1. **Aims**

In this chapter, our purpose is to calculate the data of the motor. The characterization of a motor provided important indicator for future hardware design, gearbox selection and software design. If we cannot offer motor characterization accurately, there will be uncertainties throughout the lab.

1. **Maximum current setting**

In the lab, we need to control the value of current because it directly influences the safety and the operation life of the motor. We use maximum current for 1.4 A in the lab to avoid the overheat of the motor. For voltage, we set about 5V during regular operation.

1. **Results and Computational Methods.**

**Part 1: Armature resistance**

|  |  |
| --- | --- |
| **Armature Resistance when motor is stalled** | |
| **Voltage (V)** | **Current (A)** |
| 1 | 0.32 |
| 1.4 | 0.49 |
| 1.6 | 0.58 |
| 2 | 0.72 |
| 2.6 | 0.9 |
| 3 | 1.12 |
| 3.8 | 1.28 |
| 4.2 | 1.43 |

Test results of voltage and current shown in Fig.1 below.

Fig.1 Fig.2

According to the voltage and current data from the lab, we plot V against I to determine the armature resistance R and the brush voltage . Which shown in Fig.2. In this figure, the gradient of the forecast line is armature resistance, which is 2.9048. The y-axis coordinate is brush voltage, which is -0.0336.

**Part 2: KE and KT estimating**

We use two gauges to measure both forces and use an optical tachometer to measure the speed in RPM, to calculate the torque that motor produced and the motor emf. Set the motor voltage to 5V and increase the friction torque applied to the motor in equal steps until the measured current reaches the maximum value. Fig.3 below shows the data measured in the lab.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Current (A)** | **F1 (N)** | **F2 (N)** | **Voltage (V)** | **Speed/ rpm** | **Speed/ rps** | **Torque (Nm)** | **Motor EMF (V)** |
| 0.15 | 0 | 0 | 5.02 | 4744 | 496.8 | 0 | 4.61288 |
| 0.25 | 0 | 0.2 | 5.04 | 4420 | 462.9 | 0.00101 | 4.3464 |
| 0.34 | 0 | 0.4 | 5.03 | 4236 | 443.6 | 0.00202 | 4.072968 |
| 0.49 | 0 | 0.6 | 5.01 | 3875 | 405.8 | 0.00303 | 3.617248 |
| 0.6 | 0 | 0.8 | 5.02 | 3620 | 379.1 | 0.00404 | 3.31472 |
| 0.72 | 0.1 | 1.1 | 5.01 | 3373 | 353.2 | 0.00505 | 2.952144 |
| 0.83 | 0.1 | 1.3 | 5.00 | 3111 | 325.8 | 0.00606 | 2.618616 |
| 0.94 | 0.1 | 1.5 | 5.01 | 2870 | 300.5 | 0.00707 | 2.314088 |
| 1.09 | 0.2 | 1.8 | 5.02 | 2535 | 265.5 | 0.00808 | 1.883368 |
| 1.24 | 0.2 | 2 | 5.00 | 2169 | 227.1 | 0.00909 | 1.426648 |
| 1.36 | 0.3 | 2.3 | 5.03 | 1822 | 190.8 | 0.0101 | 1.112072 |
| 1.38 | 0.4 | 2.6 | 5.03 | 1750 | 183.3 | 0.01111 | 1.051976 |

Mention that we changed RPM to RPS (radius per second) which is easy to calculate. The equation is . The equation of torque is . And the equation of motor emf is . Then we plot torque against the current in Fig.4.

Fig.4

From Fig.4, we get an equation , which is 0.0085 and is 0.0011. To get the maximum torque, we need to find the y-axis coordinate in torque against the current figure, which is Fig.5 below.

Fig.5

We can find that the maximum torque is about 0.0171.

Lastly, according to the equation , we work out by plot back emf against speed in Fig.6. Where is 0.0118.

Fig.6

**Part 3: Estimating at stall**

In this part, we reduce the voltage to allow us to measure down to the stall without reaching the maximum current limit. First, we need to create a table as same as part 2, which shown in Fig.7.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Test at just stalling** | |  |  |  |  |  |
| **I/A** | **F1(N)** | **F2(N)** | **Voltage/V** | **Torque (Nm)** | **Resistance** | **Motor EMF (V)** |
| 0.21 | 0.4 | 0.6 | 1 | 0.00101 | 4.761904762 | 0.389992 |
| 0.32 | 0.5 | 0.8 | 1.25 | 0.001515 | 3.90625 | 0.320464 |
| 0.56 | 0.7 | 1.3 | 1.5 | 0.00303 | 2.678571429 | -0.126688 |
| 0.69 | 0.8 | 1.5 | 1.75 | 0.003535 | 2.536231884 | -0.254312 |
| 0.8 | 0.7 | 1.5 | 2 | 0.00404 | 2.5 | -0.32384 |
| 0.88 | 1.5 | 2.5 | 2.25 | 0.00505 | 2.556818182 | -0.306224 |
| 1 | 1.1 | 2.2 | 2.5 | 0.005555 | 2.5 | -0.4048 |
| 1.14 | 1.5 | 2.8 | 2.75 | 0.006565 | 2.412280702 | -0.561472 |
| 1.27 | 1.1 | 2.6 | 3 | 0.007575 | 2.362204724 | -0.689096 |

Fig.7

Then, we use the data in the table to find by plot torque against the current in Fig.8.

Fig.8

From Fig.8, we can find that is 0.0061 and is 0.0005.

To check the value of R and when the motor is stalled, we plot voltage against the current in Fig.9.

Fig.9

The equation is . R is 1.9063Ω and is 0.5449V.

1. **Measurement accuracy**

In this lab, we measured the voltage and current of the motor, two forces applied in force gauge and the speed of revolution of the shaft. According to these measured values, we calculate derived value such as resistance, torque and back emf. The way we get derived value is using the forecast line of two plotted measured value, which is calculated by excel. However, there may have outliers in the measured data table. For example, in Fig.1, we can see that the sixth set of value is outlied. It deviated from the forecast line. If we deleted this set of value, we could generate a new, precise forecast line, as shown in Fig.10.

Fig.10

Compared with Fig.1, Fig.10 shows bigger armature resistance and lower negative brush voltage. Although these two figures are precise, we can get more precise derived value without the outliers.