SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE NAME: 19EEB210 / Electrical Machines and Drives

II YEAR / IV SEMESTER

Unit III – SPEED CONTROL TECHNIQUES

Topic : Speed control of D.C shunt motors

SPEED CONTROL OF DC SHUNT MOTOR

- The speed of a d.c. motor is given by

$$N \propto \frac{E_b}{\phi}$$

or $$N = K\frac{(V - I_a R)}{\phi} \text{ r.p.m.} \qquad \text{(i)}$$

where $R = R_a$ for shunt motor

$= R_a + R_{se}$. for series motor

- From exp. (i), it is clear that there are three main methods of controlling the speed of a d.c. motor, namely:

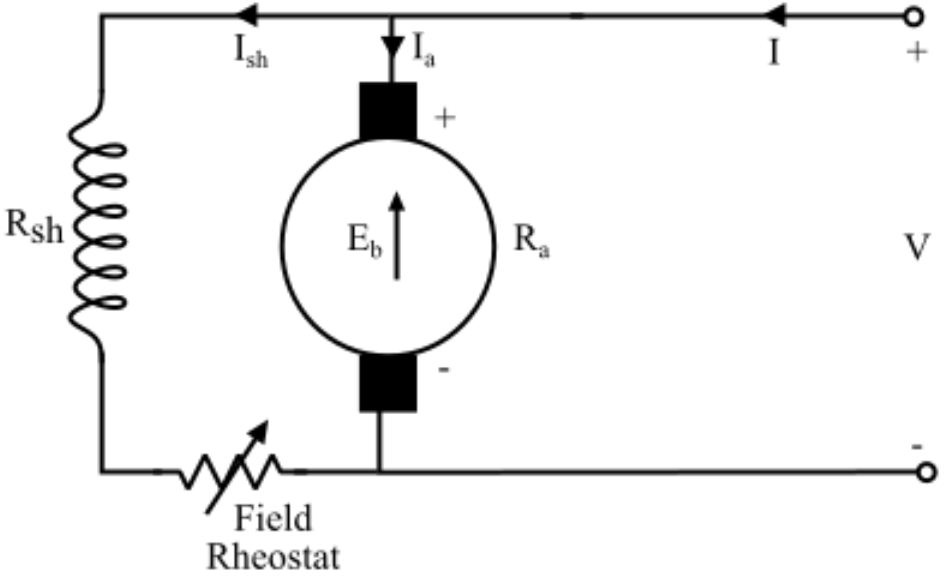
(i) By varying the flux per pole (Φ). This is known as flux control method.

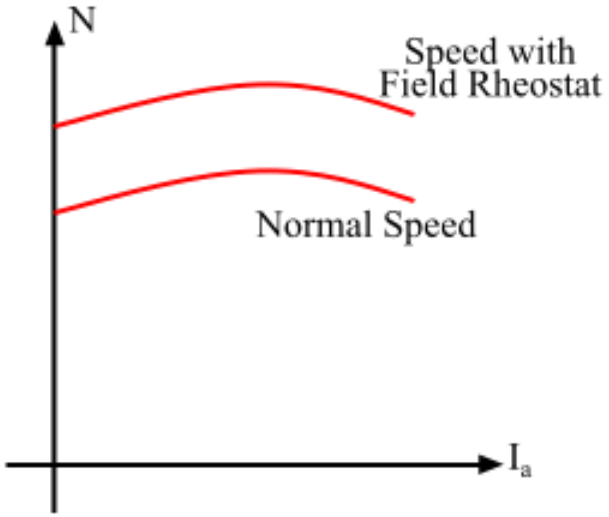
(ii) By varying the resistance in the armature circuit. This is known as armature control method.

(iii) By varying the applied voltage V. This is known as voltage control method.

FLUX CONTROL METHOD

- The flux control method is based on the principle that by varying the field flux ϕ, the speed of DC shunt motor can be changed.





$$N \propto \frac{1}{\varphi}$$

FLUX CONTROL METHOD

- In this method, a variable resistance (called field rheostat) is connected in series with the shunt field winding.
- By increasing the resistance of the field rheostat, the shunt field current Ish can be reduced and hence the field flux.
- Thus, by the flux control method, the speed of a DC shunt can only be increased above the normal speed.
- The flux control method is frequently used for the speed control of DC shunt motors because it is simple and inexpensive method.

ADVANTAGE & DISADVANTAGE

Advantages

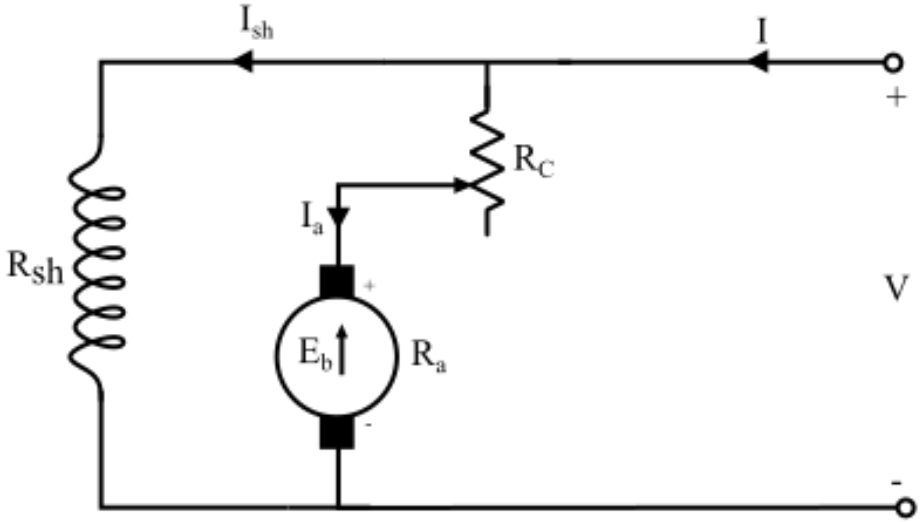
- It is a simple and convenient method.
- It is an inexpensive method as the small power loss in the field rheostat due to the small value of Ish.
- The speed control using flux control method is independent of the load on the machine.

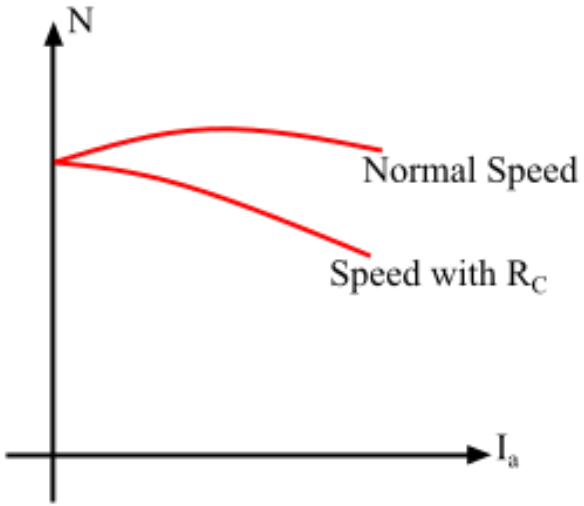
Disadvantages

- By this method, only speeds higher than the normal speed can be obtained because the total resistance of the field circuit cannot be decreased below shunt field winding resistance (Rsh).
- In flux control method, there is a limit to the maximum speed obtainable, because if the field flux is too much weakened, the commutation becomes poorer.

ARMATURE RESISTANCE CONTROL METHOD

- The armature resistance control method is based on the principle that by varying the voltage available across the armature, the back EMF of the motor can be changed, which in turn changes the speed of the shunt motor.
- In this method, a variable resistance RC (called controller resistance) is inserted in series with the armature.





ARMATURE RESISTANCE CONTROL METHOD

The speed of DC shunt motor is given by,

$$N \propto E_b$$

Also,

$$E_b = V - I_a(R_a + R_C)$$

- Thus, due to the voltage drop in the controller resistance, the back EMF is decreased and hence the speed of the motor.
- The maximum speed that can be obtained using armature resistance control method is the speed corresponding to RC = 0, i.e., the normal speed.
- Therefore, by this method only speed below the normal speed can be obtained.

DISADVANTAGE

- A large amount of power being wasted in the controller resistance since it carries full armature current.
- The output and efficiency of the motor being decreased.
- This method of speed control results in the poor speed regulation.
- The speed changes with the variation in the load because the speed depends upon the voltage drop across the controller resistance and hence on the armature current demanded by the load.

VOLTAGE CONTROL METHOD

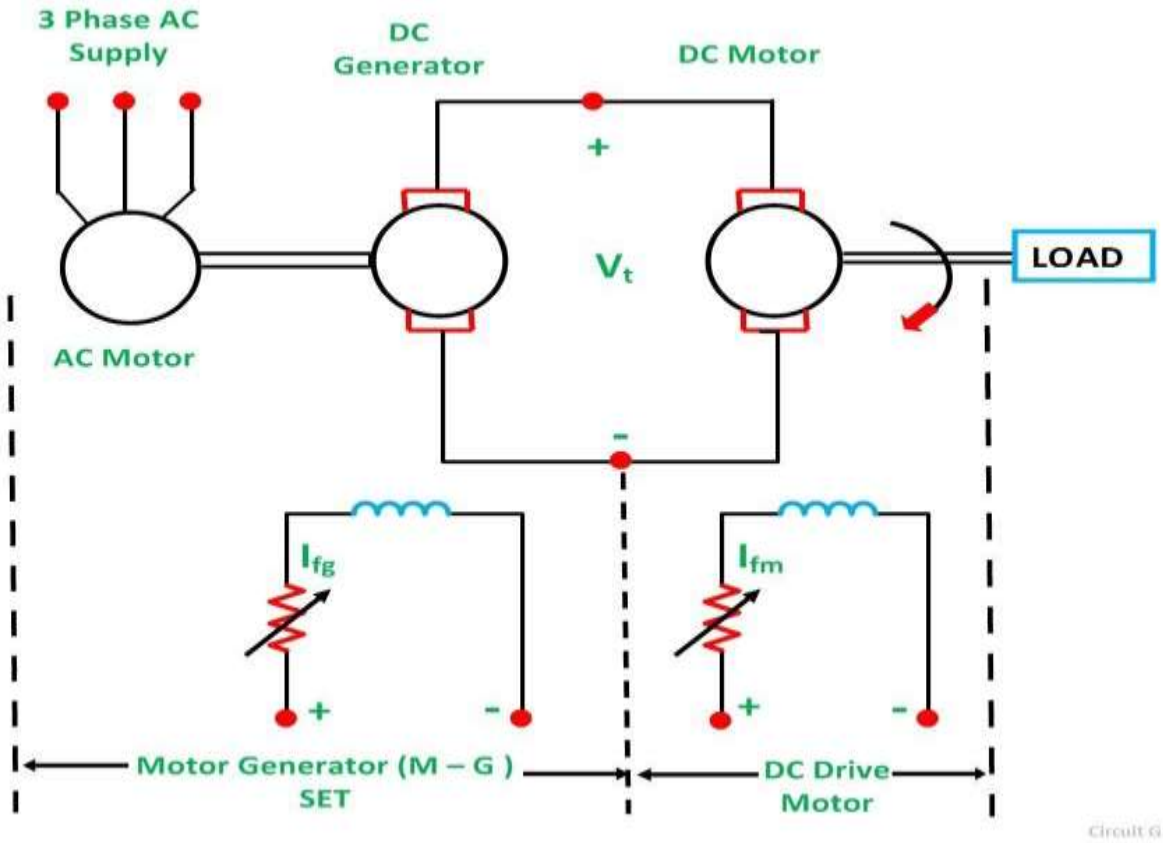
(i) Multiple voltage control

- In this method, the shunt field of the motor is connected permanently across a-fixed voltage source.
- The armature can be connected across several different voltages through a suitable switchgear.
- In this way, voltage applied across the armature can be changed.
- The speed will be approximately proportional to the voltage applied across the armature.
- Intermediate speeds can be obtained by means of a shunt field regulator.

VOLTAGE CONTROL METHOD

(ii) Ward Leonard Method

- It is achieved by varying the applied voltage to the armature. This method was introduced in 1891.

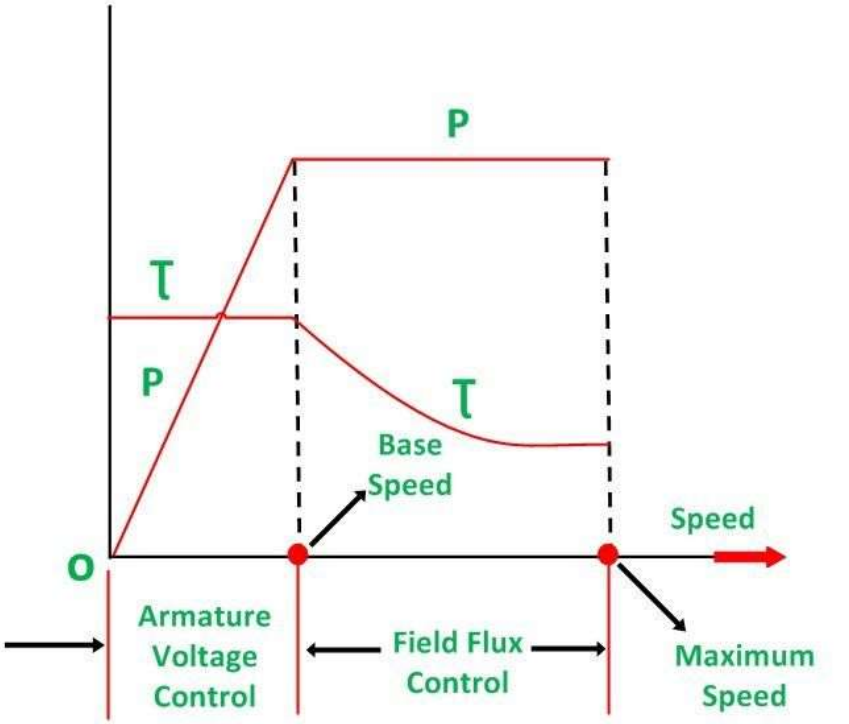


WARD LEONARD METHOD

- M is the main DC motor whose speed is to be controlled, and G is a separately excited DC generator.
- The generator G is driven by a 3 phase driving motor which may be an induction motor or a synchronous motor.
- The combination of an AC driving motor and the DC generator is called the Motor-Generator (M-G) set.
- The voltage of the generator is changed by changing the generator field current. This voltage when directly applied to the armature of the main DC motor, the speed of the motor M changes. The motor field current Ifm is kept constant so that the motor field flux ϕm also remains constant. While the speed of the motor is controlled, the motor armature current Ia is kept equal to its rated value.

WARD LEONARD METHOD

- The generated field current Ifg is varied such that the armature voltage Vt changes from zero to its rated value. The speed will change from zero to the base speed. Since the speed control is carried out with the rated current Ia and with the constant motor field flux, a constant torque is directly proportional to the armature current, and field flux up to rated speed is obtained. The product of torque and speed is known as power, and it is proportional to speed.
- Thus, with the increase in power, speed increases automatically.



Torque and Power Characteristic

ADVANTAGE & DISADVANTAGE

Advantages

- Smooth speed control of DC motor over a wide range in both the direction is possible.
- It has an inherent braking capacity.
- The lagging reactive volt-amperes are compensated by using an overexcited synchronous motor as the drive and thus, the overall power factor improves.
- When the load is intermittent as in rolling mills, the drive motor is an induction motor with a flywheel mounted to smooth out the intermittent loading to a low value.

Disadvantages

- The initial cost of the system is high as there is a motor-generator set installed, of the same rating as that of the main DC motor.
- Larger size and weight, Requires large floor area
- Costly foundation , Maintenance of the system is frequent.
- Higher losses, Lower efficiency.
- The drive produces more noise.

APPLICATIONS

Applications of Ward Leonard Drives

The Ward Leonard drives are used where smooth speed control of the DC motors over a wide range in both the directions is required. Some of the examples are as follows:

- Rolling mills
- Elevators
- Cranes
- Paper mills
- Diesel-electric locomotives
- Mine hoists

KEEP
LEARNING.

Thank u

SEE YOU IN NEXT CLASS