International Journal of Psychosocial Rehabilitation, Vol. 23, Issue 04, 2019
ISSN: 1475-7192

A Review Paper on Electromangnetic Breaking System

J. Manikandan and Ajay Yadav

Abstract--- *We had develop In this paper the electromagnetic braking system. Braking System should ensure the safety and comfort of the passenger, driver and other road user. The brake must be strong enough to stop the vehicle during emergency within shortest distance. The convential braking system are bulky and power to weight ratio is low. Electromagnetic braking system is high-tech braking system find its use in small & heavy vehicle like car, jeep, truck, busses etc. It also reduces the maintenance of braking system. The effectiveness of brake should remain constant. The proper cooling of brake gives anti fade character and efficient operation of brake. Proper lubrication and maintenance must be done to operate brake safe, effective and progressive 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.*

I. 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 conversion of kinetic energy into thermal energy (heat). When stepping on the brakes, the driver commands a stopping force several times as powerful as the force that puts the car in motion and dissipates the associated kinetic energy as heat. As a result, the brakes are required to have the ability to generating high torque and absorbing 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 plate insert the disc plate and this plate rigidly attached with wheels. 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.

J. Manikandan, Assistant Professor, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai. E-mail: kandan.arni@gmail.com
Ajay Yadav, UG Scholar, Department of Mechanical Engineering, BIST, BIHER, Bharath Institute of Higher Education & Research, Selaiyur, Chennai.

Received: 07 Apr 2019 | Revised: 06 May 2019 | Accepted: 04 June 2019

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. 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.

II. LITERATURE REVIEW

A number of theories have been proposed in the literature to explain the brake squeal phenomenon. An early experimental investigation found that variation in coefficient in the contact interface was the cause for brake to squeal. In Mills (1938) hypothesised that squeal was associated with the negative gradient characteristics of dynamic friction coefficient against the sliding velocity. He attempted to examine various drum brakes and brake linings and thought that such mechanism was a necessary condition for a brake to squeal. Sinclair (1955) through his mathematical model showed that the presence of such mechanism led to unstable oscillations and

gave rise to self-excited vibration in the system. Later, Fosberry and Holubecki (1955, 1961) suggested that the disc brake tended to squeal when either a static coefficient of friction was higher than the dynamic coefficient or a dynamic coefficient decreases with increase of speed present in the contact interface. The above mechanisms are also referred to as “stick-slip” and “negative damping” respectively in current terminology. The stick-slip theory has not received much attention recently except for explaining some low frequency brake vibration problems such as creep-groan whilst negative damping theory still has its place in

brakes squeal studies. (1961-1962) seemed to be a first researcher who turns away from the above theories. He proposed a new theory of brake squeal by which the unstable oscillation in the system could also occur even with constant friction coefficient. In describing this mechanism, he developed a model that consisted of a rigid, massless rod (pivoted at one end, O and free to another end with an angle theta) in contact with a rigid moving plane as shown in figure 2.0. An external force, L was loaded to its free end. He found that the instability of the system depended upon the friction coefficient, the magnitude of the friction force, the normal force, N. These two forces then generated a resultant force that formed an angle theta (physically the angle of free end cantilever) which crucial to the stability of the system. When the friction coefficient reached the cotangent of the angle theta, the free end cantilever woupragld ‘s’ or lock and the surface motion become impossible. Due to the flexibility (stiffness) within the system, it allowed the cantilever free itself from the spragging condition. Once the spragging has been relieved, the original contact situation re-established. This process continued and could lead to a sprag-slip limit cycle. In 1971 he attempted to confirm the sprag-slip mechanism through experimental investigation. He observed that squeal was associated with the position of the contact area between the pad and the disc and the nature of the between the cylinder and back contact

Nomenclature

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

P=average power

K.E=kinetic energy

Assume Data

Sr.no	Notation	Value	Meaning
1	M	12kg	Rotating mass
2	T	2.5sec	Braking time
3	D	0.276m	Wheel dia
4	N	150rpm	Wheel rotational speed
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	∑	59.6×10^6 S/m	Electrical conductivity of disc
13	R	0.015m	Radius of electromangnet
14	V	12	Battery Voitage
15	I	8Amp-Hr	Battery Current
16	C	465 J/Kg $^\circ$ C	Sp. Heat capacity of disc
17	K	54 watt/m$^\circ$ C	Thermal conductivity of disc
18	Volume	0.00003601 m^3	Disc volume
19	P	7850 kg/m^3	Dencity of disc
20	μo	$4\pi\times10^{-7}$	Permeability of air
21	μs	2000	Permeability of steel

Braking Force

Brake force also known as brake power is a measure of braking power of a vehicle In the case of railways, it is important that staff are aware of the brake force of a Locomotive so sufficient brake power will be available on trains, particularly heavy Freight trains.

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

V = Π *d*N/60 = (Π x 0.276 x150)/60 =2.1666 m/sec

A = (v-u)/t = (2.1666-0)/2.5 =0.86664 m/sec2

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

Braking force

T = (Fx 0.5d)/R

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

Clamp force

C = T/ (μ x Re)

=0.832/(0.25 x 0.06) =55.46 N

Brake Power

Vehicle braking system fade, or brake fade, is the reduction in stopping power that can occur after repeated or sustained application of the brakes, especially in high load or high speed conditions .Brake fade can be a factor in any vehicle that utilizes a friction braking system including automobiles, trucks, motorcycles, airplanes, and bicycles.

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

KE=0.5 x m x v2

=0.5x12x2.16662 =28.149336 Joules

Rotational Energy

The rotational energy is the energy needed to slow rotating parts. It varies for different vehicles and which gear is selected however taking 3% of the kinetic energy is a reasonable assumptio. 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

Braking fade is caused by a buildup of heat in the braking surface and the subsequent Changes and reaction in the brake system component and can be experienced with both Drum brakes. lass of stopping power, or fade can be caused by friction fade, mechanical fade or fluid fade.

Fade Stop Temperature Rise

Δt = (P x t)/ (ρ x c * Volume) = (11.61x2.5)/ (7850*465*3.601*10-5)= 1.01900

Magnetic Flux Density (B)

The flux density is the number of magnetic line of flux that pass through a certain point on a surface. The Sl unit is T (tesla), which is weber per square metre(Wb/m)

T=1/2*Σ*δ π*R2*m2*B*z2*[1-

= (0.5x59.6x106 x0.003x5π2 x 0.0152 x 0.0072 x B2) x (1-(0.035/0.996)) =18.01Wb/m2.

B = (μs x μo x n x I)/L

18.01 = (2000 x 4Π x 10-7 x n x 8)/0.048

N= 43turns/m

Magnetic Field Strength (H)

Magnetic field strength is one of two ways that intensity of a magnetic field can be expressed. Technically, a distinction is made between is made between magnetic field strength H, measured in amperes per meter (A/m),and magnetic flux density B, measured in Newton-meter per ampere (Nm/A), alos called tesla (T).

H = N x I/L

= (43 x 8)/ 0.048 =7166.66 A/m

III. RESULT

By using the electromagnetic brake as 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 percent of the duty which would otherwise have been demanded of the regular service brake (Reverdin 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 has excellent heat dissipation efficiency. Electromagnetic brakes have better thermal dynamic performance than regular friction brakes.

IV. CONCLUSION

As we discussed about the limitations of drum brakes, hydraulic brakes and pneumatic brakes electromagnetic brake is a better and reliable solution. Electromagnetic brake control system is an electric switching system which gives it 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] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Virtual instrumentation based process of agriculture by automation. *Middle-East Journal of Scientific Research*, *20*(12): 2604-2612.

[2] Udayakumar, R., Kaliyamurthie, K.P., & Khanaa, T.K. (2014). Data mining a boon: Predictive system for university topper women in academia. *World Applied Sciences Journal*, *29*(14): 86-90.

[3] Anbuselvi, S., Rebecca, L.J., Kumar, M.S., & Senthilvelan, T. (2012). GC-MS study of phytochemicals in black gram using two different organic manures. *J Chem Pharm Res*., *4*, 1246-1250.

[4] Subramanian, A.P., Jaganathan, S.K., Manikandan, A., Pandiaraj, K.N., Gomathi, N., & Supriyanto, E. (2016). Recent trends in nano-based drug delivery systems for efficient delivery of phytochemicals in chemotherapy. *RSC Advances*, *6*(54), 48294-48314.

[5] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Partial encryption and partial inference control based disclosure in effective cost cloud. *Middle-East Journal of Scientific Research*, 20(12), 2456-2459.

[6] Lingeswaran, K., Prasad Karamcheti, S.S., Gopikrishnan, M., & Ramu, G. (2014). Preparation and characterization of chemical bath deposited cds thin film for solar cell. *Middle-East Journal of Scientific Research*, *20*(7), 812-814.

[7] Maruthamani, D., Vadivel, S., Kumaravel, M., Saravanakumar, B., Paul, B., Dhar, S.S., Manikandan, A., & Ramadoss, G. (2017). Fine cutting edge shaped Bi2O3rods/reduced graphene oxide (RGO) composite for supercapacitor and visible-light photocatalytic applications. *Journal of colloid and interface science*, *498*, 449-459.

[8] Gopalakrishnan, K., Sundeep Aanand, J., & Udayakumar, R. (2014). Electrical properties of doped azopolyester. *Middle-East Journal of Scientific Research, 20*(11). 1402-1412.

[9] Subhashree, A.R., Parameaswari, P.J., Shanthi, B., Revathy, C., & Parijatham, B.O. (2012). The reference intervals for the haematological parameters in healthy adult population of chennai, southern India. *Journal of Clinical and Diagnostic Research: JCDR*, *6*(10), 1675-1680.

[10] Niranjan, U., Subramanyam, R.B.V., & Khanaa, V. (2010, September). Developing a web recommendation system based on closed sequential patterns. In *International Conference on Advances in Information and Communication Technologies, 101,* 171-179. Springer, Berlin, Heidelberg.

[11] Slimani, Y., Baykal, A., & Manikandan, A. (2018). Effect of Cr3+ substitution on AC susceptibility of Ba hexaferrite nanoparticles. *Journal of Magnetism and Magnetic Materials*, *458*, 204-212.

[12] Premkumar, S., Ramu, G., Gunasekaran, S., & Baskar, D. (2014). Solar industrial process heating associated with thermal energy storage for feed water heating. *Middle East Journal of Scientific Research*, *20*(11), 1686-1688.

[13] Kumar, S.S., Karrunakaran, C.M., Rao, M.R.K., & Balasubramanian, M.P. (2011). Inhibitory effects of Indigofera aspalathoides on 20-methylcholanthrene-induced chemical carcinogenesis in rats. *Journal of carcinogenesis*, *10*.

[14] Beula Devamalar, P.M., Thulasi Bai, V., & Srivatsa, S.K. (2009). Design and architecture of real time web-centric tele health diabetes diagnosis expert system. *International Journal of Medical Engineering and Informatics*, *1*(3), 307-317.

[15] Ravichandran, A.T., Srinivas, J., Karthick, R., Manikandan, A., & Baykal, A. (2018). Facile combustion synthesis, structural, morphological, optical and antibacterial studies of Bi1− xAlxFeO3 (0.0≤ x≤ 0.15) nanoparticles. *Ceramics International*, *44*(11), 13247-13252.

[16] Thovhogi, N., Park, E., Manikandan, E., Maaza, M., & Gurib-Fakim, A. (2016). Physical properties of CdO nanoparticles synthesized by green chemistry via Hibiscus Sabdariffa flower extract. *Journal of Alloys and Compounds*, *655*, 314-320.

[17] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2014). Wide area wireless networks-IETF. *Middle-East Journal of Scientific Research*, *20*(12), 2042-2046.

[18] Sundar Raj, M., Saravanan, T., & Srinivasan, V. (2014). Design of silicon-carbide based cascaded multilevel inverter. *Middle-East Journal of Scientific Research*, *20*(12), 1785- 1791.

[19] Achudhan, M., Jayakumar M.P. (2014). Mathematical modeling and control of an electrically-heated catalyst. *International Journal of Applied Engineering Research, 9*(23), 23013.

[20] Thooyamani, K.P., Khanaa, V., & Udayakumar, R. (2013). Application of pattern recognition for farsi license plate recognition. *Middle-East Journal of Scientific Research*, *18*(12), 1768-1774.

[21] Jebaraj, S., Iniyan S. (2006). Renewable energy programmes in India. *International Journal of Global Energy Issues*, *26*(43528), 232-257.

[22] Sharmila, S., & Jeyanthi Rebecca, L. (2013). Md Saduzzaman., Biodegradation of domestic effluent using different solvent extracts of Murraya koenigii. *J Chem and Pharm Res*, *5*(2), 279-282.

[23] Asiri, S., Sertkol, M., Guner, S., Gungunes, H., Batoo, K.M., Saleh, T.A., Manikandan A., & Baykal, A. (2018). Hydrothermal synthesis of CoyZnyMn1-2yFe2O4 nanoferrites: magneto-optical investigation. *Ceramics International*, *44*(5), 5751-5759.

[24] Rani, A.J., & Mythili, S.V. (2014). Study on total antioxidant status in relation to oxidative stress in type 2 diabetes mellitus. *Journal of clinical and diagnostic research: JCDR*, *8*(3), 108-110.

[25] Karthik, B. (2014). Arulselvi, Noise removal using mixtures of projected gaussian scale mixtures. *Middle-East Journal of Scientific Research*, *20*(12), 2335-2340.

[26] Karthik, B., Arulselvi, & Selvaraj, A. (2014). Test data compression architecture for low power VLSI testing. *Middle - East Journal of Scientific Research*, *20*(12), 2331-2334.

[27] Vijayaragavan, S.P., Karthik, B., & Kiran Kumar, T.V.U. (2014). Privacy conscious screening framework for frequently moving objects. *Middle-East Journal of Scientific Research*, *20*(8), 1000-1005.

[28] Kaliyamurthie, K.P., Parameswari, D., & Udayakumar, R. (2013). QOS aware privacy preserving location monitoring in wireless sensor network. *Indian Journal of Science and Technology*, *6*(5), 4648-4652.

[29] Silambarasu, A., Manikandan, A., & Balakrishnan, K. (2017). Room-temperature superparamagnetism and enhanced photocatalytic activity of magnetically reusable spinel ZnFe 2 O 4 nanocatalysts. *Journal of Superconductivity and Novel Magnetism*, *30*(9), 2631-2640.

[30] Jasmin, M., Vigneshwaran, T., & Beulah Hemalatha, S. (2015). Design of power aware on chip embedded memory based FSM encoding in FPGA. *International Journal of Applied Engineering Research*, *10*(2), 4487-4496.

[31] Philomina, S., & Karthik, B. (2014). Wi-Fi energy meter implementation using embedded linux in ARM 9. *Middle-East Journal of Scientific Research*, *20*, 2434-2438.

[32] Vijayaragavan, S.P., Karthik, B., & Kiran Kumar, T.V.U. (2014). A DFIG based wind generation system with unbalanced stator and grid condition. *Middle-East Journal of Scientific Research*, *20*(8), 913-917.

[33] Rajakumari, S.B., & Nalini, C. (2014). An efficient data mining dataset preparation using aggregation in relational database. *Indian Journal of Science and Technology*, *7*, 44-46.

[34] Karthik, B., Kiran Kumar, T.V.U., Vijayaragavan, P., & Bharath Kumaran, E. (2013). Design of a digital PLL using 0.35 Î¼m CMOS technology. *Middle-East Journal of Scientific Research*, *18*(12), 1803-1806.

[35] Sudhakara, P., Jagadeesh, D., Wang, Y., Prasad, C.V., Devi, A.K., Balakrishnan, G., Kim B.S., & Song, J.I. (2013). Fabrication of Borassus fruit lignocellulose fiber/PP composites and comparison with jute, sisal and coir fibers. *Carbohydrate polymers*, *98*(1), 1002-1010.

[36] Kanniga, E., & Sundararajan, M. (2011). Modelling and characterization of DCO using pass transistors. In *Future Intelligent Information Systems*, 86(1), 451-457. Springer, Berlin, Heidelberg.

[37] Sachithanandam, P., Meikandaan, T.P., & Srividya, T. Steel framed multi storey residential building analysis and design. *International Journal of Applied Engineering Research*, *9*(22), 5527-5529.

[38] Kaliyamurthie, K.P., Udayakumar, R., Parameswari, D., & Mugunthan, S.N. (2013). Highly secured online voting system over network. *Indian Journal of Science and Technology*, *6*(S6), 4831-4836.

[39] Sathyaseelan, B., Manikandan, E., Lakshmanan, V., Baskaran, I., Sivakumar, K., Ladchumananandasivam, R., Kennedy, J., & Maaza, M. (2016). Structural, optical and morphological properties of post-growth calcined TiO2 nanopowder for opto-electronic device application: Ex-situ studies. *Journal of Alloys and Compounds*, *671*, 486-492.

[40] Saravanan, T., Sundar Raj M., & Gopalakrishnan K. (2014). SMES technology, SMES and facts system, applications, advantages and technical limitations. *Middle - East Journal of Scientific Research, 20*(11), 1353-1358.

[41] Silvia Priscila, S., & Dr.Hemalatha, M. (2018). Heart Disease Prediction Using Integer-Coded Genetic Algorithm (ICGA) Based Particle Clonal Neural Network (ICGA-PCNN). *Bonfring International Journal of Industrial Engineering and Management Science*, *8*(2), 15TO19.

[42] Sharifzadeh, M. (2015). The Survey of Artificial Neural Networks-Based Intrusion Detection Systems. *International Academic Journal of Science and Engineering*, *2*(4), 11-18.

[43] Rajavenkatesan, T., Mohanasundaram, C., Ajith, A.S., & Vignesh, P. (2017). Photo Voltaic Cooling Can. *International Journal of Communication and Computer Technologies, 5*(1), 17-22.

[44] Gowshika, E., & Sivakumar, S. (2017). Smart LPG Monitoring and Controlling System. *International Journal of Communication and Computer Technologies*, *5*(1), 23-26.

[45] Soorya, B., Shamini, S.S., & Sangeetha, K. (2017). VLSI Implementation of Lossless Video Compression Technique Using New Cross Diamond Search Algorithm. *International Journal of Communication and Computer Technologies, 5*(1), 27-31.

[46] Cheriyan, J.E., SatheesBabu, S., & Balasubadra, K. (2014). Efficient Filtering and Location Detection against Insider Attacks in WSN. *International Journal of System Design and Information Processing, 2*(1), 19-22.

[47] Dr.Balasubramaniam, P.M., Preethi, S., Surya Prakash, K., Swathi, S., & Vishnu, B. (2019). Implementation of Advanced Solar Tracking and Cleaning to Improve Efficiency. *Bonfring International Journal of Networking Technologies and Applications, 6*(1), 1-5.

[48] Daund, A., Mahishi, S., & Berde, N. (2014). Synchronization of Parallel Dual Inverted Pendulums using Optimal Control Theory. *The SIJ Transactions on Advances in Space Research & Earth Exploration, 2*(2), 7-11.

[49] Rinsha, V., Varghese, J.M., and Dr.Shahin, M. (2014). A Grid Connected Three-Port Solar Micro Inverter. *Bonfring International Journal of Power Systems and Integrated Circuits, 4*(2), 25-30.

[50] Rugminidevi, G. (2014). MIMO Sonar and SIMO Sonar: A Comparison. *International Scientific Journal on Science Engineering & Technology, 17*(9), 873-881.