KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
ELECTRICAL ENGINEERING DEPARTMENT
EE-462 ELECTRICAL MACHINES

Term: 012

Experiment # 6
RETARDATION TEST FOR DC MACHINES

INTRODUCTION

When a DC motor is disconnected from its supply circuit, it will come to rest when the kinetic energy stored in the moving part of the system to which it is coupled has been dissipated. This fact can be utilized to measure and categorize the losses in the machine at any given speed.

THEORY

If a motor is brought to speed and switched off, it will slow down as represented by the running down curve shown in figure 1. The retarding torque (T) is due to the friction and iron losses. The angular retardation $\frac{d^2e}{dt^2}$ at any instant is directly proportional to the retarding torque at that instant and varies inversely with moment of inertia (J) of the rotating parts

$$\frac{d^2e}{dt^2} = \frac{T}{J} \qquad \text{...... eqn. 1.}$$

At a speed n (represented by a point A of figure 1), the power wasted is P and the retarding torque $T = \frac{P}{2\pi n}$. Therefore, the power wasted takes the form:

$$P = 2\pi n J \frac{d^2e}{dt^2} \qquad \text{....... eqn. 2.}$$

The angular retardation $\frac{d^2e}{dt^2}$ is directly proportional to the slope of the retardation curve. Hence, at the speed represented by a point A of figure 1, the retarding torque is proportional to the slope at A (slope= $\tan\alpha$):

$$T \propto 2\pi nJ \tan\alpha$$

or, $$2\pi nJ[CD] = K[CD] \qquad \text{.......eqn. 3,}$$

where CD is the subnormal of AB. In order to determine K, the power loss per unit length of the subnormal, it is necessary to determine the actual losses. (Iron+friction) losses at any given speed n and excitation current (no load test) and readings of the input current (I_0) and power (W_0) to the armature have to be recorded. The total iron and frictional losses (P) is obtained by subtracting the armature copper loss ($I_0^2 r_a$) from the measured input power (W_0):

$$P = W_0 - I_0^2 r_a \qquad \text{....... eqn. 4.}$$

EXPERIMENT

OBJECTIVE

To determine the iron and frictional losses separately and to decompose the iron losses to its components (eddy and hysteresis) at different speeds and excitation currents.

NO LOAD TEST

Connect the circuit as shown in figure 2. Start the motor with an excitation current of 1 amp. Be sure that the armature voltage is at the rated value. Record speed. Record V_0, I_0, and I_f. Measure the armature resistance (r_a) and determine the iron & frictional losses from eqn. 4.

RETARDATION TEST

Run the motor to the rated speed at 1 amp excitation current. Open switch S and take readings of speed at regular time intervals. Draw the running-down curve and determine the subnormal (FG) which corresponds to the friction and iron losses obtained from the no-load test. Then, calculate K. Plot a curve showing the iron and frictional losses versus the speed at 1 amp excitation current. Repeat retardation test with the field unexcited (open the field circuit at the same instant when opening S) using switch S_1 and plot a curve of friction losses against the speed n. Determine the friction and iron losses separately at different speed at 1 amp excitation current. Plot $\frac{P_{iron}}{n}$ against n with the aim to decompose the iron losses into its components. Determine the eddy current & hysteresis losses separately at different speeds at 1 amp excitation current. Plot curves of eddy, hysteresis, and friction losses against speed for 1 amp excitation current.

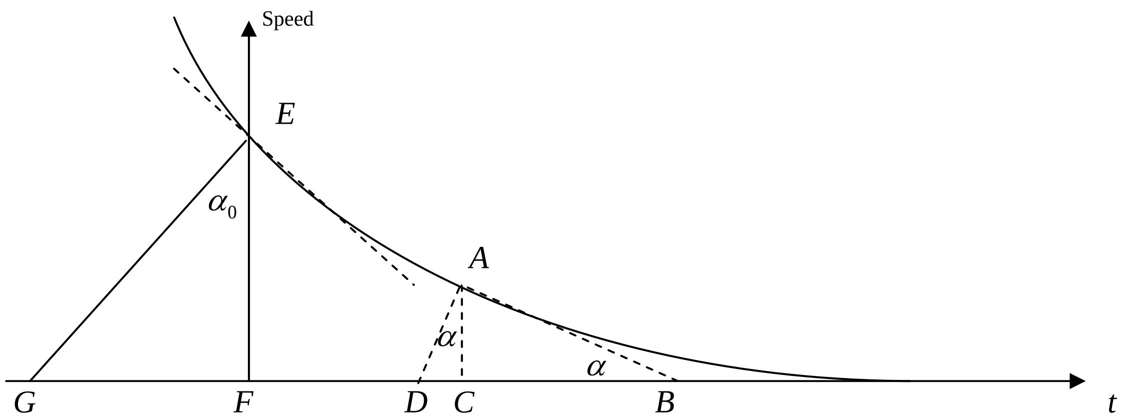

Figure 1. Running-down curve of a DC machine

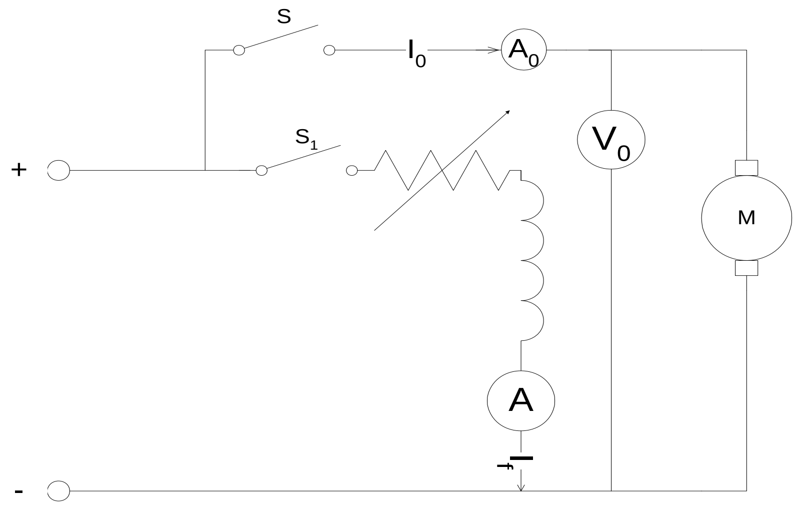

Figure 2. A DC machine