Indian Institute of Technology Hyderabad (IITH)

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Experiment-3: Speed Control of DC Shunt Motor

1. Objective

The objective of the experiment is to be familiar with the "armature control" and "field control" mechanisms of the DC shunt motor.

2. Description

For a given input voltage, the speed of a motor falls down when the load on the motor is increased. In the same way, the motor speed increases when the load on the motor is reduced. However, for any practical purpose, it is intended to run the motor at constant speed for all the loading conditions. Therefore, it is necessary to implement some speed control mechanism so as to bring the motor speed back to the original value after any load variation.

The following scenarios gives the applications of DC motors.

- ✓ where the speed is required to remain almost constant from no-load to full-load,
- ✓ where the load has to be driven at a number of speeds and any one of which is nearly constant.

Various applications of DC shunt motor include lathe machines, centrifugal pumps, fans, blowers, conveyors, lifts, weaving machine, boring mills, spinning machines, etc.

The speed control for a DC shunt motor can be effectively carried out by suitably adjusting the armature and field resistances based on the following relations.

$$E_b = \frac{NP\Phi Z}{60A}$$

$$\Rightarrow N = \frac{E_b 60A}{P\Phi Z} = \left(\frac{E_b}{\Phi}\right)\left(\frac{60A}{PZ}\right)$$

$$\Rightarrow N \propto \frac{E_b}{\Phi}$$

Where, $E_b = V_s - I_a R_a$

$$\therefore N \propto \frac{V_s - I_a R_a}{\Phi}$$

(where, E_b = back e.m.f, N = speed in rpm, P = no. of poles, Φ = flux/pole, Z = no. of armature conductors, A = parallel paths, V_s = supply voltage, I_a = armature current, R_a = armature resistance)

3. Circuit Arrangement

The circuit arrangement for the experiment "speed control of DC shunt motor" is shown in Fig. 1. Here, TA1 and TA2 are the terminals of armature winding and TF1 and TF2 are the terminals of field winding. Resistances $R_{a,ex}$ and $R_{f,ex}$ are the external resistances connected in series with the armature winding and field winding respectively.

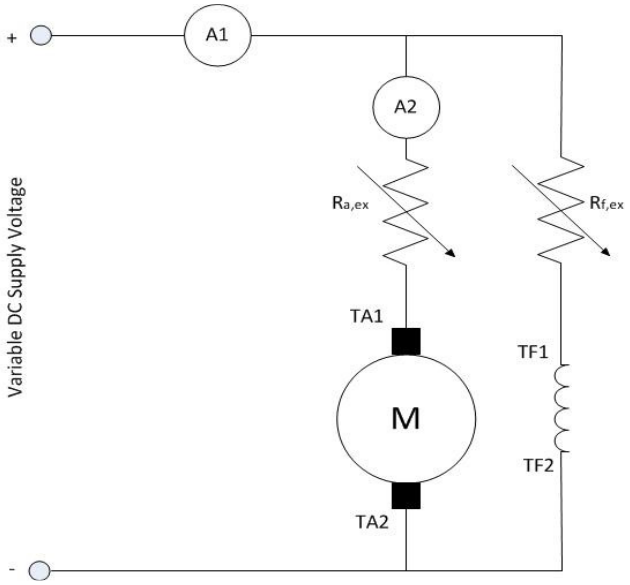

Fig. 1. Circuit Arrangement for the Speed Control of DC Shunt Motor

4. Procedure

Speed Control

1. Before starting the experiment, note down the readings of armature and field resistances.
2. Now, connect the circuit diagram as per Fig.1.
3. Set the armature rheostat at maximum position and field rheostat at minimum position.
4. Slowly increase the supply voltage up to 180 V and keep it constant at this value.
5. Try to bring the machine speed to 1500 r.p.m by first adjusting the armature resistance and then by adjusting the field resistance.
6. Note down the values of the armature/field resistances and currents when the machine speed is 1500 r.p.m.
7. Repeat the same procedure for input voltages of 190 V, 200 V, 210 V and 220 V. Ensure that the motor speed and armature current do not exceed the rated values, which are 1500 r.p.m. and 4.5 A, respectively.

Speed Regulation

8. Vary the field rheostat for different values and observe the occurrence of above rated speed values.
9. Similarly observe the below rated speed values by varying armature rheostat.

5. Results

I. UNDER REST CONDITION:

Field Resistance (R_f) = Armature Resistance (R_a) =

II. SPEED CONTROL TEST OBSERVATIONS:

Input voltage	Corresponding Speed	Total armature resistance (self + injected) corresponding to 1500 r.p.m	Total field resistance (self + injected) corresponding to 1500 r.p.m	Armature Current (I_a)	Field Current (I_f)
180					
190					
200					
210					
220					

III. SPEED REGULATION TEST OBSERVATIONS:

ABOVE RATED SPEED MEASUREMENTS:

Input voltage	Speed	Total field resistance (self + injected)	Field Current (I_f)
220			

BELOW RATED SPEED MEASUREMENTS:

Input voltage	Speed	Total armature resistance (self + injected)	Armature Current (I_a)
220			

6. Conclusions

1 Comment on “Speed Control” and “Speed Regulation” application of DC Shunt Motor.

2 Comment on how the armature control and field control methods can be used for obtaining below and above rated speeds.

3 Plot the variation of

a. Speed with field current (I_f)

b. Speed with armature current (I_a)

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