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ELECTROMAGNETIC BRAKING SYSTEM

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ABSTRACT

The point to create this project electromagnetic braking system model was that to create a braking system capable of applying brakes without any friction and without losing the energy supplied to the system. It uses a two electromagnets which runs by the supply of power from the circuit. There is a wheel that is attached to the motor so whenever the power is supplied the wheel starts to rotate with the help of the D.C motor For the purpose of cooling the electromagnets we uses a fan which we placed near the electromagnets so we can say that this fan works as a air type cooling system. A metal bar is placed between the electromagnets and wheel so when the magnetic flux passes perpendicular to the direction of rotation of wheel electromagnets produces eddy currents which flows in the direction opposite of the wheel which causes retardation and then stops the rotating wheel or rotor. This model helps in a way to be a used a retardation equipment in vehicles where sudden or emergency brakes are not commonly used.

Keywords: Electromagnets, Wear, Flux, Eddy Current, Fade, Rotor.

I. INTRODUCTION

Electromagnetic brakes go by a few other names including electro-mechanical brakes, and EM brakes. These types of brakes use electromagnetic forces to generate friction or resistance, allowing objects to stop or slow down their movements. These are not to be confused with eddy current brakes which use the direct application of magnetic force to create resistance. They are assemblies of electrical elements, activated by electric power, for the slowing or stopping of shafts in equipment drives. Types include friction, hysteresis, eddy current, and magnetic particle. Though only braking with an actual magnetic interface is discussed here, the term electromagnetic brake also refers to two other things. Here are the three definitions:

A braking system whose force is supplied by an adjustable spring counteracted by a solenoid, a centrifugal thruster, and an actuator, in which the actuating force is supplied by current flowing through a solenoid or an electromagnet.

An emergency braking system that is automatically applied to an electric-powered apparatus when a power failure occurs.

II. METHODOLOGY

Method and analysis which is performed in your research work should be written in this section. A simple strategy to follow is to use keywords from your title in first few sentences.

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III. MODELING AND PARTS

Construction

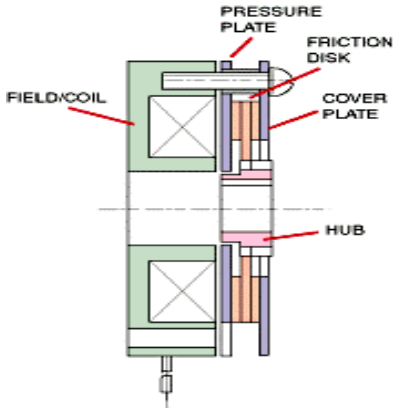
The basic motive of develop this project was to study and analyze electromagnetic braking system which can replace the conventional hydraulic braking system. First step of making this brake was to make a frame and the stand to fit the wheel on it, then the wheel was made and attached to the spook wheel and then the spook was attached to the stand with the help of bearings. The copper wire was winded to the small cylindrical vessel to make an electromagnet. Next step was the welding of U shaped metal rod to the L shaped metal bar this welded part emerges as the brake shoe for the braking system and the ends of this shoe rests in the electromagnet. The

motor is attached to the base so that the motors of the wheel and the electromagnet is connected to the external battery through a circuit. So when the battery is turned on they work respectively.

Our model is divided mainly into two different units:

1) Driving Unit.

2) Braking Unit.



Driving Unit

1. Electric Motor: It is defined as a device that converts electrical energy into mechanical energy. While working in the normal mode most of the electrical motors operates through the interaction between magnetic fields of the motor and the winding current to generate force within the motor. Electric motors are classified into various type on the basis of power source, application, type of motion, etc.

2. Wheel: when the motor runs the wheel also start rotating because both wheel and motor are connected through the connecting chain and chain rings.

3. Power Control: It is the division that controls the power supply to the whole system and also controls the motion of motion.

Braking Unit

1. Electromagnet: It is a type of magnet in which magnetics fields are generated by the help of electric current. When the electricity is supplied magnetic field generated but when the supply is turned off the magnetic field disappears. It consists of insulated wire wounded in a coil when the current pass through the wire the fields are generated with the hole of coil as the center.

2. Brake Shoe: It is part that will stop the main wheel when the electromagnet is turned on.

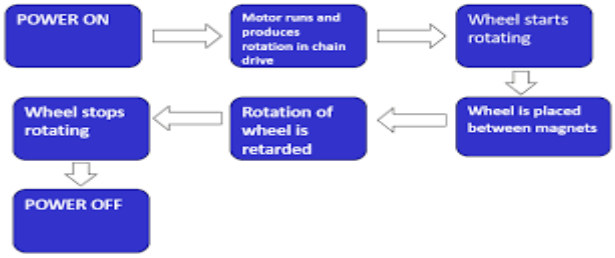
OTHER PARTS

1. Spring: A spring also called helical spring (coil spring) is a mechanical part which stores energy and subsequently releases it in order to absorb shock or to maintain a force between two contacting surfaces. Spring works on Hooke's law. Two springs ae used in the model to push the brake shoe in its original position.

2. Bearing: The main purpose of bearings to reduce the rotational friction and support the radial and axial loads. In this model we used 608 2RS type of bearing.

3. WORKING

When electricity is applied to the coil of an electromagnet, the magnetic flux attracts the armature to the face of the brake. As it does so, it squeezes the inner and outer friction disks together. The hub is normally mounted on the shaft that is rotating. The brake housing is mounted solidly to the machine frame.



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4. FABRICATION

a) **Base plank:** Base plank is made of wooden rectangular base which act as base for all the components of EMBS. It has the dimension of 80*50*1 cm.

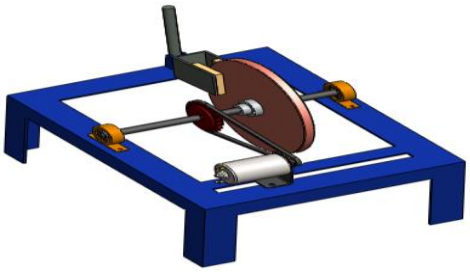
b) **Electric motor:** In this project we used D.C motor to move the wheel.

c) **Electromagnet:** In this project the wheel is stopped with the help of electromagnet which is made by winding copper on cylindrical vessel.

4.1 Complete Fabrication Process of the System

Methodology of fabricating an electromagnetic braking system model:

- Analysis of problems in fabrication
- Designing of the required components of system.
- Selection of best materials according to the need.
- Purchasing materials.
- Fabrication of the electromagnet.
- Preparation of report and submission the authorites.



IV. CALCULATIONS

Braking force

The total braking force required can easily be calculated by using Newton's Second law of Motion:

$V = \Pi*d*N/60$

$= (\Pi \times 0.276 \times 150)/60$

$=2.1666 m/s$

$A= (v-u)/t$

$= (2.1666-0)/2.5$

$=0.86664 m/sec^2$

$F= m*A=12 \times 0.867$

$=10.40N$

Braking force

$T = (F \times 0.5d)/R$

$= (10.40 \times 0.5 \times 0.276)/1.725$

$= 0.832Nm$

Clamp force

$C = T/ (\mu \times Re)$

$=0.832/ (0.25 \times 0.06)$

$=55.46 N$

Brake power

Assuming the stop is from the test speed down to zero then the kinetic energy is given by:-

$KE=0.5 \times m \times v^2$

$=0.5x12x2.1666^2$

$=28.149336$ Joules

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Sr. No.	Notations	Value	Meaning
1	M	12 kg	Rotating mass
2	t	2.5 sec	Braking time
3	d	0.276 m	Wheel dia.
4	N	150 rpm	Rotational speed of wheel
5	R	1.725	Ratio of wheel diameter& disc diameter
6	R_d	0.08m	Disc radius
7	μ	0.25	Coefficient of friction
8	R_e	0.06m	Effective disc radius
9	E	29.0 joules	Total energy of rotating mass
10	I	8 Amp-hr	Current through coil
11	L	0.048m	Length of solenoid
12	Σ	59.6×10^6 S/m	Electrical conductivity of disc
13	R	0.015 m	Radius of electromagnet
14	V	12 V	Battery Voltage
15	I	8 Amp-hr	Battery Current
16	C	465 J/Kg °C	Sp. Heat capacity of disc
17	K	54 watt/m °C	Thermal conductivity of disc
18	Volume	0.00003601 m^3	Disc volume
19	P	7850 kg/ m^3	Density of disc
20	μo	$4\pi \times 10^{-7}$	Permeability of air
21	μs	2000	Permeability of steel

Rotational Energy:

The rotational energy is the energy required to slow rotating parts. It varies for different vehicles and which gear is selected however taking 3% of the kinetic energy is a reasonable assumption. The power is then given by:

$P = E/t = 29.0/2.5 = 11.61 watt$

This is the average power. The peak power at the time of braking is double of this.

Brake heating

Fade Stop Temperature Rise

$\Delta t = (P \times t)/ (\rho \times c \times Volume)$

$= (11.61 \times 2.5)/ (7850*465*3.601*10^{-5})$

$= 1.01900 ^\circ C$

Magnetic flux density (B):

$T=1/2*\sum*\delta*\pi*R^2*m^2*B*z^2*[1- (((R/A)^2) / ((1-(M/A)^2)^2)]$

$= (0.5 \times 59.6 \times 10^6 \times 0.003 \times 5^2 \times \pi \times 0.015^2 \times 0.007^2 \times B^2) \times (1- (0.035/0.996))$

$B = 18.01 Wb/m^2.$

$B = (\mu s \times \mu o \times n \times I)/L$

$18.01 = (2000 \times 4\Pi \times 10\text{-}7 \times n \times 8)/0.048$

$N = 43 turns/m$

Magnetic field strength (H):

H = N x I/L = (43 x 8)/ 0.048

=7166.66 A/m

V. CONCLUSION

This report briefly shows the performance of an electromagnetic braking system which has various components and is most cost effective and efficient methodologies to use the energy supplied. With the application of the effective and strong electromagnet and the different methodologies we can have greater efficient braking system than the conventional one.

ACKNOWLEDGEMENTS

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VI. REFERENCES

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