Pneumatic Disc Break (ABS)

Vamsi Renati[1], Jagadeesh Sake[2], Kiran Kumar Naik Sugali[3], Fayaz Hussain Shaik[4], Y. Sudheer[5]

Department of Mechanical Engineering, Tadipatri Engineering College, Tadipatri

Abstract

The aim is to design and develop a control system based on breaking system of an electronically controlled safely automotive wheel braking system. Based on this model, control strategies such as an 'antilock braking system' (ABS) and improved manoeuvrability via individual wheel braking are to be developed and evaluated. The anti-lock brake controller is also known as the CAB (controller anti-lock brake). An anti-lock braking system (commonly known as ABS, from the German name "Anti blockier system") is a system on motor vehicles which prevents the wheels from locking while braking. The purpose of this is twofold: to allow the driver to maintain steering control and to shorten braking distances. The solenoid controlled braking system is used for this project. When the brake pedal or Bush Button is activated by the driver, the solenoid Valve (Cut off Valve) activates/deactivate the pneumatic braking system simultaneously at constant speed. The braking is applied gradually to the vehicle, so that the vehicle stops smoothly with safe.

Keywords: Anti-lock Braking System (ABS), Electronic Brake Control, Solenoid Valve Pneumatic Braking System, Individual Wheel Braking, Controller Anti-lock Brake (CAB), Vehicle Safety

Introduction

A recent typical ABS is composed of a central electronic unit, four speed sensors (one for each wheel), and two or more hydraulic valves on the brake circuit. The electronic unit constantly monitors the rotation speed of each wheel. When it senses that one or more wheel is rotating slower than the others (a condition that will bring it to lock), moves the valves to decrease the pressure on the braking circuit, effectively reducing the braking force on that wheel.

On high-traction surfaces such as bitumen, whether wet or dry, most ABS-equipped cars are able to attain braking distances better (i.e. shorter) than those that would be possible without the benefit of ABS. A moderately-skilled driver without ABS might be able, through the use of cadence-braking, to match the performance of a novice driver with an ABS-equipped vehicle. However, for a significant number of drivers, ABS will improve their braking distances in a wide variety of conditions.The word ‘pneuma’ comes from Greek and means breather wind. The word pneumatics is the study of air movement and its phenomena is derived from the word pneuma. Today pneumatics is mainly understood to means the application of air as a working medium in industry especially the driving and controlling of machines and equipment.Pneumatics has for some considerable time between used for carrying out the simplest mechanical tasks in more recent times has played a more important role in the development of pneumatic technology for automation.Pneumatic systems operate on a supply of compressed air which must be made available in sufficient quantity and at a pressure to suit the capacity of the system. When the pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure. Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of the air at intake conditions namely at atmosphere pressure and normal ambient temperature. The compressibility of the air was first investigated by Robert Boyle in 1962 and that found that the product of pressure and volume of a particular quantity of gas.

The usual written as

$PV = C$ (or) $P_1V_1 = P2V2$

In this equation the pressure is the absolute pressured which for free is about 14.7 Psi and is of courage capable of maintaining a column of mercury, nearly 30 inches high in an ordinary barometer. Any gas can be used in pneumatic system but air is the mostly used system now a days.

Related Work

The cylinder block forms the fundamental structure of an engine, housing both the cylinder liners and guides that facilitate piston movement. To ensure the structural integrity under static and dynamic loading conditions, the component undergoes finite element analysis (FEA). A solid geometry model of the cylinder block was designed in CATIA V5 R21 and subsequently imported into HYPERMESH 11 via the IGES file format. Within HYPERMESH, a standard cross-section mesh was created for the metallic domain. The model was analyzed using the ANSYS solver, applying appropriate loads and boundary conditions to validate structural performance. Multiple materials were assessed, including aluminum, grey cast iron, steel, titanium, and copper. The simulation incorporated continuous stress and deformation monitoring to prevent structural failure. For vibrational analysis, Lanczos eigenvalue extraction was used to determine natural frequencies and corresponding mode shapes of the cylinder block.D. Venkatesan, V. Senthil Kumar, and M. Sathish Kumar [2] This study investigates the mechanical and thermal behavior of an internal combustion engine block using FEA techniques. A 3D CAD model was developed in CATIA and imported into ANSYS for meshing and analysis. Static structural analysis was performed to evaluate stress and deformation under applied forces simulating engine operating conditions. Additionally, thermal analysis was carried out to understand heat flow and temperature distribution during combustion. Modal analysis identified natural frequencies and mode shapes, aiding in vibration control. Materials including aluminum and cast iron were compared to determine their suitability based on structural stability and thermal performance.Ashutosh Kumar Singh, R. Shrivastava, and V. Singh [3] This research focuses on the structural assessment of a V-12 engine cylinder block using finite element methods. The block was designed in CATIA and meshed in HYPERMESH, then analyzed in ABAQUS under static load conditions representing internal combustion pressure. The study compared two materials—Compacted Graphite Iron (CGI GJV 450) and aluminum alloy (NASA 398)—to evaluate which material better withstands operational stresses. The analysis showed that CGI exhibits higher structural stiffness with minimal deformation, making it ideal for high-load, high-performance applications. The outcome assists in selecting optimal materials for future cylinder block design.Y. Krishna Teja and G. Rajesh Kumar[4]This paper presents a methodology for the design and rapid prototyping of a single-cylinder engine block with an emphasis on manufacturing optimization. The block was modeled in CATIA V5 and parametric automation was achieved using Visual Basic programming. NC toolpaths for CNC machining were generated for prototype production. FEA simulations were conducted in ANSYS to analyze the mechanical response under operational loads. The process minimized material waste and machining time, enabling faster iteration cycles. The approach is particularly effective for design validation during early engine development stages.R. Rakesh, B. Gowtham, and N. Karthikeyan[5]This study focuses on the structural and thermal analysis of a horizontal K-type engine cylinder block. The geometry was developed in CATIA, and the model was subjected to transient thermal and static structural analysis using ANSYS. The simulation included realistic boundary conditions to replicate engine operating environments. Key performance indicators such as stress intensity, thermal distribution, and deformation were observed. Additionally, topology optimization techniques were used to reduce component weight without compromising structural strength. The findings contribute to the design of lightweight and thermally efficient engine blocks for modern applications.

Methodology:

Selection of pneumatics

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Pneumatics is an attractive medium for low cost mechanization particularly for sequential or repetitive operations. Many factories and plants already have a compressed air system, which is capable of providing both the power or energy requirements and the control system (although equally pneumatic control systems may be economic and can be advantageously applied to other forms of power).The main advantages of an all-pneumatic system are usually economy and simplicity, the latter reducing maintenance to a low level. It can also have out standing advantages in terms of safety.

Production of compressed air

Pneumatic systems operate on a supply of compressed air, which must be made available, in sufficient quantity and at a pressure to suit the capacity of the system. When pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.

The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure.Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of the air at intake conditions namely at atmosphere pressure and normal ambient temperature.

Components and description

1. Pneumatic cylinder
2. 3/2 solenoid valve

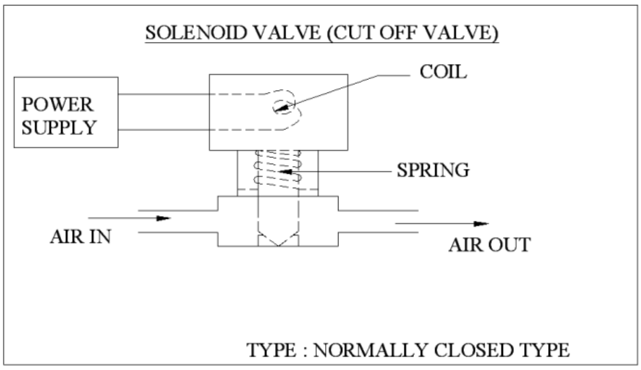
1. Pneumatic cylinder:

The cylinder is a Single acting cylinder one, which means that the air pressure operates forward and spring returns backward. The air from the compressor is passed through the regulator which controls the pressure to required amount by adjusting its knob. A pressure gauge is attached to the regulator for showing the line pressure. Then the compressed air is passed through the single acting 3/2 solenoid valve for supplying the air to one side of the cylinder. One hose take the output of the directional Control (Solenoid) valve and they are attached to one end of the cylinder by means of connectors. One of the outputs from the directional control valve is taken to the flow control valve from taken to the cylinder. The hose is attached to each component of pneumatic system only by connectors.

2. Solenoid valve:

The directional valve is one of the important parts of a pneumatic system. Commonly known as DCV, this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal movable parts.

This valve was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve. A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one is which the plunger is pulled when the solenoid is energized.



Advantages:

- It requires simple maintenance cares
- The safety system for automobile.
- Checking and cleaning are easy, because of the main parts are screwed.
- Easy to Handle.
- Manual power required is less
- Repairing is easy.
- Replacement of parts is easy.
- No Oil wastage.

Disadvantages

- Initial cost is high.
- High maintenance cost

Applications

It is very much useful for Car Owners & Auto-garages. This Antilock braking system is used for smooth braking of the vehicles.

Conclusion

From the analysis of the above research studies, it is evident that the brake response time varies significantly across different vehicle systems. Anti-lock Braking Systems (ABS) enhance vehicle stability and reduce stopping distance effectively on both dry and slippery surfaces. However, on loose terrains such as gravel or snow, ABS may lead to a longer braking distance, though it still contributes to better vehicle control. Integrating pneumatic systems into braking automation emerges as a practical solution due to their operational simplicity, cost-effectiveness, and minimal maintenance requirements. Additionally, the use of infrared (IR) sensors enhances automation by enabling precise object detection and control. A centralized compressor setup, powered electrically and linked with solenoid valves, serves as a reliable and economical alternative to using multiple electric motors. Pneumatic actuators, known for their durability and inherent shock-absorbing behavior, also help minimize brake disk jamming in heavy-load conditions. Overall, pneumatic-based braking solutions offer a robust, efficient, and cost-effective approach, especially in vehicles operating under substantial weight conditions.

References

[1] S.Mithun, S.Mariappa, Suresh Gayakwad" Modeling and simulation of pneumatic brake system used in heavy commercial vehicle" (2014) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 11, Issue 1 Ver. II (Jan. 2014), PP 01- 09

[2] SahilJitesh Antilock Breaking System (ABS) International Journal Of Mechanical Engineering and Robotics Research ISSN 2278 – 0149 Vol. 3, No. 4, October, 2014© 2014 IJMERR.

[3] Ayman A. Aly, El-ShafeiZeidan , Ahmed Hamed, Farhan Salem An Antilock-Braking Systems (ABS) Control: A Technical Review Received April 23, 2011; revised May 18, 2011; accepted May 25, 2011

[4] Mr. Kushal V. Gawande, Mr.Bharat A. Shende, Mr. Vipul B. Meshram "Automatic Pneumatic Braking System" March 2017, Volume 4, Issue 03 JETIR (ISSN-2349-5162)

[5] Robert D. Hoover, Jr., MD, MPH, FACP "Pneumatic Compression Devices "February 2009

[6] Ketan H. Mhatre "Electro-pneumatic braking system "VIVA Institute of Technology, Virar, Maharashtra International Journal of Emerging Research & Development ISSN: 2454-132X Impact factor: 4.295 (Volume 4, Issue 3).

[7] DivyataKhachane Antilock Braking System and Its Advancement-ISSN: 2395 -0056 Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072.

[8] KartikBhasin HMR Institute of Technology & Management, Hamidpur, New Delhi-110036. (IJRASET) ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177 Volume 7 Issue VIII, Aug 2019

[9]Dr. Deepak Kumar B.Tech Scholar, Department of Mechanical Engineering, Poornima Group of Institutions. Professor, Department of Mechanical Engineering, Poornima Group of Institution

[10]Karan Dutt ANALYTICAL DESCRIPTION OF PNEUMATIC SYSTEM International Journal of Scientific & Engineering Research, Volume 4, Issue 9, September-2013

[11]Mansaf Ali Abro ,Shoaib Shaikh , Ali Asghar , Syed Nadeem Mian and Imtiaz Hussain Kalwar Department of Energy Engineering, Hamdard University main campus Karachi, Pakistan Design and Analysis of Anti-Lock Braking System. 2018.

[12]Vu Trieu Minh*, Godwin Oamen, Kristina Vassiljeva, and Leo Teder. Development of Anti-lock Braking System (ABS) for Vehicles Braking. Received June 14, 2016

[13]Ayman A. Aly, El-ShafeiZeidan, Ahmed Hamed, Farhan Salem. An Antilock-Braking Systems (ABS) Control A Technical Review. Department of Mechanical Engineering, Received April 23, 2011.

[14]Saurabh.S.Murkute, ShinuPhilipose, Anmol.M.Arora, Jitendra.D.Patil, Ketul.V.Chauhan, Yogendra.R.Borje,Abhishek.A.Dahake. Review Paper on Concept of Antilock Braking System (ABS).

International Journal of Innovative Research in Science,Engineering and Technology Vol. 7, Issue 9, September 2018.

[15]Stanisa j. Peri Dragan S. Anti Vlastimir D. NikoliDarko .Miti c Marko T. Milojkovi Sa sa S. Nikoli . Journal of ELECTRICAL ENGINEERING, VOL. 65, NO. 1, 2014