FRICITIONLESS BRAKING SYSTEM FOR WIND TURBINE

Deshmukh M.S.*1, Bhamre V.G. *2

*1 (M.E Student, Mech. Dept. SND College of Engineering & RC, Yeola)
*2 (Guide & HOD, Mechanical Dept., SND College of Engineering & RC, Yeola)
maheshsdeshmukh11@gmail.com*1, sndheadmech@gmail.com*2

Abstract

The eddy-current is created by the relative motion between a magnet and a metal (or alloy) conductor. The current induces the reverse magnetic field and results in the deceleration of motion. The proposed mechanism implements this phenomenon in developing a braking system. The potential applications of the braking system can be decelerating system to increase the safety of an elevator or any guided rail transportation system. To provide scientific investigation for industrial application of magnetic braking, this study presents four systematic engineering design scenarios to design a braking system.

The constant magnetic field is the simple and easiest design to implement. The optimal magnetic field distribution is obtained by minimizing the deceleration effort. The constant magnetic field distribution offers a compromise between performance and magnetic field requirements. The advantages of the section-wise guide rail are tolerable deceleration and simple design requirement and manufacturing processes. In the study, an experimental braking system using constant magnetic field is build to demonstrate the design procedure.

Keywords: eddy current generation, piece of magnet, braking force, deceleration.

1. Introduction

Foucault Bae J. S. (2004) found that when magnetic flux linked with a metallic conductor changes, induced Currents are set up in the conductor in the form of closed loops. These currents look like eddies or whirl pools and likewise are known as eddy currents. They are also known as Foucault’s Cure.

When a time-varying magnetic flux passes through a conductive material, eddy currents are generated in the conductor. These eddy currents circulate inside the conductor generating a magnetic field of opposite polarity as the applied magnetic field. Bee J. S. (2004) the interaction of the two magnetic fields causes a force that resists the change in magnetic flux. However, due to the internal resistance of the conductive material, the eddy currents will be dissipated into heat and the force will die out. As the eddy currents are dissipated, energy is removed from the system, thus producing a damping effect. There are several different methods of inducing a time-varying magnetic field, and from each method arises the potential for a different type of damping system. Therefore, the research into eddy current and magnetic damping mechanisms has led to a diverse range of dampers. The majority of the eddy current damping has taken place in the area of magnetic braking that has received significant interest is the use of eddy current dampers for the suppression of structural vibrations. However, much of this research is not concentrated in one area, but has been applied to a variety of different structural systems in a number of distinct ways. Skin color. Our statistical observations also support this claim. In particular, in Figure 2, we show three images we have acquired, each containing a hand gesture, together with scatter plots of the red versus green components of the pixel intensities for skin and non-skin regions in the images. We observe that the
R/G ratio stays within a narrow band of values for skin pixels, whereas it is much more variable for non-skin pixels. Therefore, we could use this ratio to decide whether a pixel is likely to belong to the hand region or not. In particular, we empirically observe that the Most of the braking systems utilize friction forces to transform the kinetic energy of a moving body into heat that is dissipated by the braking pads. The over use of friction-type braking systems causes the temperature of the braking pads to rise, reducing the effectiveness of the system. There relative motion between the magnet and the metal (or alloy) conductor produces an eddy current that induces a reverse magnetic field and results in deceleration.

An eddy current is a swirling current set up in a conductor in response to a changing magnetic field. By Lenz's law, the current swirls in such a way as to create a magnetic field opposing the change; to do this in a conductor, electrons swirl in a plane perpendicular to the magnetic field. Because of the tendency of eddy currents to oppose, eddy currents cause energy to be lost. More accurately, eddy currents transform more useful forms of energy, such as kinetic energy, into heat, which is generally much less useful. In many applications the loss of useful energy is not particularly desirable, but there are some practical applications. One is in the brakes of some trains. During braking, the metal wheels are exposed to a magnetic field from an electromagnet, generating eddy currents in the wheels.

The magnetic interaction between the applied field and the eddy currents acts to slow the wheels down. The faster the wheels are spinning, the stronger the effect, meaning that as the train slows the braking force is reduced, producing a smooth stopping motion.

Without using friction, an eddy-current braking system transforms the kinetic energy of the moving body into heat energy that is dissipated through the eddy current in the conductor. However relative velocities between the magnet and the conductor are required to activate an eddy-current braking system. Because of the simplicity of this mechanism, it can be used as a decelerator or auxiliary braking system to ensure the safety of system. Studies on the actuation of electro-mechanical machines using an eddy current can be traced back to the early 20th century. The mathematical description of the eddy current induced in a conductor under varying magnetic fields is rather complicated.

Therefore, in developing eddy current braking systems, designers usually make certain assumptions to allow a simple mathematical representation of the magnetic field. This makes it possible to derive the analytic solution of the induced eddy current distribution caused by the interaction between the moving conductor and the magnetic field. In this study, four systematic engineering design scenarios to design a braking system are presented as constant magnetic field, an optimal magnetic field distribution, piecewise constant magnetic fields and a section-wise guide rail with a constant magnetic field. The constant magnetic field is the simplest and easiest design to implement. Fig. 2 indicates the rotating plate carries the magnets on periphery connected to wind turbine shaft and stationary plate connected to generator. Magnets passing through the conductor induce an eddy current in the copper or Al, inducing drags that decreases motion. To achieve better performance, the smaller gaps between the copper and magnets are required. To reduce the deformation of the copper strips, they are divided into sections. Based on
the magnetic braking system above, we used the approximate mathematic model of the magnetic field to derive the braking force caused by the eddy current.

Fig. 2 Frictionless braking system mechanism

The wind turbine is being non-conventional source so in order provide the effective braking system which provides the safety against failure and advantage over the other system. The kind of requirement the best suitable brake is frictionless brake. The many of advantages it having non-contact, no wear, no electric actuation, light in weight so it can be very useful for wind turbine.

The braking system is being totally depends upon the Eddy Current phenomenon. This phenomenon tells by Lenz’s law. It shows that when rotating disc (or plate) is with magnetic induction come to close with the Non-ferrous material disc (or plate) which is Stationary then Eddy current is produce in Stationary plate, such eddy current oppose to rotary motion of rotating plate and finally it is stop. Now this concept is being used for the wind Turbine for braking purpose in order to avoid the failure of wind turbine.

3. Experimental Results

The project consists of Turbine Blades which is circular in shape mounted on Rotor. This Vertical Wind turbine is mounted on shaft which is further connected with Generator where it receives kinetic energy (K.E) of turbine into Electrical energy. Now one supporting plate is mounted below the Generator in order to take load and provide the support to another part of set-up, two Bearings are mounted on shaft in order to give rotary motion and support to shaft. After the Bearing the actual Breaking mechanism is start where one circular disc is mounted on wind turbine shaft at the end. This plate (Running plate) consist of permanent magnet which is mounted on plate in circular manner and along the same axial direction the another plate (Stationary plate) is mounted on different shaft which is made up of Aluminium. The gap is maintain between this two similar dimension plate for the actuation of brake for braking action. The movement of Stationary plate is done by Lead Screw. The whole set-up is in vertical manner so vertical support is given to it which is shown in Fig.3

Fig. 3 Project setup for wind turbine

The Frictionless Braking system is being depends upon the intensity of wind which will provide the information about speed at which the braking action is to start for actuation at optimum speed. The variable consider for Experiment that provide idea about the required actuation at optimum speed are Kinetic Energy of wind turbine shaft (K.E), Distance between the Rotating plate & Stationary plate (δd), Time required for Braking Action (T), Angular speed of wind Turbine shaft, Braking force (F) and this parameter can be check at different Linear speed of wind Turbine shaft (V). The gap is being maintained in mm. Now the Kinetic Energy
of running plate or wind turbine shaft is being measured by Anemometer and Angular speed of wind turbine shaft is measured by Tachometer. The different graph are plotted that showing the variation of one parameter with different, that give the actual task of braking system.

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Gap between two plates (mm)</th>
<th>Speed (rpm)</th>
<th>Velocity (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>2</td>
<td>643</td>
<td>13</td>
</tr>
<tr>
<td>02</td>
<td>3</td>
<td>750</td>
<td>13</td>
</tr>
<tr>
<td>03</td>
<td>8</td>
<td>929</td>
<td>13</td>
</tr>
<tr>
<td>04</td>
<td>16</td>
<td>1014</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 1. Experimental reading

To take the experimental reading we maintain the velocity of wind at thirteen (m/s) by using the blower. Now by varying the gap between two plates we are noted the various speeds. From this reading it is clear that when the gap between two plates increases then speed of turbine shaft also increases.

4. Conclusion

From above Experimental result We can conclude that when gap between two plates goes on increasing then braking force between that two plates also reduces and hence the speed of wind turbine shaft increases. So we can avoid the failure of turbine at high speed by maintaining suitable gap between plates according to the speed requirement and available wind intensity at that point.

5. References:

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