Variable voltage control of a contactless brake system using an eddy current

Prof. V. P. Sawant, Aditya Bobade, Shubham Moholkar, Rushikesh Biradar

Abstract:-This project aims to create a electromagnetic braking system model capable of applying brakes without any friction loss and without losing the energy supplied. It uses two electromagnets which runs by the supply of power from the circuit. Also, there is a wheel which is attached to the motor so when the power the supplied, by the help of motor the wheel rotates. A metal bar is in the vicinity of the electromagnets and wheel so when the electromagnets produces eddy currents which stops the rotating wheel or rotor. This model helps in a way to be a used a retardation equipment in vehicles.

***Keywords*- Eddy current, Electromagnet, Induction, Variable voltage, Contactless Braking.**

1. Introduction

Electromagnetic brakes (also called electro-mechanical brakes or EM brakes) slow or stop motion using electromagnetic force to apply mechanical resistance (friction). The original name was "electro-mechanical brakes" but over the years the name changed to "electromagnetic brakes", referring to their actuation method. Since becoming popular in the mid-20th century especially in trains and trams, the variety of applications and brake designs has increased dramatically, but the basic operation remains the same. Electromagnetic brakes are the brakes working on the electric power & magnetic power. They work on the principle of electromagnetism. These brakes are an excellent replacement on the convectional brakes due to their many advantages. The reason for implementing this brake in automobiles is to reduce wear in brakes as it frictionless. Electromagnetic brakes are of today's automobiles. The working principle of this system is that when the magnetic flux passes through and perpendicular to the rotating wheel the eddy current flows opposite to the rotating wheel/rotor direction. This eddy current trying to stop the rotating wheel or rotor. This results in the rotating wheel or rotor comes to rest/ neutral**.** It is found that electromagnetic brakes can develop a negative power which represents nearly twice the maximum power output of a typical engine, and at least three times the braking power of an exhaust brake. Performance of electromagnetic brakes make them much more competitive candidate for alternative retardation equipment compared with other retarders. By using by using the electromagnetic brakes are supplementary retardation equipment, the friction brakes can be used less frequently, and therefore practically never reach high temperatures. The brake linings would last considerably longer before requiring maintenance and the potentially "brake fade" problem could be avoided. In research conducted by a truck manufacturer, it was proved that the electromagnetic brake assumed 80% of the duty which would otherwise have been demanded of the regular service brake. Further the electromagnetic brakes prevent the danger that can arise from the prolonged use of brake beyond their capability to dissipate heat. This is most likely to occur while a vehicle descending a long gradient at high speed. The installation of an electromagnetic brake is not very difficult if there is enough space between the gearbox and the rear axle. If did not need a subsidiary cooling system. It relay on the efficiency of engine components for its use, so do exhaust and hydrokinetic brakes. The exhaust brake is an on/off device and hydrokinetic brakes have very complex control system. The electromagnetic brake control system is an electric switching system which gives it superior controllability.

2. Methodology

Most brakes commonly use friction between two surfaces pressed together to convert the kinetic energy of the moving object into heat though other methods of energy conversion may be employed. For example, regenerative breaking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel brakes are generally applied to rotating axles or wheels, but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps raised into the air during landing. Since kinetic energy increases quadratically with velocity an object moving at 10 m/s has 100 times as much energy as one of the same mass moving at 1 m/s, and consequently the theoretical braking distance, when braking at the traction limit, is 100 times as long. In practice, fast vehicles usually have significant air drag, and energy lost to air drag rises quickly with speed. Almost all wheeled vehicles have a brake of some sort. Even baggage carts and shopping carts may have them for use on a moving ramp. Most fixed-wing aircraft are fitted with wheel brakes on the undercarriage. Some aircraft also feature air brakes designed to reduce their speed in flight. Notable examples include gliders and some world war 2 -era aircraft, primarily some fighter aircraft and many dive bombers of the era. These allow the aircraft to maintain a safe speed in a steep descent. The saab b17 dive bomber and Vought F4U Corsair fighter used the deployed undercarriage as an air brake. Friction brakes on automobiles store braking heat in the drum brake or disc brake while braking then conduct it to the air gradually. When traveling downhill some vehicles can use their engine to brake. When the brake pedal of a modern vehicle with hydraulic brakes is pushed against the master cylinder, ultimately a piston pushes the brake pad against the brake disc which slows the wheel down. On the brake drum it is similar as the cylinder pushes the brake shoes against the drum which also slows the wheel down.

3. Principle of operation

Faraday's law of induction

Faraday's law of induction is a basic law of electromagnetism predicting how a magnetic field will interact with an electric circuit to produce an electromotive force (EMF)—a phenomenon called electromagnetic induction. It is the fundamental operating principle of transformers, inductors, and many types of electrical motors, generators and solenoids. The Maxwell–Faraday equation is a generalization of Faraday's law, and is listed as one of Maxwell's equations.

Lenz’s Law

Lenz's law is a common way to understand how electromagnetic circuits obey Newton's third law and the conservation of energy. Lenz's law is named after Heinrich Lenz, and it says:

An induced electromotive force (emf) always gives rise to a current whose magnetic field opposes the change in original magnetic flux. Lenz's law is shown with the negative sign in Faraday's law of induction:

which indicates, that the induced emf ($\mathscr{E}$) and the change in magnetic flux ($\partial\Phi B$) have opposite signs. The induced emf and the resulting induced current are counter clockwise when B is directed out from the page and the area of the circuit is decreasing. The flux through this circuit is decreasing in the outward direction. Now the induced current I produces its own magnetic field, and we may use the right-hand grip rule to compute the direction of this field. The result is that the magnetic field due to the induced current is also directed outward within the circuit. It is as though nature, through this induced field, tried to compensate for the reduction in the flux due to the applied field B. This turns out experimentally to be a general rule, so that we may say that, “The direction of the induced emf is always such as to result in opposition to the change producing it” That is Lenz's law.

Calculation

Mild steel C-45 is selected for our project.

1. Easily available in all sections.
2. Welding ability
3. Machining ability
4. Cutting ability
5. Cheapest in all other metals.

Material = C 45 (mild steel)

Take F.O.S. 2

$\sigma t = \sigma b = 540/F.O.S. = 270$ N/mm2 $\sigma s = 0.5\ \sigma t$

= 0.5 x 270

=135N/mm2

DESIGN OF MOTOR

Power of motor = 373 N- m /s

Rpm of motor = 1140 rpm

Calculation for final speed & torque Power of motor = P = 373 watt.

$P = 2\pi N T / 60$

Where,

N→ Rpm of motor = 1140 rpm

T →Torque transmitted

$373 = (2\pi \times 1140 \times T) / 60$

T = 3.12 N-m

T1= 3124 N-mm

Now, pulley of 75 and 125 diameter is mounted

So, ratio: 1.66

T2 = 5206.6 N-mm

N2= 686.7 rpm

CONCLUSIONS

While concluding this part, we feel quite satisfied with having completed the project synopsis well on time. We hadenormous practical experience on the manufacturing schedules of the working project model. We are, therefore, happy to state thatthe inculcation such of mechanical aptitude proved to be very useful. We are overwhelmed at the arriving of the targeted mission.Undoubtedly the joint venture had all the merits of interest and enthusiasm shown by all us the credit goes to the healthy coordinationof our batch colleague in bringing out a resourceful fulfilment of our assignment described by the university. The designcriterion imposed challenging problems which however were welcome by us due to the availability of good research papers. Theselection of choice of raw materials helped us in minimizing the level of wear and tear.

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