Design and Fabrication of Contactless Braking System with Eddy Current

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Abstract— This paper presentation explores the working principle contactless braking system with eddy current. Conventional braking system uses friction to slow down the revolving object. Stopping is mainly on the basis of contact surface that were designed. In conventional braking system, the energy given to operate the brake is enormous. This will leads to change the brake liner frequently. For this issue we are in the move to contactless braking system. In friction brakes, which apply pressure on two separate pressure plates, eddy current brakes reduces the speed of an object by creating eddy currents through electromagnetic induction which create resistance, and in turn either heat or electricity. In this paper, linear magnetized mover is applied to eddy current braking system for high speed.

Key words: Contactless Braking System, Eddy Current

I. Literature Review

Test-Bed Test System of Automobile Eddy Current Retarder[1] Yunda HU Et al ,In motoring condition, power is not suspended under some rotation, and is balanced between power and load braking torque of retarder. In the process, torque balance is also needed to be detected and recorded, as well as balanced temperature of rotor and stator.

Optimal robust control of a contactless brake system using an eddy current[2] kapjin Lee Et al mentioned .maximum braking torque obtained when, a=120, b=40, r=88mm From simulation and experimental results, it is observed that the eddy current brake (ECB) provides a fast braking response because it is capable of fast anti-lock braking.

Design considerations for an automotive magneto rheological brake[3] Kerem Karakoc Et al mentioned However, the proposed MRB configuration was not able to generate sufficient braking torque to stop a vehicle. Therefore, an improved MRB design should be suggested (e.g. by increasing the number of disks or completely redesigning the magnetic circuit configuration) in future designs, taking into account the temperature effects and more accurate description of the material properties as well.

Performance evaluation of a hybrid electric brake system with a sliding mode controller[4] Jeonghoon Song Et al mentioned Because it is a contactless brake system, the HEBS reduces or eliminates the heat dissipation, brake pad wear, and noise generation problems that occur when a CBS is used. It also alleviates the problems of energy consumption, heat dissipation, and current saturation that arise when an ECB is used at low vehicle speeds.

II. Introduction

Attractive brakes are a moderately new innovation that is starting to pick up notoriety because of their high level of security. As opposed to moderating a train by means of grinding, (for example, balance or slide brakes), which can regularly be influenced by different components, for example, downpour, attractive brakes depend totally on certain attractive properties and resistance. Truth be told,

Attractive brakes never interact with the train. Attractive brakes are comprised of maybe a couple lines of neodymium magnets. At the point when a metal balance (Commonly copper or a copper/aluminum amalgam) goes between the columns of magnets, swirl streams are produced in the blade, which makes attractive field restricting the balance's movement.

The resultant braking power is straightforwardly relative to the velocity at which the balance is traveling through the brake component. This very property, in any case, is additionally one of attractive braking's burdens in that the vortex drive itself can never totally hold a train in perfect condition. It is then regularly important to hold the train set up with an extra arrangement of balance brakes or "kicker wheels" which are straightforward elastic tires that reach the train and successfully stop it.

Attractive brakes are noiseless and are much smoother than grinding brakes, bit by bit expanding the braking control so that the general populations on the ride don‘t encounter quick changes in deceleration. Numerous advanced exciting rides, particularly those being fabricated by Intiman, have used attractive braking for quite a while. Another real crazy ride creator actualizing these brakes is Bollinger and Maxillary in 2004 on their Silver Bullet altered liner, making it the initially suspended exciting ride to highlight attractive brakes, and again utilized them on their more up to date tasks, for example, Leviathan at Canada's Wonderland. These later applications have demonstrated successfully agreeable and important for these modified napkins which frequently give the feeling of flight. There additionally exist outsider organizations, for example. which give different designs of the innovation to be utilized to supplant and retrofit stopping mechanisms on existing crazy rides to build wellbeing, enhance rider solace, and lower upkeep expenses and work.

III. Components Used

This demonstration shows magnetic braking applied to a rotating metallic disk. This might, for example, serve to control resistance to motion in exercise machines. Magnetic braking can also find applications in roller coasters and railroad trains, in which the metallic conductor has the shape of a linear rail.

Fig. 1: motor

In contrast to conventional friction brakes, there is no direct contact between interacting surfaces, which makes magnetic braking more reliable and reduces wear and tear. A magnetic brake is a device that leverages strong magnetic forces to slow a vehicle down. There are various different types of magnetic brake systems, including ones that use Electromagnets to actuate traditional friction pads, and those that leverage magnetic repulsion itself to provide resistance. These can be found on a variety of vehicles, from trains to roller coasters. By increasing or decreasing the amount of electric current, the stopping power of an Eddy current brake can be correspondingly attenuated up or down. Rather than pads pressing harder on a rotor, the resistive magnetic force is amplified. Though there is no physical contact, the process still generates increased slowing, along with heat, as a result of the resistance.

Fig. 2: Stand that holds the electromagnets in place

Eddy current brake systems are used mostly in larger vehicles, like trains. A sub-type of the Eddy current brake is known as the linear Eddy current brake. Instead of the normal circular design, magnetic coils are wound around a straight rail. The coils alternate between a positive and negative magnetic charge, so, when activated, generate resistance and slowing action. This design is less widely used than traditional electromagnetic brakes on train systems, but, in places like Europe, is becoming more common on high-speed rail systems. Unpowered versions of the linear design — which instead use permanent, rare Earth magnets — are the brake of choice on most roller coasters. As anyone who has ridden a roller coaster will be aware, these non-electromagnetic types work on an on-off basis, and cannot be easily modulated. This results in very abrupt periods of deceleration, and, for this reason, they are not a popular choice on more comfort-oriented vehicles, like trains.

IV. WORKING PRINCIPLE

Magnetic Braking When an electrical conductor, such as copper or aluminum, moves through the field of a permanent magnet or an electromagnet, electromagnetic induction creates eddy currents, which dissipate some of the kinetic energy into Joule heat and results in slowing the motion of the conductor. This principle is utilized in the construction of magnetic brakes.

The assortment of papers that have been reviewed in this paper shows that use of eddy current dampers has seen a number of diverse applications. However, many of the applications are not directed towards the commercial market and are developed to suit a niche field. The eddy current damper does have numerous advantages over other damping systems. For instance, due to the non-contact nature of the damper it does not change the dynamics of the structure or cause mass loading and added stiffness, as many other damping mechanisms do. Additionally, because the damper does not contact the structure, there is no need for a viscous fluid, seals, or the periodic maintenance needed by many other damping and braking systems. Furthermore, eddy current damping systems are easy to install, and the damping force can easily be controlled through adjustment of the position or strength of the magnets. The question left unanswered is, where eddy current damping mechanisms will be in the future. There are several locations that are particularly well suited for eddy current dampers, but perhaps the most promising is in space.

The advantages listed above provide a combination of attributes that are not available in other damping mechanisms. When a device is placed into orbit, the system must function for its entire lifespan without requiring any type of maintenance. This can place limitations on the type of damper used, leaving few systems left. Perhaps the two damping systems that require the least amount of maintenance after their placement are eddy current dampers and constrained layer damping.

Fig. 3: Complete experimental setup

The drawback of constrained layer damping is that it modifies the system's structural properties, while the drawback of the eddy current damper is that it typically requires a second structure to support the magnets. However, the extremely cold temperatures that are present in space actually improve the damping performance of the eddy current damper, due to the decrease in resistivity of the conductor.

The opposite is the case for constrained layer damping treatments, because the extreme cold can cause stiffening of the viscoelastic material and the vacuum pressure could cause out gassing if not properly sealed, thus making their use in space problematic. The use of these dampers in space may be the key to developing better eddy current technology that may open a commercial market. One commercial market that may be a key location for eddy current damping is the vibration absorbers used in vehicles. The dampers currently used tend to require replacement throughout the life of the automobile and lose effectiveness over time. The eddy current damper could potentially replace these devices if sufficient research were carried out. A second area of the automobile that may benefit from the use of eddy current the braking system. The use of eddy currents for braking purposes could potentially lead to regenerative braking that would reduce the amount of electrical energy required to power the electromagnets. The automobile market is a key commercial market that can typically open doors for the technology used.

Finally, the use of eddy currents for active damping mechanisms may allow a more effective damper to be developed. The use of eddy current dampers as active control mechanisms is limited in the current literature. One application that may be effective is to displace the magnet relative to the moving conductor, in an attempt to increase the net velocity between the two devices and instigate a higher damping force. Other active control methods may use electromagnets to damp vibrations out. If the amount of research into eddy current damping continues to grow, this type of damper will surely find its way out of niche applications and into the commercial market.

V. Conclusion

The advantages of electromagnetic brakes over friction brakes, they have been widely used on heavy vehicles where the brake fading problem is serious. The same concept is being developed for application on lighter vehicles. A Halfback magnetized mover was applied to a high-speed eddy current braking system. Based on analytical 2-D field solutions considering dynamic end effect, the magnetic field, eddy current distribution, and forces according to the secondary relative permeability and conductivity were presented. It was observed that the air-gap flux density has a non-uniform distribution for the high speed. Comparisons between numerical simulations and experimental data were also presented.

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