Speed Control of DC Shunt Motor with Field and Armature Rheostat Control Simultaneously

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Abstract

We are in the age of that world where energy plays a very important role. Since we have abundant sources of energy but we can’t use them directly due to some economical and geographical problem. So it is necessary to convert available energy to fulfill our requirements. DC Motors plays an important role in energy conversion process. It is a machine which converts electrical energy into mechanical energy. In mechanical system, speed varies with number of task so speed control is necessary to do mechanical work in a proper way. It makes motor to operate easily. Shunt motor is a special type of DC motor which runs at a constant speed. But using field and armature rheostat control method we can make it more versatile. Field rheostat provides above normal speed and armature rheostat provides wide range of below normal speed. So applying both methods simultaneously, we can obtain wide range of speed for different applications. The main problem of this method is bulky rheostat is required across the armature so a large amount of power is wasted in the controlling resistance and poor speed regulation results for the lower speed. So we are limited for lower speed. But for industrial application it is more suitable, economic and energy efficient. We can use such motor in lathes, centrifugal pumps, machine tools and modern electric drives. This method of speed control is independent of load on the motor and permits remote control of speed.

1. Introduction:
DC motors consist of rotor-mounted windings (armature) and stationary windings (field poles). In all DC motors, except permanent magnet brushless motors, current
must be conducted to the armature windings by passing current through carbon brushes that slide over a set of copper surfaces called a commutator, which is mounted on the rotor.

The commutator bars are soldered to armature coils. The brush/commutator combination makes a sliding switch that energizes particular portions of the armature, based on the position of the rotor. This process creates north and south magnetic poles on the rotor that are attracted to or repelled by north and south poles on the stator, which are formed by passing direct current through the field windings. It's this magnetic attraction and repulsion that causes the rotor to rotate.

The dynamic behavior of the DC machine is mainly determined by the type of the connection between the excitation winding and the armature winding including the commutation and compensation winding.

The greatest advantage of DC motors may be speed control. Since speed is directly proportional to armature voltage and inversely proportional to the magnetic flux produced by the poles, adjusting the armature voltage or the field current will change the rotor speed.

Speed control means change of a speed to a value required for performing the specific work process. This adjustment should not be taken to include the natural change in speed which occurs due to change in the load on the drive shaft. The electrical speed control has many economical as well as engineering advantages over mechanical speed control. There are so many methods for controlling the speed of a DC shunt motor but field rheostat control method is most reliable, economic and independent of load on the motor. This method is only applicable when we want speed which is higher than the normal speed of the motor. In this method, an increase in controlling resistance reduces the field current with a consequent reduction in flux and an increase in speed. But if we want to obtain low speed to control the low speed mechanical drive, we use armature rheostat control method. In this method, the speed at full load can be reduced to any desired value depending on the amount of resistance. But if we use both techniques in same machine then we can control motor from zero speed to maximum. In field control the adjustment can be obtained by means of a small rheostat and relatively good speed regulation is obtained for all speed but with the armature control a bulky resistance is required. So if we use both methods simultaneously, cost of the machine will increase a little but we will get a large range of speed control. To neutralize the effect of power loss heat sink can be used.

So by this method we can control the speed of a DC shunt motor to perform various tasks in effective and economic way.
2. Circuit Diagram:

3. Working Principle
From the above circuit diagram, we can conclude that if we want to increase the speed of the shunt motor, we will vary the field resistance. As resistance increased, the value of the field current will reduce. On weakening of field current, flux of the field will reduced results in increase of speed.

If we want to decrease the speed, firstly we should keep the field resistance at minimum value and then we will increase the armature resistance. As armature resistance increases, the voltage drop across armature increases. Because the supply voltage is normally constant. So by this method we can deal with ranges of speed and entire phenomenon can be analyzed by using following relation:

\[ N = KV - \frac{I_a(R_a + R)}{\phi} \]

4. Advantages:
This method has lots of advantages like it has very fine speed control over whole range in both directions. Uniform acceleration and good speed regulation can be obtained by this method.

5. Disadvantages:
Due to use of bulky rheostat across the armature, a large amount of power is wasted and arrangement is a little bit costly. It gives low efficiency at light loads.

6. Conclusion:
This is the easiest and economic method to control the speed of a DC shunt motor. In INDIA, it is more considerable about the cost of any product. Because we have energy
crisis. We have more energy consumption than generation. So energy conservation is more important for developing country. We should be in search of some economical and having less pollutant fuels.

Today, adjustable frequency drives can provide precise speed control for AC motors, but they do so at the expense of power quality, as the solid-state switching devices in the drives produce a rich harmonic spectrum. The DC motor has no adverse effects on power quality.

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