

## **EDDY CURRENT BRAKING STUDY FOR BRAKE DISC OF ALUMINIUM, COPPER AND ZINK**

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### **ABSTRACT**

An eddy current braking experiment was conducted to study the behaviour of three different materials to be used as brake disc which are aluminium, copper and zink. The experiment also aimed to see the effects of increasing the current induced into electromagnet which produce drag force that will slow down the motion. Results from the experiment have been recorded using optical tachometer connected to PULSE analyzer which captured the speed (RPM) and time (s). A few graph been presented in this paper to show the best material to be used as the brake disc for electromagnetic braking system using eddy current project. This preliminary result will leads to a deeper research in field of electromagnetic braking and its potential application.

*Keyword:* Eddy current braking; aluminium; copper; zink; electromagnet; PULSE analyzer.

### **INTRODUCTION**

Towards green technology, which focused on the importance of environment conservation, a transition to a new braking system is needed. A new braking system to replace the current braking system which used the brake pad will help to reduce the air pollution that actually happen while using conventional braking system. Brake wear debris represent obviously potential hazard to environment (Kukutschova et al, 2009). Wear debris contains several hazardous elements that may interact with DNA of living organisms and cause carcinogenesis (Uexkull et al, 2005). Besides that, copper from brake pad wear also find its way into stormwater and tributaries feeding into San Francisco Bay, killing invertebrates and algae and harming fish (Peters 2008).

Besides that, a few researchers also noted that there are few problems with the conventional braking system. The conventional type brake system which

uses hydraulic system has many problems such as time delay response due to pressure build-up, brake pad wear due to contact movement and bulky size (Lee et al, 1998). These are the few common problems that actually happen in the current use of conventional braking system.

Realizing the importance of a new braking system that could lead into environmental friendly and reduce common problems mentioned earlier, an experiment will be conducted to study the behaviour of eddy current braking system which uses the electromagnet for three different kind of materials. The materials are aluminium, copper and zink as the brake disc material. In electromagnetic induction, eddy current is one of the most important phenomena which can be applied in various kinds of research and application. This eddy current braking occurred when a magnetic drag force is produced to slow down the motion when a conducting material is moving through a stationary conducting material (Jou et al, 2006). The changing magnetic flux induces eddy currents in the conductor and these currents dissipate energy and generate drag force (Jou et al, 2006). Therefore, there are no contacting elements by using this electromagnetic braking system which will lead to reduce the wear of brake pad. This situation will also reduce the wear debris pollution into our environment.

## EXPERIMENTAL PROCEDURE

Based on a laboratory experiments conducted by Manuel I. Gonzalez (Gonzalez 2004), a setup has been developed to study the eddy current braking by using electromagnet. Figure 1 and 2 shows the setup for this study that has been carry out in the semi-anechoic chamber in an acoustic lab and three different kinds of disc materials, respectively. A few changes have been made in the setup such as using an optical tachometer that connected to PULSE analyzer to record the revolution per minute (rpm) and time instead of using the digital tachometer and stopwatch. Besides that, this study also used the DC power supply of 0-10A for the electromagnet and 0-30V for DC motor power supply, instead of using 0-3A and 0-24V power supply, respectively.

For this experiment,  $a$ ,  $V$ ,  $t$ ,  $d$ ,  $I$ ,  $N$  represent the air-gap, voltage supplied to the motor, disc thickness, disc diameter, current induced and number of electromagnet turns, respectively. First, the air gap will be adjusted for 1 mm, 3mm or 5mm. Then, voltage will be supplied constantly to the motor which has been attached along with the disc. The disc that been used is 1mm of thickness with 200mm of diameter. While the disc was rotated, current will be induced in the electromagnet to produce electromagnetic field and generate drag force to slow down the motion. Current will be increased and the reading captured by the PULSE analyzer will be recorded for every increment of the current induced. The experiment procedure will be repeated for copper, followed by zink.

To capture the speed reduction towards time, we use a slightly different procedure. After the disc was rotated, the PULSE analyzer will be started to capture the speed of brake disc. At the same time, the induced current will be increases constantly until the certain limits. For this study, electromagnet with

250 turns and 50 turns has been used, and their maximum permissible currents induced are 4.5A and 8.5A, respectively. After it reached the current limit, the PULSE analyzer will be stopped.

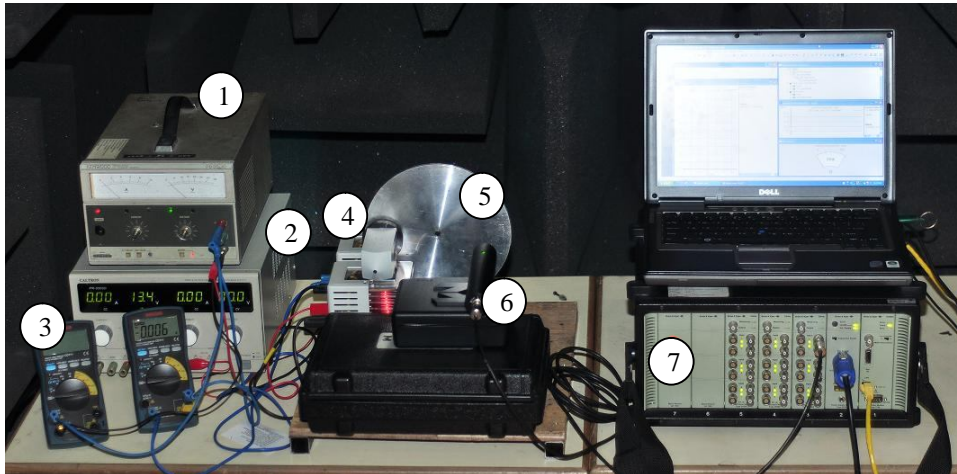


FIGURE 1 The experimental setup of eddy current braking experiment using electromagnet. 1:power supply for electromagnet, 2: power supply for motor, 3:multimeter, 4: electromagnet, 5: disc attached to motor, 6:optical tachometer, 7:PULSE analyzer

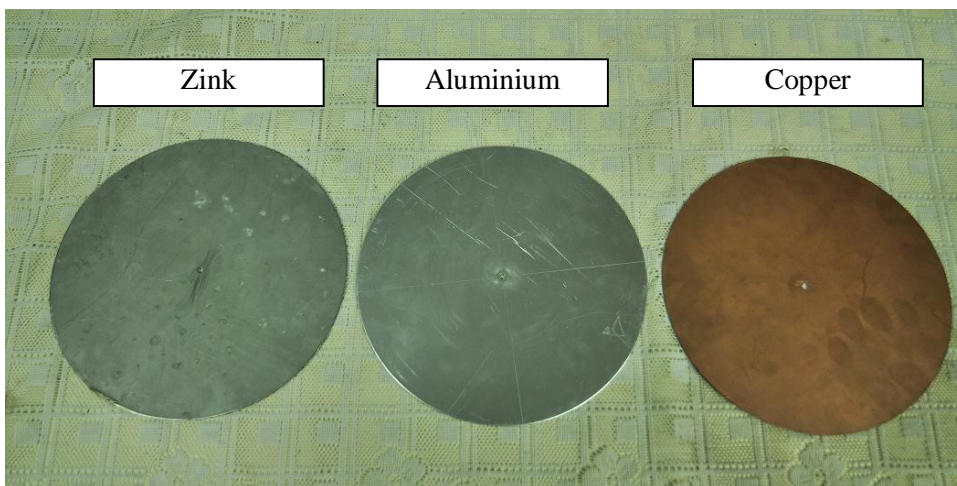


FIGURE 2 Three different kind of disc materials which are Aluminium, Copper and Zink

## RESULT AND DISCUSSION

Figure 3 shows the graph of speed versus current for aluminium, copper and zink disc with the use of 250 turns of electromagnet, disc thickness of 1mm, air gap of 1mm and motor with voltage supplied of 11V. As shown in the graph, as the current been increased from 0A to 4.5A, the speed is decreased for all the materials tested. Aluminium demonstrates the highest deceleration compared to the other two materials which are copper and zink. The speed of the aluminium disc has been decreased from about 99.0rpm to 29.5rpm. Copper stand as the second highest with deceleration from about 99.0rpm to 49.0rpm, followed by zink as the lowest deceleration of about 99.0rpm to 91.0rpm.

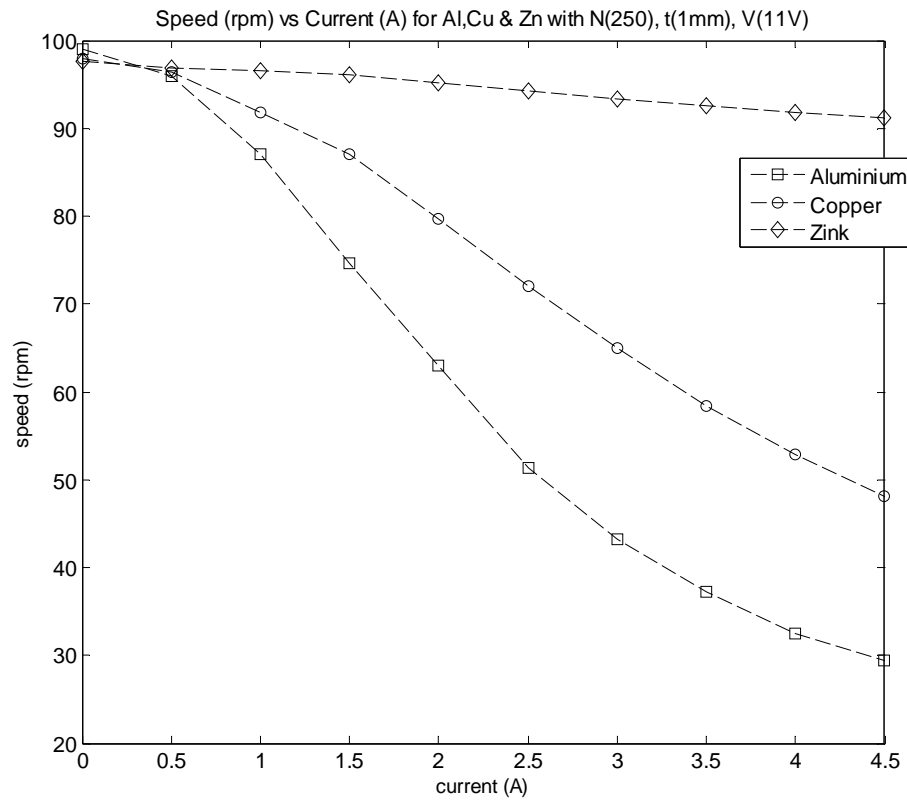


FIGURE 3 Speed(rpm) versus current (A) for aluminium, copper and zink N(250), thickness(1mm) and V(11V)

Figure 4 shows the graph of speed versus time for aluminium and copper disc with the use of electromagnet 250 turns, motor voltage supplied of 11V,

1mm of disc thickness and air gap. However, in this test, the comparison is only between aluminium and copper because these two materials have high reaction to the electromagnetic based on high speed deceleration. The graph shows that from the initial speed of about 99.0rpm has been decreased to about 30.0rpm in 33.5s, compared to copper with the speed deceleration of about 99.0rpm to 50.0 rpm in 42.0s. Again, it is proved that aluminium has the highest speed deceleration compared to the copper disc.

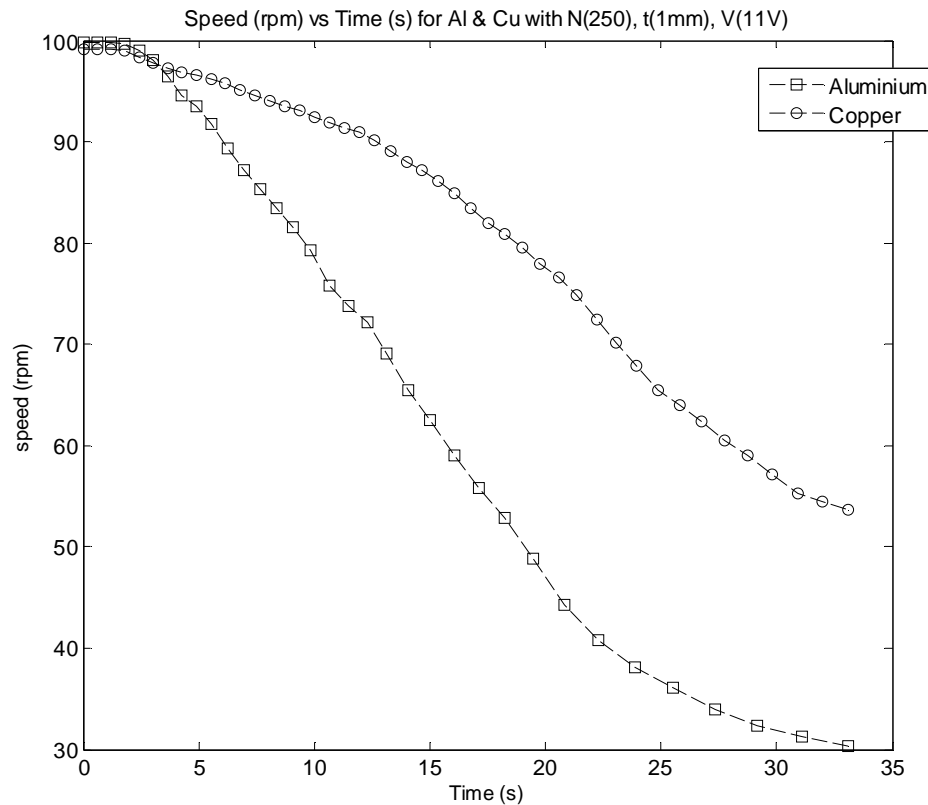


FIGURE 4 Speed (rpm) versus time (s) for aluminium and copper with N(250), thickness (1mm), air gap (1mm) and V(11V)

### CONCLUSION

From the experiment that has been conducted, it can be concluded that aluminium is the best material compared to copper and zink to be use as the disc brake for eddy current braking using electromagnetic. Aluminum reacts better and faster compared to the other two materials. Besides that, the findings show that the increment of current induced will increase the drag force that been produced which will slow down the motion better.

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