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Development In Electromagnetic Braking System

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Abstract :

In this paper we have discussed development of the electromagnetic braking system. Braking System should ensure the safety and comfort of the passenger, driver and other road users. The brake must be strong enough to stop the vehicle during emergency within shortest distance. The conventional braking system is bulky and power to weight ratio is low. Electromagnetic braking system is high-tech braking system and finds its use in small & heavy vehicles like car, jeep, truck, busses, etc. This paper represents about minimizing the brake failure in order to avoid the accident. It also reduces the maintenance of braking system. The effectiveness of brake should remain constant. Proper cooling of brake gives anti fade character and efficient operation of brake. Proper lubrication and maintenance must be done to operate brake safely, effectively and progressively with minimum fatigue to driver. This system provides better response time for emergency situations and in general keeps the friction brake working longer and safer.

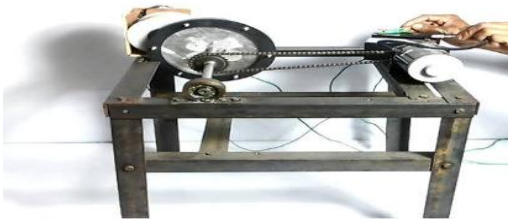
Keywords - Brake, Electromagnetism, Brake power, Torque

Introduction:

Electromagnetic brakes have been used as supplementary retardation equipment in addition to the regular friction brakes on heavy vehicles. We outline the general principles of regular brakes and several alternative retardation techniques in this section. The Working principle and characteristics of electromagnetic brakes are then highlighted. The principle of braking in road vehicles involves the as the force that puts the car in motion and dissipates the associated kinetic energy as heat. Brakes must be able to arrest the speed of a vehicle in a short period of time regardless of how fast the speed is. As a result, the brakes are required to have the ability to generate high torque and absorb energy at extremely high rates for short periods of time. Brakes may be applied for a prolonged periods of time in some applications such as a heavy vehicle descending a long gradient at high speed. Brakes have to have the mechanism to keep the heat absorption capability for prolonged periods of time. In the electromagnetic brake, the coil or solenoid attracts a steel disc. The steel disc presses a brake disc made of sintered or asbestos material between itself and a stationary steel disc. The torque is thus 'grounded' and braking action takes place. This type of brake is used in machines like lathes, presses, etc. In electro-magnetic braking system, electro-magnetic property is used. Due to this, action of braking will be done. In this system, electro magnet iron plate, liners, tension spring, stud, disc brake plate are used. The brake liners are attached with electromagnet and iron plate individually and both plates insert the disc plate and this plate rigidly attached with wheels. The battery of minimum 12 volts is used for external power supply. Electromagnet consists of wire wound over a soft iron core. When current is passed through the coil, it produces a magnetic field which magnetizes the core into the bar magnet with the polarities. Strong magnetic field is obtained by high currents of large

self-induction. High currents are not always feasible, which is why a high self-induction is obtained by making a loop of wire in the shape of a coil, a so-called solenoid. More current and more turns produce a stronger magnetic field which results in stronger electromagnet. When current is switched OFF, field disappears and the iron core is no longer a magnet. This ability of an electromagnet provides a strong magnetic force of attraction. Shape geometry and material used in construction of electromagnet decide the shape and strength of magnetic field produced by it.

Construction and working:



ELECTROMAGNETIC BRAKING SYSTEM

The working principle of electromagnetic brake is based on the creation of eddy current within the metal disc rotating between two electromagnets, which set up a force opposing the rotation of disc. If electromagnet is not energized, the rotation of disc is free & accelerates uniformly under the action of weight to which shaft is connected. When the electromagnet gets exercised, the rotation of disc is retarded & the energy absorbed appear as heating of disc and brake is applied.

Calculations:

Let,

V = Initial velocity

U = Final velocity

A = Deceleration of rotating mass

F = Braking force

T = Braking torque

H = magnetic field length

N = No. of turns/ length of solenoid

C = clamping force

P = average power

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K.E. = kinetic energy

Assume data:-

Braking force:

The total braking force required can simply be calculated using Newton's Second Law.

V = Π *d*N/60 = (Π * 0.276 *150)/60 =2.1666 m/sec

A = (v-u)/t = (2.1666-0)/2.5 =0.86664 m/sec^2

F= m*A=12 * 0.867 =10.40N

Braking force

T = (F*0.5d)/R

= (10.40 * 0.5 * 0.276)/1.725 = 0.832Nm

Clamp force:

C = T/ (μ * Re)

=0.832/ (0.25 * 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* m*v^2

=0.5*12*2.16662 =28.149336 Joules

Rotational Energy:

The rotational energy is the energy needed to slow rotating parts. It varies for different vehicles and according to 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 =11.61watt

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

Sr.no.	Notation	Value	Meaning
1.	M	12 Kg	Rotating mass
2.	T	2.5 sec	Braking time
3.	D	0.27 cm	Wheel diameter
4.	N	150 rpm	Wheel rotational speed
5.	R	1.725	Ratio of wheel diameter & disc diameter
6.	R_d	0.08 m	Disc radius
7.	μ	0.25	Coefficient of friction
8.	R_e	0.06 m	Effective disc radius
9.	E	2 J	Total energy of rotating mass
10.	I	8 amp-hr	Current through coil
11.	L	0.048 m	Length of solenoid
12.	∑	$59.6*10^5$ 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^{0}c	Sp. Heat capacity of disc
17.	K	54 watt/m^{0}c	Thermal conductivity of disc
18.	Volume	0.000036 m^3	Disc volume
19.	Þ	7850 Kg/m^3	Density of disc
20.	$μ_o$	$4π*10^{-7}$	Permeability of air
21.	$μ_s$	2000	Permeability of steel

Fade Stop Temperature Rise

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$\Delta t = (P*t)/ (\rho*c*Volume) = (11.61*2.5)/ (7850*465*3.601*10\text{-}5) = 1.01900C$

Magnetic flux density(B):

$$T=1/2*\Sigma*\delta \quad \pi*R2*m2*B*z2*\left[1- \frac{\frac{R}{a}*\frac{R}{a}}{\left\{1-\frac{m}{a}*\frac{m}{a}\right\}*2}\right]$$

$= (0.5*59.6*106*0.003*5\pi2*0.0152*0.0072*B2)* (1-(0.035/0.996)) =18.01Wb/m2.$

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

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

N= 43turns/m

Magnetic field strength (H):

$H = N*I/L$

$= (43*8)/ 0.048 =7166.66 A/m$

Result:

By using the electromagnetic brake as supplementary retardation equipment, the frictions 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 "brake fade" problem could be potentially avoided. In research conducted by a truck manufacturer, it was proved that the electromagnetic brake assumed 80 percent of the duty which would otherwise have been demanded of the regular service brake (W.G. Revering 1974). Furthermore, the electromagnetic brake prevents the dangers that can arise from the prolonged use of brakes 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. It does not need a subsidiary cooling system. It does not effect on the efficiency of engine. Electromagnetic brake also has better controllability. Thermal stability of the electromagnetic brakes is achieved by means of the convection and radiation of the heat energy at high temperature. The electromagnetic brakes have excellent heat dissipation efficiency. Electromagnetic brakes have better thermal dynamic performance than regular friction brakes.

Conclusion:

After considering the limitations of drum brakes, hydraulic brakes and pneumatic brakes, the electromagnetic brakes are a better and reliable solution. Electromagnetic brake control system is an electric switching system which gives it a superior controllability. The installation of an electromagnetic brake is not very difficult. From the foregoing, it is apparent that the electromagnetic brake is an attractive complement to the safe braking of heavy vehicles. Good results with current design, a larger budget would improve performance.

References:

1) Dr. Kirpal Singh Automobile Engineering and Technology, Vol 1

2) R.A. Barapate "Electromagnetic Engineering" Tech nova Educational Publication.

3) Khurmi & Gupta "Machine Design" S Chand Publication.

4) V.B. Bhandari "Design of Machine Elements" Tata McGraw Hill.

5) K. Balaveera Reddy "Design data hand-book for mechanical engineering.

6) Flemming, Frank; Shapiro, Jessica (July 7, 2009). "Basics of Electromagnetic Brakes". Machine design : pp. 57–58

7) Kren, Lawrence; Flemming, Frank (August 5, 1999). "Getting a Handle on Inertia". Machine design: pp. 92–93.