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AN OVERVIEW OF AUTOMOBILE AIRBAG DEFECTS

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ABSTRACT

Automotive airbag system has augmented occupant safety through the incorporation of increasingly sophisticated features. An airbag is an automotive safety restraint system consisting of a cushion, designed to inflate rapidly during collision. It absorbs the shock and reduces the number the casualty rate. The success of this safety system heavily depends on its correct implementation and timing of its inflation. The objective of this study is to present front air bag defects and its adverse effects on the occupants. It is important to understand how failures occur and which mechanism is responsible for injuries. This study shows the importance of using the seat belts alongwith airbag to provide adequate safety to the occupants.

KEYWORDS: Airbag, Belt, Collison, failure and automobile.

INTRODUCTION

Airbag was invented by John W. Hetrick and modified by David S.Breed in 1952 and 1967 respectively. Since then it has revolutionized occupant's safety. Car occupants form 64% of the total road casualties. An US study shows that about 3.3million airbags have been deployed, saving more than 6377 and preventing countless injuries.[14] An airbag is a occupant safety device. It is a type of occupant restraint system that consists of a flexible fabric bag, also known as air cushion. Designed to protect occupants in frontal crashes, airbags inflates in milliseconds after a crash is detected cushion that protects the body from the hard interior structures of a vehicle as it decelerates. Airbags are directly linked to the life of the drivers and the passengers, as they are used as last line of defense in a collision. Hence the proper functioning of system is vital. In order to obtain a precise and reliable airbag operation, a robust system has to be designed. It is estimated that in all crash scenarios, airbags deduce fatalities by 16%for unbelted drivers and 13%for belted drivers. Airbags are intended to augment the safety along with seatbelts. Airbag in conjunction with seatbelts are effective injury prevention device; however their deployment can introduce new injuries. [9]

Fig 1. Airbag

This paper is presents the study of different types of defects occurring in the airbag restraint system and provides effective ways of overcoming these defects. Chemical propellant used in airbags has been under radar. Sodium azide, used heavily to form nitrogen as an inert gas, is a toxic substance which reacts only at high temperature range. Other factors include study of injuries caused by airbags, airbag activation while vehicle is stopped, airbag activation while driving and no airbag activation despite high accident severity. In order to appreciate the damaging potential airbags have, it is important to understand how airbag deployment ocuurs and which mechanisms are responsible for the injuries they cause.

LITERATURE REVIEW

Nowadays the increment in the road accidents has let to increasing death rate in India. Airbags can be used to prevent mortality during collision and provide safety of occupant. Frequent research in the field of automobile safety has to led the advancements in the airbag design. Different researcher worldwide presented their research work on airbag design and development. These theories are presented and helpful for new modification in existing airbag design and prevent the occupant life. Klaus and Dieter [1] have focused on problems caused by airbags i.e. "injuries caused by the airbag", "airbag activation while the vehicle is stopped", " airbag activation while driving" and no "airbag activation despite high accident safety". This paper also concludes that airbag itself, its components, its activation behavior and safety must still be optimized.Gregor et al.[2] has shown that "the activation of irreversible restraint systems significantly before the collision arises remarkable potential for the reduction of the injury risk of the frontal car occupant". The extent of this potential depends strongly on the relevance of the backup, since the setup of the airbag system is a compromise between the two different scenarios on the timeline.Young et al. [3] has predicted that the safety issue for automobile safety will always be an increasing concern. The objective of his study was to report the process of an inflator development, particularly focused on the new design of inflator propellants with the various compositions performed experimentally. Mane et al. [4] has proposed an airbag deployment system based on pre-crash information to overcome airbag malfunctions, caused by the limitations of systems based on crash algorithm. Various sensors like wheel speed sensor, steering angle sensor, acceleration sensor, are utilized, in addition to ultrasonic sensors are used to design the system. Kerry et al. [5] highlighted that the chest and pelvis injury metrics are most affected by the implementation of various airbag and restraint combinations. Specifically, the chest metrics were most affected by the addition of the frontal airbag and the knee bolster airbag most affects the pelvis and femur metrics.Ulas et al. [6] has conducted an experimental investigation on the determination of ballistic properties of a composite propellant for airbag application. The experimental results were obtained using a high-pressure optical strand burner.Tasnim et al. [7] have concluded that air bags must inflate very rapidly to be effective, and therefore come out of the steering wheel hub or instrumental panel with considerable force, generally at a speed over 100 mph. the 3-point automatic seat belt, seat belt tensioner and airbag constitute a carefully matched passenger protection system. Implementation of these safety restraint systems with due care and regulation can further drop the fatality rate and serious injuries at the time of road accidents. Nhtsa [8] conducted evaluations of some of these technologies through participation in the MVSRAC Advanced Air Bag Technology Working Group, and through other cooperative research programs. Test procedures have been developed for assessing overall air bag system performance and aggressivity issues for out-of-position occupants. Crash reconstructions were carried out to better understand and emulated he circumstances that occur in the real world and to enhance test procedure development. Tschopp et al.[9] showed that, the National High-Way Traffic Safety Administrations (NHTSA) report has claimed more than a million vehicle crashes occuring in the United States in the year 2009, which injured half a million people and claimed more than 33,808 lives (NHTSA, 2009). Among the injured or killed, head injury is the most common cause of death during worst-case side impact scenarios, and the head is the most likely injured body region, even among occupants using a three-point restraint system.Azah Mohamed et. al. [10] in their study stated, Improper deployment of airbag has resulted an increase in the mortatility rate, accidental injuries and broken bones due to low crash severity and wrong deployment decisions. Therefore, the authorities and industries have been looking for more innovative and a mordenised product in the upcoming future. Coben L [11] suggested the Airbag induced injuries appear to relate to the proximity of the motorist to the unit when it inflates. Suggestions have been made to improve the seat belt restraint systems, ergonomic consideration of driver's position and the improvisation in the airbag inflation units inorder to minimize deployment injury risk." Yi Yang et al. [12] has suggested that Airbag systems such as frontal and side-impact airbags are developed to reduce occupant injuries during vehicle collisions. Yet, such systems have caused serious injuries to improper positioned occupants especially to smaller females and

children. The primary objective of this study is to examine the different influential factors such as mass flow rate, fabric permeability ratio, fabric maximum inflated depth that contributes to occupant injuries in airbag-related accidents. Tike and Chaudhari [13] have presented their study on information about the introduction of the airbag system of an automobile using its constructional and installation properties.Zeeshan A[14] has studied the unassuming danger of car airbags: injuries secondary to airbag deployment.Dipan et al.[15] has suggested that overall damaged caused by the frontal and rear crash can be minimized by improving performance of seat belts and the airbag restraint system.

CONSTRUCTION AND WORKING OF AIRBAGS:

An airbag is made up of a thin, nylon fabric. It is folded into the steering wheel or dashboard or more recently, the seat. Hence the airbag is needed to be flexible enough to be placed into small volumes and strong enough to withstand the influence of an explosive charge and impact of passengers when inflated. In order to balance these conditions, the fabric must be resistant towards UV light. It should have high elongation, low specific fabric weight, high tenacity for tearing, heat resistance up to 190ºC, low and even air permeability,improved pliability and pack height and an excellent seam integrity[7].

An airbag is composed of a housing assembly, door assembly, cushion assembly and an inflator. This inflator system is an essential component, generating the propellant gas for airbag. When an airbag is activated, it absorbs the collision force of the passenger by inflating the cushion.It minimizes the force exerted by any point of the automobile on occupant's body by increasing the interval of over the force being applied and by scattering the force over a large area of cushion[3].

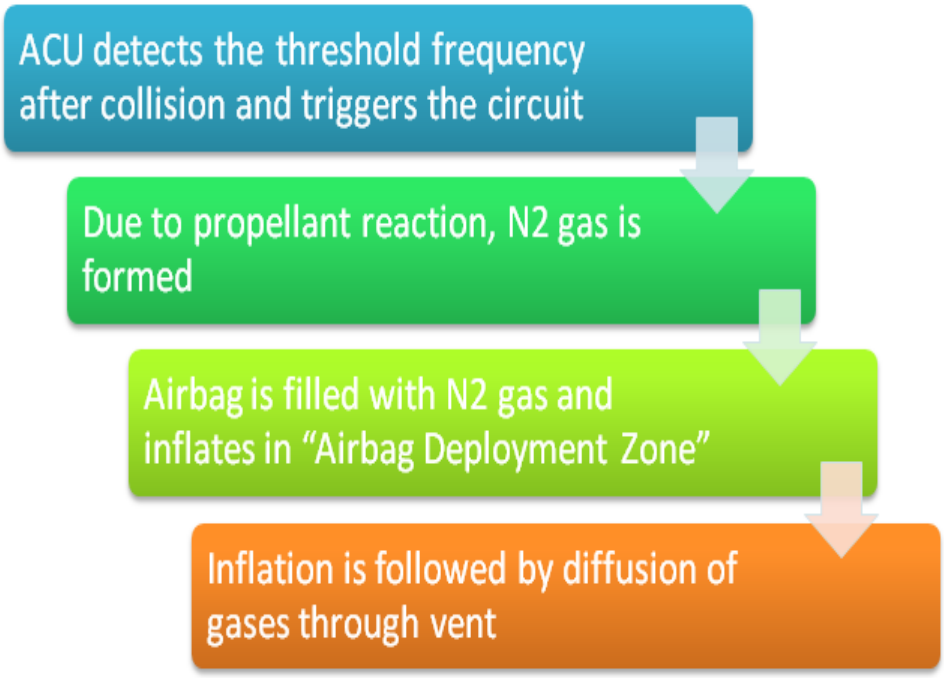
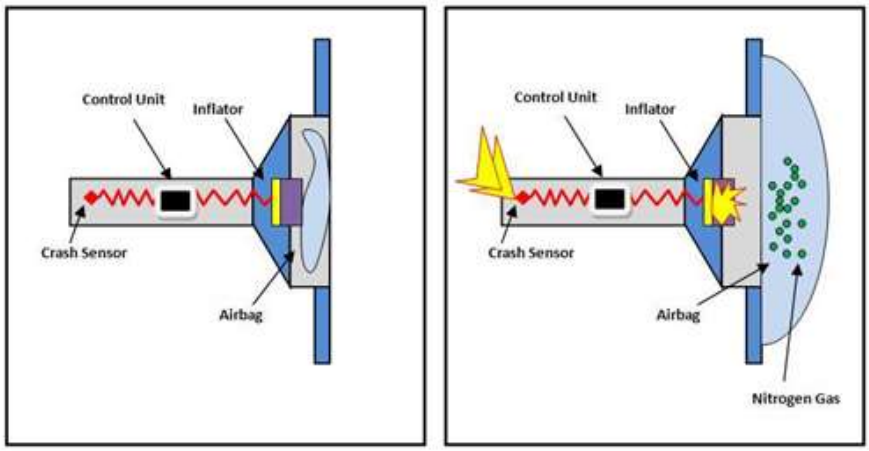


Fig 2. Air bag trigger flow diagram

Once the electrical circuit has been turned on by the sensor, a pellet of sodium azide (NaN_3) is ignited. A rapid reaction occurs, generating nitrogen gas (N_2). This gas fills a Nylon 6,6 bag at a velocity of 150 to 250 miles per hour. This process, from the initial impact of the crash to full inflation of the airbag, takes only about 40 milliseconds. Ideally, the body of the driver (or passenger) should hit the airbag just after inflation. Otherwise, the high internal pressure of the airbag would create a surface as hard as stone.

(1) 2 NaN3 → 2 Na + 3 N2 (g)

(2) 10 Na + 2 KNO3 → K2O + 5 Na2O + N2 (g)
(3) K2O + Na2O + 2 SiO2 → K2O3Si + Na2O3Si (silicate glass)[13]



Before Collision After Collision
Fig 3. Crash sensing and deployment [14]

Steps of Airbag inflation

It consists of an array of sensors, connected to the Airbag Control Unit (ACU). Airbags inflates rapidly after collision.

ACU detects the threshold frequency and triggers a pulsating current. This current starts the chemical reaction that fills the nylon fabric with gas. Sodium azide(NaN_3) and potassium nitrate(KNO_3) react within the inflation system to produce nitrogen gas.

The area undertaken by the airbag inflation system is known as 'airbag deployment zone'. To trigger the airbag the speed needs to be greater than 20mph and in a frontal direction.

Inflation of airbag is immediately followed by its deflation. The gas diffuses through special vents, preventing the occupants from sufferin major injuries.[7]

DEFECTS OCCURRING IN AIRBAG

Since the last decade or so, automotive airbag system has come under denunciation. Crash results have shown that airbags must deploy within 40ms, in order for them, to act as a protective device for the occupants[6]. Within this hardware environment the possibilities in reduction of the injury risk for occupants is more or less exploited. Due to various uncontrollable factors the failure percentage of the airbag system as a has increased substantially. A significant amount of study have spotted the following factors,Propellant issue [14], Injuries caused by Airbags, airbag activation while vehicle is stopped, Airbag activation while driving & No airbag activation despite high accident severity [1], to be the major cause of concern for the airbag defects.

Propellant issue: Propellant causes the formation of inert gas to be filled inside the fabric and hence forms the backbone of this system. Various techniques such as stored gas system and solid-propellant gas generation have been considered, with the latter being the most reliable one. Sodium azide based inflators are are vastly used in airbag system[6]. This chemical reacts withKNO_3 and forms N_2 and inflate the airbag. Burns therefore arise due to chemical, thermal, and or mechanical insult [14].

Injuries caused by airbags: Injuries to drivers have been associated with three primary injury patterns. The first involves multiple rib fractures, with additional associated lacerations of abdominal organs. The second pattern results from contact with the face and chin causing basilar skull fracture and subarachnoid hemorrhages. The third pattern involves cardiac and pulmonary and hemorrhages without any accompanying rib fractures. Airbag inflation causes severe burns to the skin and other upper parts of the body. It can throw off the shrapnel, which may break into the skin quiet easily. Failure of deployment of airbag while driving leads to severe car crash injuries which have

shot up in the last decade or so. Another flaw in the deflation of airbags is the release of dust-like particles, mostly cornstarch and talcum powder used to lubricate the airbag. This chemical causes irritation to eyes and open wounds.

Airbag activation during static state: The driver airbag automatically gets activated without any external application of force, while in a static position. No major damage has been reported except for the contusions on arm and wrist. Such a problem arises due to short circuit leading to the activation of driver airbag.

Airbag activation while driving: Moisture in the control mechanism is the main cause of this problem. According to the car manufacture moisture presence causes an interference voltage which ultimately results the airbags to actuate.

No airbag activation despite high accident severity: The injuries to the driver passenger is hazardous sand fatal. The severity of injuries and the degree of damage make it clear that the proper deployment of airbag could have provided the greatest protection.

CONCLUSION

Airbags have proved to be a life saving invention. They work at their best when coupled with seat belts. Airbag helps to minimize the danger to life during crash, as recorded by the studies. There exist many complications to be solved for further scope, which have been studied during the seminar.The propellant situation needs immediate attention, which has resulted to one of the biggest automobile recalling in the history. Negligence towards quality of the product has led to an unwanted feeling in the occupant's heart because of the explosive nature of the airbags.

Airbag if supplemented with a seat belt provides the proper resistance to the damage occurring in the otherwise simple airbag system. Nowadays with a properly restraint system, it is possible to survive even severe crashes without life-threatening injuries. The main component of this restraint system in modern day cars are a 3 point safety belt with one or more pretensioners, a beltforce-limitation and an airbag with one or more inflator stages.The effectiveness of the seat belt in reducing fatal and severe injuries among rear and front seat passengers estimates between 35-67%.

REFERENCES

[1] KalusLangwieder, Thomas A. Hummel, "The Effect Of Airbags on Injuries and Accident Costs". Paper Number 98-S1-W-27.
[2] GregorGsterin, Wolfgang Sinz, Walter Eberle, JulienRichert, WilfriedBullinger "Improvement of Airbag Through Pre-Triggering". Paper Number 09-0229.
[3] Young-DukSeo, Suk Ho Chung, Jack J. Yoh," Automotive airbag inflator analysis using the measured properties of modern propellants". 13 January 2011.
[4] Mane A.R, Puranik V. G.," Airbag Deployment System Based On Pre-Crash Information". International Journal of Innovative Research in Science, Engineering and Technology, April 2014,Volume 3, Special Issue 4, pp.365-371.
[5] Kerry A. Danelsona, Adam J. Golmana, Andrew R. Kempera, F. Scott Gayzika,H. Clay Gablera, Stefan M. Dumaa, Joel D. Stitzela," Finite element comparison of human and Hybrid III responses in a frontal impact".
[6] A. Ulas, G.A. Risha, K.K. Kuo," Ballistic properties and burning behavior of an ammonium perchlorate/guanidine nitrate/sodium nitrate airbag solid propellant".
[7] Tasnim N. Shaikh, SatyajeetChaudhari and HirenRasania," Air Bag: A Safety Restraint System of an Automobile." Sep-Oct 2013,Vol. 3, Issue 5, pp.615-621.
[8] Lori Summers, WilIiam T. Hallowell,Glen C. Rains," NHTSA'S ADVASYCED AIR BAG TECHNOLOGY RESEARCH PROGRAM". Paper 9865-W-29
[9] Xingqiao Deng, S. Potula, H. Grewal, K.N. Solanki, M.A. Tschopp, M.F. Horstemeyer," Finite element analysis of occupant head injuries: Parametric effects of the side curtain airbag deployment interaction with a dummy head in a side impact crash". World Academy of Science, Engineering and technology International Journal of Mechanical, Aerospace, Industrial, Mechatronic and Manufacturing Engineering, 2013 Vol:7, No:3, pp.153-158.

[10] AiniHussain, Membe, M A Hannan, Azah Mohamed,HilmiSanusi and BurhanuddinYeopMajlis, "Decision Algorithm for Smart Airbag Deployment Safety Issues", World Academy of Science, Engineering and Technology International Journal of Computer, Electrical, Automation, Control and Information Engineering , 2008. Vol:2, No:3, pp.959-965.
[11] Coben, L., "The Risk and Benefits of Airbag Systems: Are They Needlessly Killing and Injuring Motorists?" SAE Technical Paper 970492, 1997.
[12] Yi Yang Tay, RasoulMoradi& Hamid M. Lankarani," A DoE Method in Predicting Injuries to Out-of-Position Occupants from Torso-Only Side-Impact Airbags", Global Journal of Researches in Engineering Automotive Engineering ,Year 2013, Volume 13 ,Issue 2, Version 1.0
[13] Rishikesh H. Tike, Prog. Mukesh C. Chaudhari, "The airbag system for 2-wheeler vehicle system", International Journal Of Research In Aeronautical And Medical Engineering, Year 2014, Volume2, Issue 2.
[14] Zeeshan Ahmad, "The Unassuming Danger Of Car Airbags: Injuries Secondary To Airbag Deployment",March 2011.
[15] Dipan Bose, Carlos Arregui-Dalmases, DaivdSachez-Molina, "increased risk of driver fatality due to unrestrained rear-seat passengers in severe frontal crashes",Nov 2012

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