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Review Article

The Study of Relationship between Properties and Current & Various Resistance on Simulation in Motor Stalled with Series Circuit

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Abstract

The relationship between torque and current & various resistance is important in motor so in this study the motor properties is searched and find it can increase with current in different conditions which includes voltage, resistance of armature and times. The torque can increase with the current increasing. In terms of increasing the time to 140s the torque will increase certain. The maximum torque is 0.5Nm which is under condition of U=18V, R_m=8.5Ω& t=60s with armature radius of 5mm and its mass of 5.7g. The effective turn is U>R_m>t which expresses the prior factor among these three parameters.

Keywords: current; torque; relationship; force; voltage; resistance; time; motor.

1. INTRODUCTION

The motor has important attribution for example the current with resistance and meantime dynamics including the torque is another important factor which can estimate the torque of motor. So we continue to study the dynamics of motor after current is searched [1-4]. When the current increases it will change and the force will change too. However the detail situation has been not studied by now. So it is investigated that the torque of armature in motor is searched in this paper in order to observe the intrinsic relationship of them. Controlling motor with series circuit resistance is important to measure the property in electricity. The test measure is complicate and difficult with wire and load. So if having a method to model its course is supposed the best one. So it is supposed that the certain one is proposed to proceed and check their utilities.

In this study the series circuit resistance is adopted for measuring the rotation, power & torque of motor. To try to establish model to draw the curve between them and find variable value is our research destination. Once it is feasible the method will be adopted to evaluate the DC motor property in advance. In this paper to compare with actual value is to look for and find feasible parameters to map the gap between the model and practice. To regulate the resistance on series circuit will regulate the current which affects the motor load and property. So the resistance will play the role of regulating property in motor, which has an important role. In this study the deep research is done to simulate the circuit resistance for confirming the intrinsic relationship between them and look for method to search the effective factor to motor property with simulation. In this study the torque、power and rotation has been searched and try to find their intrinsic relationship to a new method to control the motor which is the destination. For the sake of precise controlling the conditions are needed to find and arrange their effective turn to check the priority.

1. Modeling of motor in series circuit

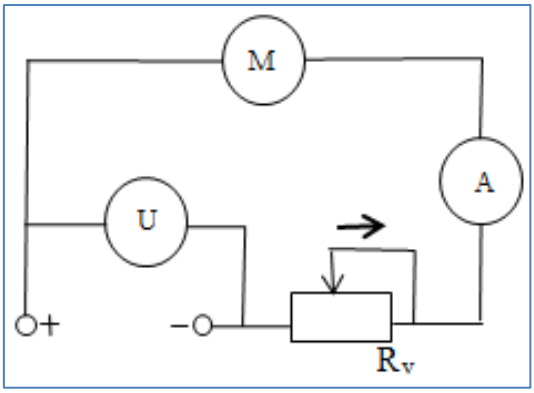

Fig-1: Circuit simulation under motor and variable resistance R_v.

According to power defining it gains

So $dP = d(Fv)$ (1)

Here F is motor force; v is its speed.

According to electric principle in terms of Figure 1 it has

$$\sum P = P_m + P_v = \sum(i_m^2 r_m + i_v^2 r_v) \quad (2)$$

$$P_m = i_m^2 r_m \quad (3)$$

Here P_m is motor power; P_v is variable power; ; r_m is motor resistance; r_v is variable resistance; $i_m$is motor current; i_v is variable current.

From energy conservation law it has

$$P_m t = \frac{1}{2} I_m \omega^2 = Fvt \quad (4)$$

According to (1) and (4) it has

$$\frac{1}{2} I_m \omega = FRt \quad (5)$$

Here ω is angular speed.

The rotary inertia of motor armature is

$$I_m = \frac{1}{2} m R_m^2 \quad (6)$$

From (5) it has

$$\omega = \sqrt{2FRt / I_m} \quad (7)$$

From (3) it has

$$F = 9.55 \frac{i_m^2 r_m}{2nR} \quad (8)$$

Since

$$n = \frac{30\omega}{\pi R^2} \quad (9)$$

According to (7), (8) and (9) it has

$$\omega = \sqrt[3]{\frac{9.55 i_m^2 r_m \pi t}{15m}} \quad (10)$$

\and $$v = R\sqrt[3]{\frac{9.55 i_m^2 r_m \pi t}{15m}} \quad (11)$$

Here R_m is armature diameter; n is rotation; t is time; m is mass of rotor ie armature.

So $$a = \dot{v} = \dot{\omega} R = \frac{R}{3}\sqrt[3]{\frac{9.55 i_m^2 r_m \pi}{15mt^2}} \quad (12)$$

From (9) it has

$$n = \frac{30}{R^2}\sqrt[3]{\frac{9.55 i_m^2 r_m t}{15m\pi^2}} \quad (13)$$

And $$dT = 9.55 \frac{i_m^2 dr_m}{n} \quad (14)$$

P is from (3), T is from (14) and n is from (13). Here T is torque.

2. DISCUSSIONS

In series circuit the properties have been investigated through the relationship to current and resistance in this study. Detail curves are as below like rotation、power and torque. The condition is four 9~18V, 2.5~8.5Ω and 60~120s at armature mass is 5.7~6.4g.

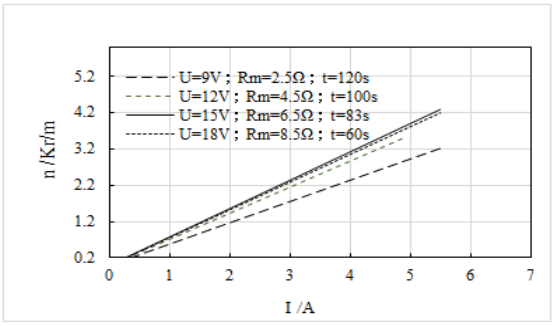

Fig-2: The curve of rotation and curent with m=6.4g in the motor

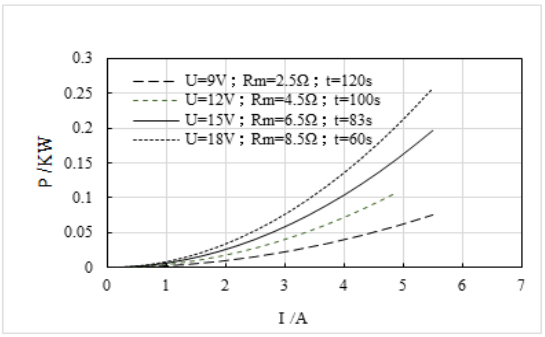

Fig-3: The curve of power and curent with m=6.4g in the motor

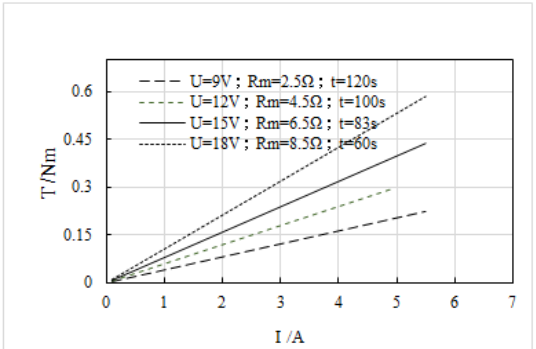

Fig-4: The curve of torque and current with m=6.5g in the motor

In Figure 2~4 the rotation、power and torque may incline when the current inclines. The biggest rotation、power and torque is 4.2Kr/m、0.25KW and 0.6Nm with 5.5A respectively. When the volatge increases from 9V to 18V the ones will increase too. The effective turn is U>R_m>t which expresses the prior factor among these three parameters.

In Figure 5 the rotation will decline as the various resistance inclines. When the voltage inclines the rotation may incline too. The biggest n is 4.7Kr/m in 1Ω and it may decline steeply to 1.7kr/m in 6Ω. it expresses that the control of rotation is available through varioius resistance under voltage、resitance and times.

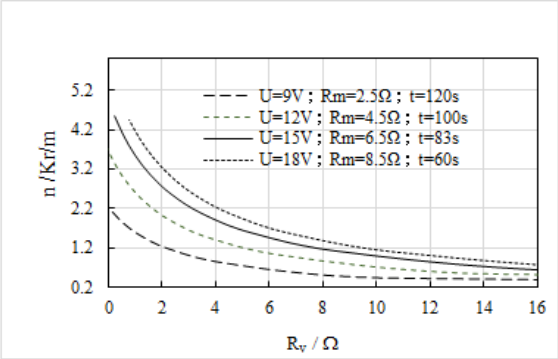

Fig-5: The curve of rotation and various resistance with m=5.7g in the motor

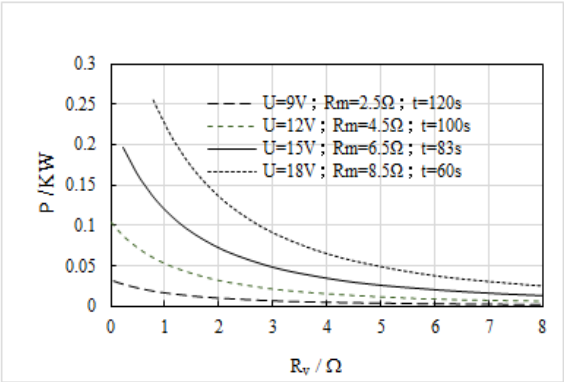

Fig-6: The curve of power and various resistance with m=5.7g in the motor

In Figure 6 the same trend is gained as above mention with mass of 5.7g in armature. The rate power can attain from 20W to 220W whilst the stall one can attain from 10W to 400W as above mention.

When the voltage increases torque will be big with mass of 5.7g as seen in Figure 6~8 and resistance increases it will be big too. It will decrease when the voltage become big. So the effective factor turn is U>R_m>t which is concluded in this paper. In Figure 7 on nominal current of 1Ω the torque will distribute to 0.1~0.5Nm whilst in stall current of 6Ω it will arrange from 0.05~0.25Nm.

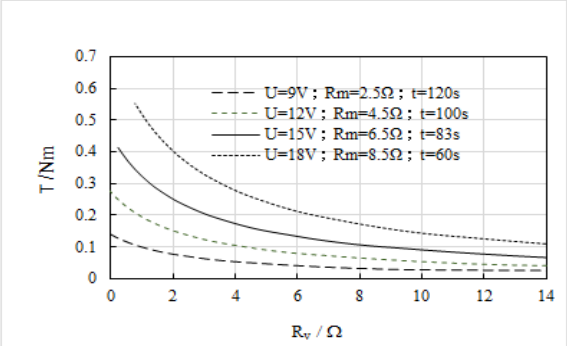

Fig-7: The curve of torque and various resistance with m=5.7g in the motor

Overview the maximum torque has been at U=18V, R_m=8.5Ω, t=60s whilst the minimum one has been at U=9V, R_2=2.5Ω, t=120s. The effective turn is U>R_m>t which expresses the important factor among these three parameters. The former is formed through U and R_m common role so it is higher than secondary condition. This is high value which makes role in motor rotor to increase its torque and force. So we choose the big voltage and resistance to promote motor rotor properties.

3. CONCLUSIONS

The torque can be presented in a nominal &stall status. It can be controlled through resistance. But the torque is controlled in terms of armature mass and current because of their strong role. So if we promote its value it shall be controlled that current and voltage is main factor in this research. The conditions of U=18V, R_m=8.5Ω, t=60s result in the biggest stall force 550Nm according to change time, resistance and voltage. Then it is U=15V, R_m=6.5Ω, t=83s; U=12V, R_m=4.5Ω, t=100s and U=9V, R_2=2.5Ω, t=120s with the smallest 120Nm in turns. The effective turn is U>R_m>t which expresses the prior factor among these three parameters.

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