voltage would simply correspond to a small residual value which would allow a small filed current to flow. Increasing the filed current now increases the mmf. This in turn increases the induced EMF. Due to the saturation of the m/c's magnetic circuit the m/c attains a fine steady state value. This provides another method to measure the No-Load voltage characteristics.

As mentioned in the previous paragraph a shunt no-load voltage build up occurs in a self excited m/c. The loading test can then be conducted on this m/c by loading it and keeping the filed resistance to some fixed initial value. Ideally the Loading curve would be double valued V vs I curve. (2 values of V for one value of I). The terminal voltage drops of much more rapidly with a load in a shunt generator than with a load in a separately excited generator due to the fall in the field current along with the terminal voltage.

The external characteristics of a Shunt generator can be effectively determined without actually carrying out the load test. How? Where and when is it more feasible?

PROCEDURE:

A) OCC Characteristics of DC shunt generator:

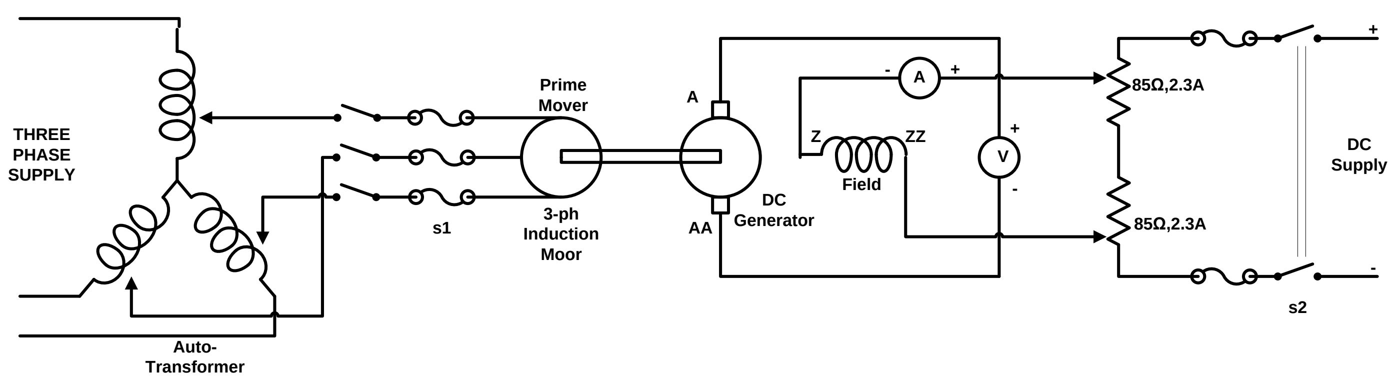

Figure 1: No load test on DC Shunt generator

1) Connect the circuit as shown in figure 1 with switches S1 and S2 open. Ensure that the DC supply is not short-circuited while connecting the rheostat to DC supply.
2) Now close switch S1 and slowly increase the voltage supplied to 3-phase induction motor using auto-transformer until it rotates at the rated speed of DC machine.
3) Close switch, S2 and gradually increase the excitation current through field to its maximum admissible value and then slowly decrease it to zero. Do it several times until the magnetic circuit attains the cyclic state. (**NOTE**: The armature voltage shown when the excitation current is zero corresponds to the residual magnetism in field).
4) Start from zero excitation and gradually increase the excitation. Note down the armature voltage (V_a) and the field current (I_f) at every step. Continue until the armature voltage reaches to maximum value as found in (3).
5) Similarly note down armature voltage and field current for decreasing values of excitation current.
6) Plot the graph of V_a Vs I_f.
7) The armature voltage, starts from a voltage due to residual magnetism, and increases linearly with field current initially and then saturates with increasing field current. The slope of the linear part of the graph gives critical field resistance.

B) Load test or External characteristics of DC shunt generator:

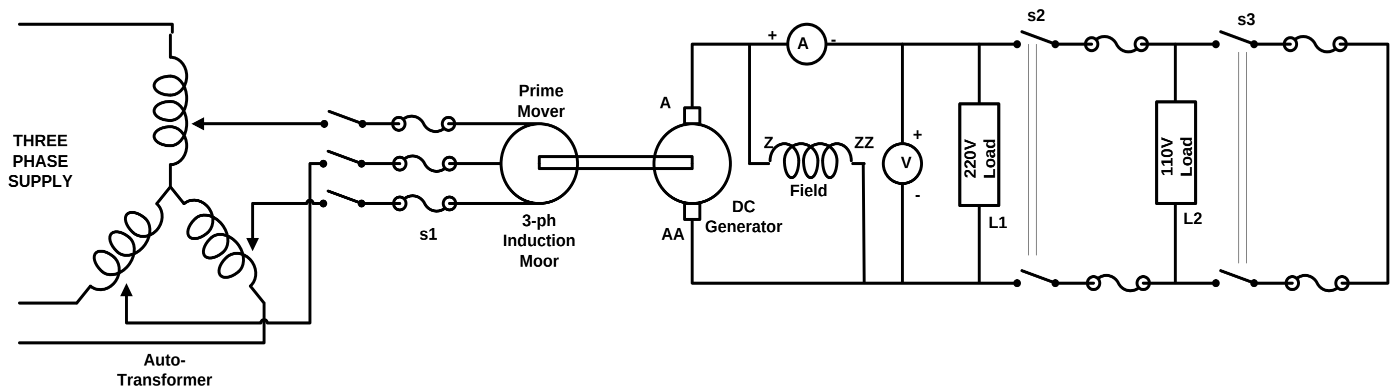

Figure 2: Load test on DC Shunt generator

1) Connect the circuit as shown in figure 2 with switches S1, S2, S3 open and all steps of load L1 are also open.
2) Now close switch S1 and slowly increase the voltage supplied to 3-phase induction motor using auto-transformer until it rotates at the rated speed of DC machine.
3) Increase the load gradually using load L1 until voltmeter reaches 110V and note down armature voltage (V_a) and load current (I_L) at every step.
4) Then close switch S2. Now continue to increase the load gradually using both L1 and L2 until voltmeter reaches 20V and note down armature voltage (V_a) and load current (I_L) at every step. (Why two loads L1 and L2 are used? Can't we use a single load instead?)
5) Now close switch S3 to short the armature of DC generator and note down the load current (I_L).
6) Plot the graph of V_a Vs I_L.
7) The armature voltage decreases with increase in load current until certain value of load current and then both of them decrease together.