Experiment NO. 1:6

SEPARATION OF MECHANICAL, EDDY-CURRENT AND HYSTERESIS LOSSES IN D.C. GENERATOR BY AN AUXILIARY MOTOR

OBJECT:

The object of this experiment is to determine the mechanical losses, eddy-current and hysteresis losses of the D.C. generator under test. The efficiency curve is also to be determined.

THEORY:

The various losses occurring in a machine can be sub-divided as follows.

a)Copper losses:

1. Armature copper loss = $I_a^2 R_a$, where R_a = resistance of armature, interpoles and series field winding. The loss is about 30-40% of full- load losses.

2. Field copper loss in the case of shunt machine, it is practically constant= $I_{sh}^2 R_{sh}$= V I_{sh}. In case of series generator, it is = $I_{se}^2 R_{se}$ where R_{se} is resistance of the series field winding. This loss is about 20 - 30% of full-load losses.

3. The loss due to brush contact resistance, this is usually included in the armature copper loss.

b)Magnetic losses (iron losses or core losses) (Pi).

1. Hysteresis loss:

This loss P_h is a measure of the electric energy required to overcome the retentively of the iron in the magnetic flux path; using watts as the unit,

$P_h = K_h B_{max}^x f V$

Where V is the volume of iron in the armature

K_h is a constant for the grade of Iron employed.

B is the flux density raised to the Steinmetz exponent. With modern values of iron, x is no longer 1.6 And f is the frequency, in HZ, of reversal of flux.

$$f = p\ N/120$$

P: number of poles
N: armature speed in r.p.m.

$P_h = K1\ N$

2. Eddy Current Loss P_e

This loss is given by the following relation:

$P_e = K_e t^2 B_{max}^2 f^2\ V$

Where:

K_e is an eddy current constant.

T is the thickness of each lamination it is constant.

$P = K_2\ N^2$ $(f \propto N)$

Then:

$P_i = P_h + P_e = K_1\ N + K_2\ N^2$

$P_i / N = K1 + K2\ N$, and this is the equation of a straight line, the intercept of this line on the vertical axis gives K1, while the slope of the line gives K_2, as shown in fig.(1).

c) The mechanical lasses (Pm).

1. Friction loss of bearings and commutator.
2. Air-friction of windage loss of rotating armature.

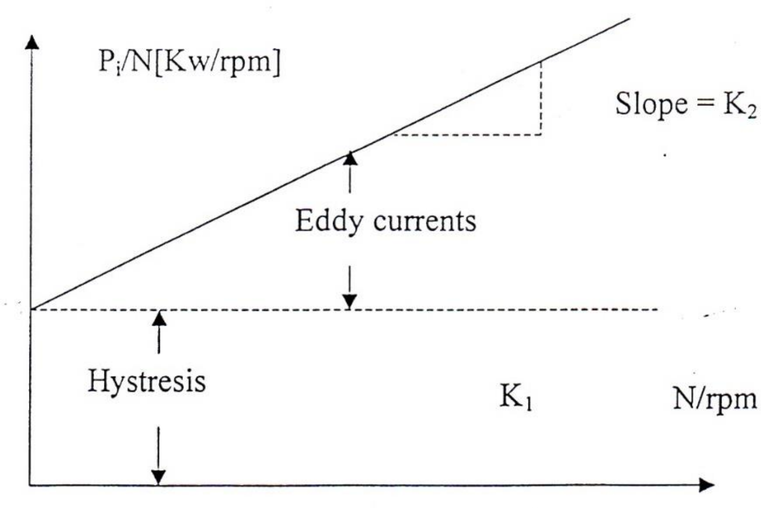

Fig . (1)

PROCEDURE:

(Take the name plat data of the machines used in this exp.)

RUN (1): (The machine "G" is coupled to an auxiliary motor "M" with excitation)

1. Connect the generator under test coupled to an auxiliary motor "M" as shown in fig. (2) with the generator excitation normal, run the motor until rated speed and $R_{add} = 0$, measure (V_G) and (I_f) (I_f must be kept constant).

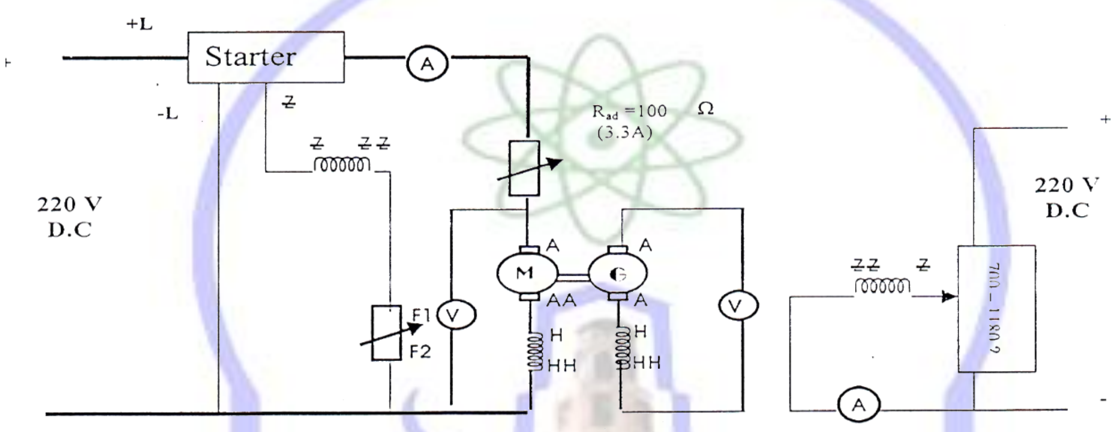

Fig. (2)

2. Run up the set to about 10% above rated speed, then the motor excitation being maintained after that constant.

3. Reduce the speed in steps to a slow a value as possible by increasing (R_{ad}). Readings are taken according to table (1) in each step.

Measured Value	N					
	V_m					
	I_m					
Calculated Value	$V_m I_m$					
	$I_m^2 R_m$					
	$P_1 = V_m I_m - I_m^2 R_m$					

Table (1)

$P_1 = (P_i)_M + (P_m)_M + (P_i)_G + (P_m)_G$

RUN (2): (Generator coupled and unexcited)

Repeat as in item (1). for the same speeds but with the generator excitation interrupted.

Tabulate the results as in table (2).

Measured Value	N					
	V_m					
	I_m					
Calculated Value	$V_m \times I_m$					
	$I_m^2 \times R_m$					
	$P_2 = V_m I_m - I_m^2 R_m$					

Table (2)

$P_2 = (P_i)_M + (P_m)_M + (P_m)_G$

RUN (3): (Generator uncoupled)

1. Repeat in item (1) for the same speed but with the generator ncoupled.

Tabulate the results as in table (3)

Measured Value	N					
	V_m					
	I_m					
Calculated Value	$V_m \times I_m$					
	$I_m^2 \times R_m$					
	$P_3 = V_m I_m - I_m^2 R_m$					

Table (3)

$P_3 = (P_i)_M + (P_M)_M$

2.Measure the resistance of the armature circuit of the motor R_m and the resistance of the armature circuit of the generator R_G.

DISCUSSION:

1. Calculate the iron losses $(P_i)_G$ and the mechanical losses (P_m) of the generator from the results above for the different speeds and plot them to a speed. base.

2. Plot $(P_i/N)_G$ against the speed and find the values of (K_1) and (K_2) from the graph

3. Knowing the coefficients (K_1) and (K_2) calculate the hysteresis loss $P_h = K_1N$ and the eddy current $P_e = K_2 N^2$ for each speed. Tabulate the results as in table (3)

Speed	N						
Mechanical losses	$(P_m)_G = P_2 - P_3$						
Iron losses	$(P_i)_G = P_1 - P_2$						
Hysteresis loss	$(P_h)_G$						
Eddy current	$(P_e)_G$						

4. Determine the efficiency curve of machine "G" at rated voltage and rated speed for different currents.