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Review Article

The Modeling of Properties and Parameters on Variable Resistance with Series Circuit in Micromotor I

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Abstract: The model of variable resistance and micromotor is established and it is found that the acceleration will attain the 40mm/s^2 at 5A and U=18V, Rm=8.5Ω, t=6s. the maximum and minimum acceleration arrives 60mm/s^2 and 18mm/s^2. The effective turn is U>R_m>t. The maximum force is 280N on the other side the minimum one is 80N which is found in this study.

Keywords: Acceleration; current; variable resistance; series circuit; voltage; time; micro DC motor.

1 INTRODUCTION

The motor acceleration and force is an important parameters in series circuit with other resistance. Therein the variable resistance has been adopted to draw the relationship curve to observe the the trend and value for further research on it. Furthermore the big effective factor will be proceeded further to search the deep intrinsic nature between them. Because DC motor is simpler one to compare with AC motor the DC motor has been searched firstly to gain the satisfactory result to control it is the destination of this paper [1-4]. In the controlling the motor the detail factors are important parameters for us to regulate and arrive the destination of control. All the base is the mathematical modeling to motor for the convenient regulation in advance. Therefore in this study the fit modeling has been established and simulate the all the properties happened to motor for searching deep intrinsic relation. Therein the course has been modeling with electrical and mechanical parameters to look forwards to finding the severe failure phenomenon ie. Stall matter. It makes the abnormal working even no rotary so that it must be substituted for another good one which makes the time to increase so as to prevent from wasting time to create benefit. So the modeling may proceed with all the matter to solve these problem in prediction. This is the most aim to be solved in this paper and further direction.

2 Modeling for motor properties

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

$$\sum P = P_m + P_v = \sum(i_m^2 r_m + i_v^2 r_v) \text{ …… (2)}$$

$$P_m = i_m^2 r_m \text{ …… (3)}$$

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

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

According to (1) and (4) it has

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

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Here ω is angular speed.
The rotary inertia of motor armature is

$$I_{\mathrm{m}} = \frac{1}{2} m R_m^{\ 2} \quad \text{…….. (6)}$$

From (5) it has

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

From (3) it has

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

Since

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

According to (7)、(8) and (9) it has

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

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

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

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

From (9) it has

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

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

So from (12) it has $F = ma$ …….. (15)

P is from (3), T is from (14) and n is from (13), F is from (15).
Here T is torque.

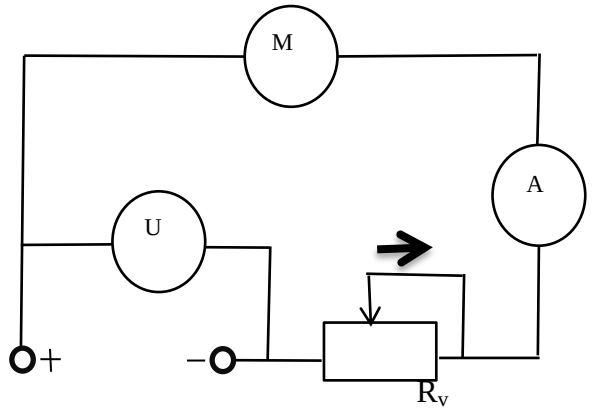


Figure 1: Circuit simulation under motor and variable resistance R_v

The motor armature mass is 5.7g and its diameter ϕ is 14 and 16mm in this study. The motor resistance is supposed 10Ω, 15Ω,20Ω, 25Ω for each stage whilst the voltage is used 8V, 12V, 16V and 20V respectively. The maintaining time in variable resistance is 6s, 8.5s, 10s, 12s respectively.

The motor armature mass and voltage being 6V、9V、12V、15V、 18V and 21V, its resistance being 2.5Ω、4.5Ω、6.5Ω、 8.5Ω、12.5Ωand time from from 6s to 14s are used to simulate the equation which is deduced in model as above. Discussion is proceeded as below.

2 DISCUSSIONS

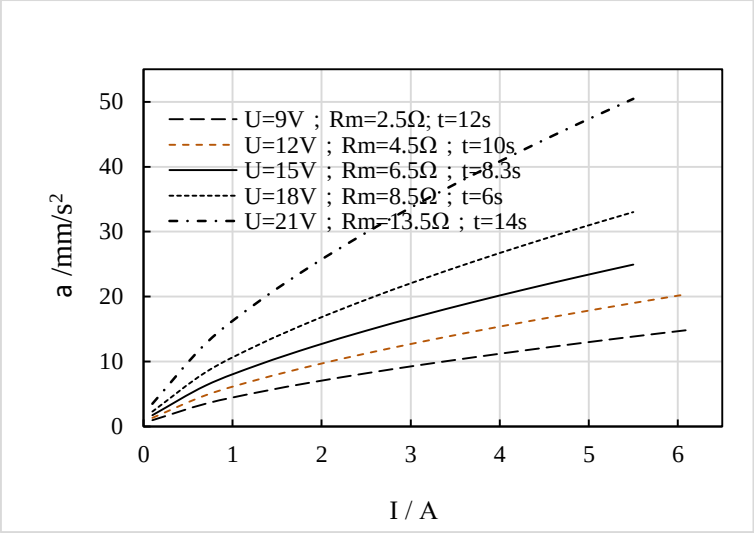
The motor acceleration will increase as its current increases and the same as above will happen as to force.

When the voltage increases acceleration will be big with radius of 7mm and mass of 5.7g as seen in Figure 1 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 nominal current of 1A the acceleration will distribute to 4~17mm/s^2 whilst in stall current of 6A it will arrange from 15~50mm/s^2.

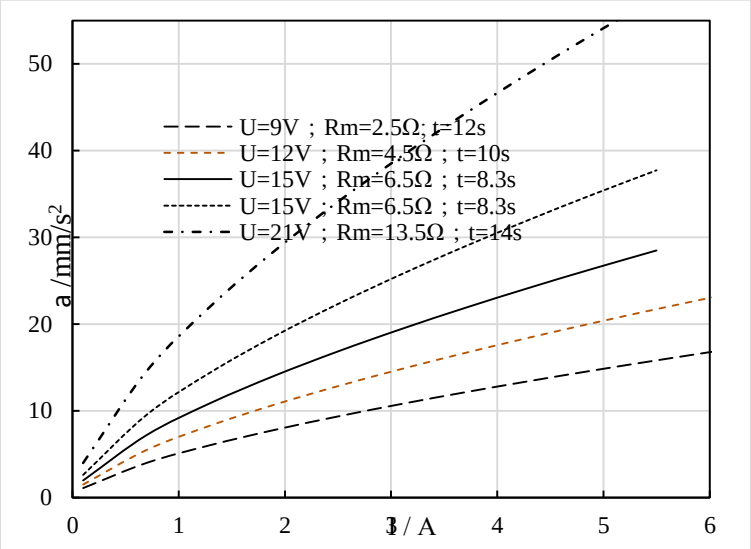
In Figure 2 the same trend is gained as above mention with radius of 8mm and mass of 5.7g in armature. The rate acceleration can attain from 4mm/s^2 to 20mm/s^2 whilst the stall one can attain from1 8mm/s^2 to 60mm/s^2 as above mention in terms of prediction.

The force in Figure 3 arranges from 20N to 75N in rate status with radius of 7mm and the same mass of armature in time of 6~14s whilst it arranges from 70N to 250N in stall in terms of prediction. Meantime the force in Figure 4 arranges from 20N to 100N in rate status with radius of 6mm and the same mass of armature in time of 6~14s whilst it arranges from 90N to 280N in stall in terms of prediction.

Overview the maximum acceleration has been at t=14s,R_m=12.5Ω,U=21V whilst the minimum one has been at t=12s,R_2=2.5Ω,U=9V. 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 to motor rotor to increase its acceleration and force. So we choose the big voltage and resistance to promote motor rotor properties.

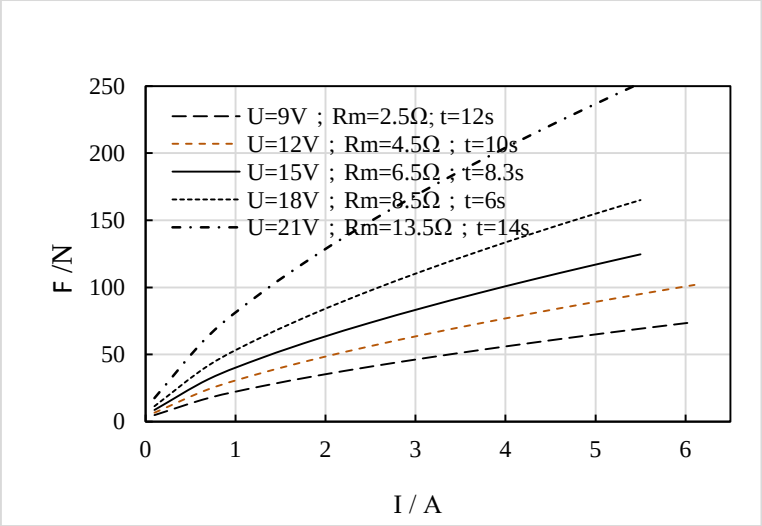


(a) R=7mm

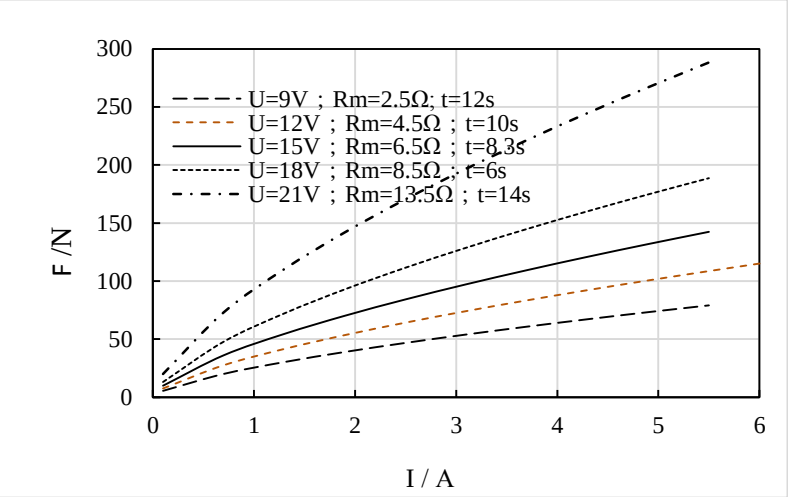


(b) R=8mm

Figure 2: The curve of acceleration and current with R and m=5.7g in the motor



(c) R=7mm



(d) R=8mm

Figure 3: The curve of force and current with R and m=5.7g in the motor

3 CONCLUSIONS

The acceleration and force can be presented in a nominal &stall status. It can be controlled through resistance. But the acceleration is too small in terms of armature radius of 7mm and time of long 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 t=14s, R_m=12.5Ω, U=21V result in the biggest stall force 280N according to change time, resistance and voltage. Then it is t=8s, R_m=8.3Ω, U=18V; t=8s, R_m=6.5Ω, U=15V; t=10s, R_m=4.5Ω, U=12V and t=12s, R_m=2.5Ω, U=9V with the smallest 85N in turns. The effective turn is U>R_m>t which expresses the prior factor among these three parameters.

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