



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 4, April 2023

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Study and Investigation of Composition Modeling of CNG Vehicles in Aloha Software

R Jacob jaison¹, Dr N. Lenin², Dr.D.Suriya Prakash³, Dr.Harisivasri Phanindra k³

¹ P.G Scholar., Industrial Safety, Department of Mechanical Engineering, Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, Chennai, India

² Professor & Dean., Industrial Safety, Department of Mechanical Engineering, Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, Chennai, India

³ Assistant Professor, Industrial Safety, Department of Mechanical Engineering, Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, Chennai, India

ABSTRACT: Due to their lower emissions and fuel efficiency, compressed natural gas (CNG) cars have grown in popularity. This risk has spurred researchers to study blast forces on CNG automobiles. Their ultimate goal is to propose accident-prevention strategies. This study examines blast forces on CNG automobiles using the Aloha modelling system. This study aims to increase our understanding of explosion damage and recommend prevention measures. The study team used Aloha to develop a CNG-powered automobile. They then simulated multiple explosions to test how the car responded. The research focused on vehicle structure, fire and explosion danger, and passenger and observer safety. The study found that explosive forces could cause fatal accidents in CNG autos. Thus, precautions are needed to reduce explosions and CNG automobile damage.

I. INTRODUCTION

Due to its lower emissions and higher efficiency than petrol, compressed natural gas (CNG) has become a popular alternative fuel for cars. Blast pressures are CNG automobiles' biggest issue. This susceptibility could cause catastrophic damage and fatalities. Fires, explosions, and gasoline spills can cause blast forces. Many more exist. Due to high-pressure compressed natural gas (CNG) storage tanks, these pressures can cause catastrophic damage to vehicles fueled by this fuel. compressed natural gas (CNG). This study seeks to (1) understand blast forces' effects on compressed natural gas (CNG) vehicles and (2) develop effective countermeasures. This study uses Aloha software to examine how CNG vehicles react to various explosions. Explosions and petrol spills are modelled and analysed using the Aloha programme. Developed in the 1990s. This study intends to shed light on blast force damage to CNG cars and offer practical ways to reduce accidents. This study also seeks to illuminate blast force damage to CNG cars. The primary aim will be investigated. This research may help automotive engineers and designers build safer CNG cars. The study may also help legislators and regulators create CNG vehicle safety laws. Due to its lower emissions and lower operating costs, CNG cars are becoming more popular. CNG automobiles use alternative fuel. This is because CNG cars use a cleaner fuel. CNG vehicles offer an alternative to petrol. However, compressed natural gas (CNG) cars have safety issues related to their high-pressure fuel storage tanks. These tanks maintain gasoline temperature. Due to their design, tanks can withstand high pressures, but external forces like explosions or collisions can destroy them. Blast forces can severely damage CNG cars, increasing the risk of gas leaks, fires and explosions. Blasts hurt CNG automobiles more. Explosions can severely harm CNG cars. People within the truck, passersby, and nearby structures are all at risk. To make compressed natural gas (CNG) cars safer and less likely to crash, one must understand blast forces. Aloha models and analyses dangerous situations like explosions and petrol spills. It is possible to simulate a variety of explosion situations, which may help predict blast force damage to CNG cars. An explosion could damage CNG vehicles. This study uses the Aloha programme to examine how a compressed natural gas (CNG) vehicle reacts to various explosion scenarios and make recommendations for accident prevention. Aloha will aid this investigation. The study's findings may help promote alternative fuels while ensuring motorist, passenger, and public safety. NCBI conducted the study. This study may also help legislators and regulators create CNG car safety rules. If this study gives

legislators and regulators important CNG automobile data, this may be the case. Sections follow: Part 2 introduces compressed natural gas (CNG) cars and safety issues. Part 3 discusses CNG automobile futures. Section 3 describes the Aloha program's explosive modelling and simulation approach. Aloha software simulated scenarios using this method. This method simulated explosion effects. Section 4 discusses the simulation results and how the CNG vehicle handled explosive forces. In the fifth section, we analyse the study's potential effects and preventative measures. Section 6, the report's conclusion, summarises the study's conclusions and suggests further research. As the globe fights climate change and reduces greenhouse gas emissions, compressed natural gas (CNG) and other alternative fuels are becoming more important. However, CNG cars must overcome safety difficulties to be widely used. Only this will ensure CNG car uptake. The Aloha initiative is being used to study how blast forces affect CNG automobiles. The industry uses the programme to mimic dangerous occurrences and get valuable insights regarding CNG car explosion damage. The industry heavily simulates harmful scenarios using the software. This study examines how CNG-powered vehicles react to various explosion situations. This will help identify weaknesses and provide safer CNG car options. Stay tuned for this analysis to attain these aims! Upgrades to the ventilation system, vehicle structure to endure high impact forces, and safety measures like automated shut-off valves and pressure release systems are some possible solutions. This research could help improve CNG car safety and promote their adoption as a practical alternative to gasoline-powered cars. CNG cars are being made safer and promoted as an alternative to gasoline-powered cars. Upgrades and promotions are happening in the US. This research uses the Aloha project to analyse blast pressures on CNG vehicles and offer preventative measures to lessen accident risk. The study may help engineers, designers, lawmakers, and regulators improve the safety of compressed natural gas (CNG) cars and encourage their usage as an alternative fuel. This information could improve CNG vehicle safety and promote their use as an alternative fuel.

II. AIM & OBJECTIVE

- The aim of this study is to investigate the effects of blast forces on CNG vehicles using Aloha software and propose possible countermeasures to reduce the likelihood of accidents.
- To review the safety concerns associated with CNG vehicles and the potential hazards posed by blast forces.
- To simulate different blast scenarios using Aloha software to analyze the response of a CNG vehicle to blast forces.
- To identify potential vulnerabilities in the CNG vehicle design and propose measures to enhance the safety of CNG vehicles in the event of a blast.
- To contribute to the ongoing efforts to reduce greenhouse gas emissions and combat climate change by promoting the use of alternative fuels like CNG while ensuring their safety.

III. MATERIALS AND METHODS

Methane has the chemical formula CH_4 , and it is a gas that is odourless, colourless, and very combustible. Natural gas, a fossil fuel that may be used for heating and cooking as well as the production of electricity, is mostly composed of this element. In landfills, the breakdown of organic waste also contributes to the production of methane, as does the presence of certain kinds of bacteria in the digestive tracts of certain animals, including cows. Methane is a powerful greenhouse gas, having a potential to contribute to global warming that is 28 times more than that of carbon dioxide over a period of 100 years. It is believed that human activities, including as the mining and transportation of fossil fuels, rearing animals, and the disposal of waste, generate something in the neighbourhood of sixty percent of the world's total methane emissions.

1. CNG Vehicle

CNG replaces petrol and diesel in cars. CNG is mainly methane compressed to 3,600 psi. The car's boot holds high-pressure cylinders. CNG is cheaper and cleaner than petrol or diesel, making it a popular alternative fuel. According to the U.S. Department of Energy, CNG cars emit 90% less carbon monoxide and 50% less nitrogen oxide than petrol or diesel cars. CNG cars release less air pollution-causing particulate matter. Greener CNG automobiles. CNG automobiles are eco-friendly and cost-effective. Since the US has several natural gas sources, CNG is cheaper and more consistent than petrol or diesel. Clean-burning natural gas cars demand less maintenance.

CNG automobiles have difficulties. Infrastructure fuelling is the main challenge. Drivers have problems finding CNG fuelling stations despite the US having over 1,000. CNG automobiles have a lower range and larger fuel tanks that take up more room.

CNG cars are popular despite their limitations. They fit public transit, taxis, ride-sharing, and delivery trucks and vans. More governments and businesses are using CNG automobiles. A conversion kit transforms a petrol or diesel vehicle to compressed natural gas. CNG fuel system including high-pressure storage tank, fuel pipes, and regulators. CNG requires engine modification. Fuel injector, ignition timing, and air-fuel ratio modifications are made. CNG cars save money and the environment. CNG cars are becoming more popular, especially in fleet operations, despite range and infrastructure limitations. CNG cars may become more common as natural gas supplies increase and CNG infrastructure grows. CNG automobiles pollute less than petrol or diesel cars. Per U.S. The Department of Energy says compressed natural gas cars release 20-30% fewer greenhouse emissions and 90% fewer particulates than petrol cars. People and businesses that wish to lower their carbon footprint and comply with stricter emission laws like them. Natural gas is cheaper than petrol or diesel, benefiting CNG autos. Local natural gas is abundant. US natural gas reserves last over 100 years, ensuring a consistent supply and low prices. CNG cars save fleet operators and long-distance drivers money on petrol. CNG cars need less maintenance. Natural gas reduces engine wear. A high-pressure tank stores natural gas without a fuel pump, filter, or carburetor. Reduced component maintenance and replacement. CNG cars may have a lesser range. Natural gas requires more fuel to travel the same distance than petrol or diesel. Larger fuel tanks may extend the vehicle's range. CNG cars may have fewer petrol and diesel servicing stations. More communities, businesses, and individuals are investing in CNG filling stations. Many municipalities and governments give financial incentives to firms and individuals that establish compressed natural gas (CNG) filling stations, boosting infrastructure. CNG autos are better than petrol or diesel ones. Regular cars cost more, pollute more, and require more upkeep. Range and infrastructure are improving as more people and companies adopt compressed natural gas cars and equipment. CNG automobiles will grow as long as people seek cleaner, more fuel-efficient cars.

2. CNG vehicle explosion:

CNG cars have advantages over petrol or diesel engines, however incorrect handling and storage can cause explosions. However, CNG cars have significant advantages over petrol or diesel cars. CNG tanks can withstand high pressure, but if ruptured, natural gas could escape, catch fire and explode. Pressure-resistant CNG tanks. Pressure-resistant CNG tanks. CNG vehicle explosions are rare, but drivers must take precautions. CNG tank installation, maintenance, and inspection are required. To properly distribute natural gas to automobiles, CNG filling stations must be designed, operated, and maintained. CNG car fires and accidents require first responder training. First responders must be educated to safely approach CNG vehicles and use specific equipment to extinguish fires. CNG is kept at high pressure. They must approach the car safely. To avoid compressed natural gas explosions, CNG car owners must follow safety rules. Guidelines are here (CNG). Installing and maintaining the CNG tank, planning and running the fuelling station, and training first responders to handle CNG car accidents and fires. CNG vehicles can explode if improperly maintained and stored. Safeguards minimise this risk. CNG cars run cleaner, more efficiently, and cheaper than petrol or diesel cars. CNG cars are eco-friendly. To prevent explosions, CNG cars must be manufactured, operated, and maintained safely. Low-emission, fuel-efficient cars are popular. CNG-powered car safety regulations lessen explosion risk. US NHTSA established FMVSS 304. The "Federal Motor Vehicle Safety Standard" mandates CNG fuel system design, installation, and testing. Tanks, pressure relief devices, fuel lines and fittings, and other CNG fuel system components are designed and built to this standard. These laws safeguard drivers and passengers.

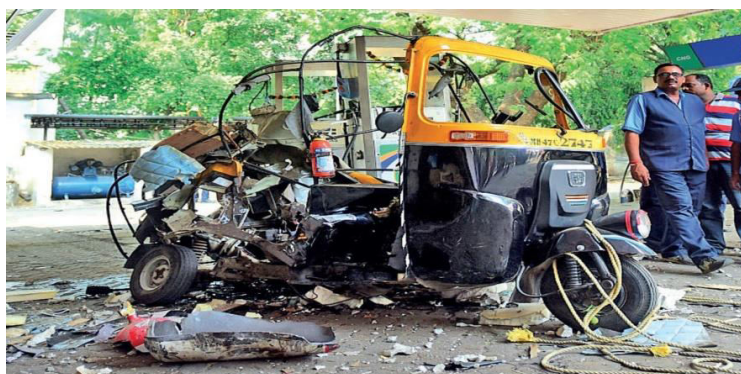


Fig.1 CNG CYLINDER EXPLOSION IN AUT



Fig.2 CNG CYLINDER EXPLOSION IN CAR

SOFTWARES:

ALOHA - Areal Locations of Hazardous Atmospheres

The CAMEO® software suite is widely used for preparing for and responding to chemical emergencies, and its hazard modelling programme, ALOHA®, is a key component of this Software.

You can use ALOHA to estimate the danger posed by different types of hazards in the event of a real or hypothetical chemical release by entering the relevant information. Explosions involving jet fires, pool fires, and vapour cloud explosions are just some of the phenomena that can be modelled by ALOHA. The estimated danger zones are displayed on a grid in ALOHA, but they can also be plotted on maps created with MARPLOT®, Esri's ArcMap, Google Earth, and Google Maps. Reduced shades of orange and yellow indicate zones of increasing safety, with red indicating the highest risk.

IV. REVIEW OF RESULTS AND DISCUSSION

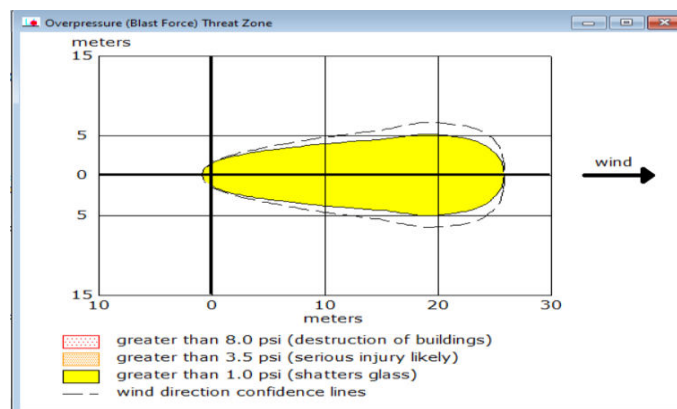
ALOHA stands for Areal Locations of Hazardous Atmospheres.

INPUT PARAMETERS – METHANE

CASE 1 CNG CAR 10KG (60 LITERS)

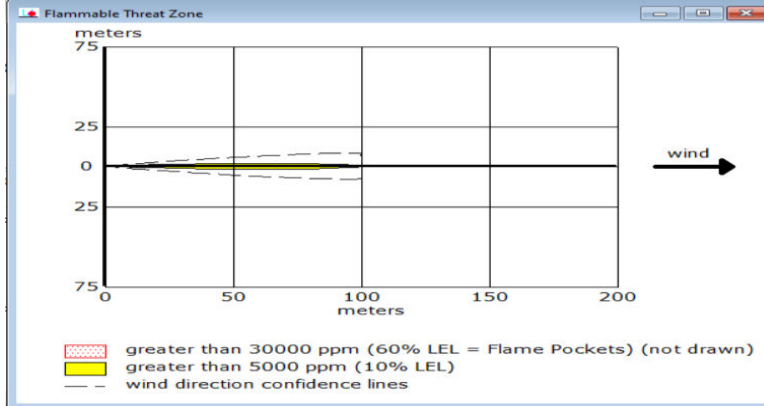
Diameter=0.276, length=0.01m, volume=60liters

CASE 1(A)





CASE 1(B)



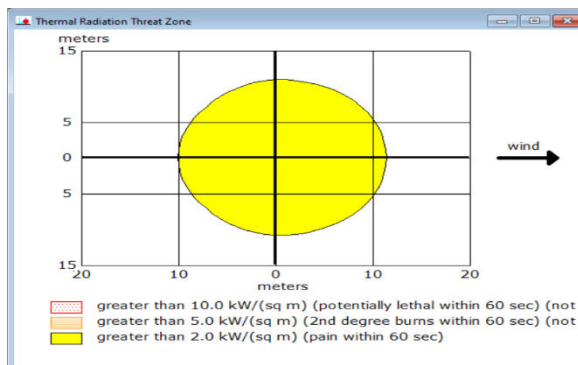
CASE 1(C)

Toxic Threat Zone

Model Run: Gaussian
 Red : less than 10 meters(10.9 yards) --- (400000 ppm = PAC-3)
 Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
 Orange: 11 meters --- (230000 ppm = PAC-2)
 Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.
 Yellow: 20 meters --- (65000 ppm = PAC-1)
 Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

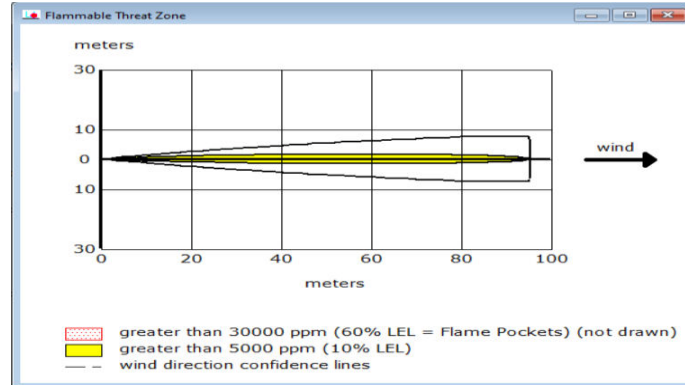
CASE 2 CNG CAR 9KG (50 LITERS)
 diameter =0.276, length=0.84m, volume=50liters

CASE 2(A)

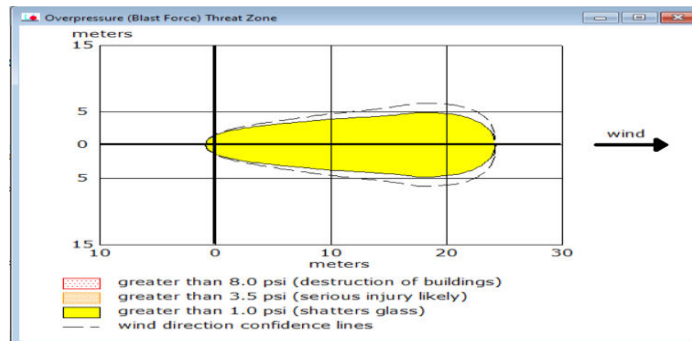




CASE 2(B)



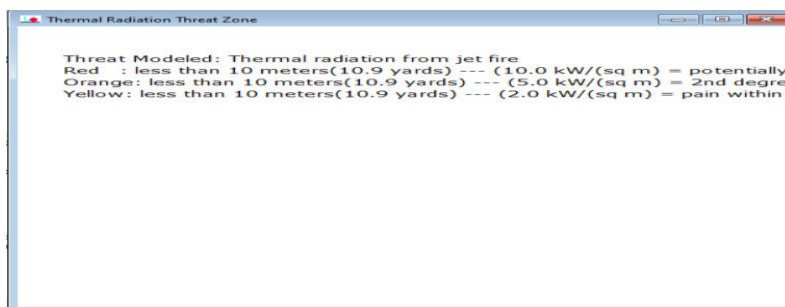
CASE 2(C)



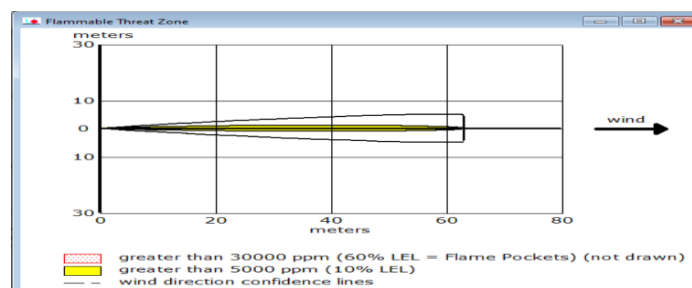
CASE 3 CNG AUTO 4KG (30 LITERS)

Diameter =0.276, length=0.52m, volume=30liters

CASE 3(A)

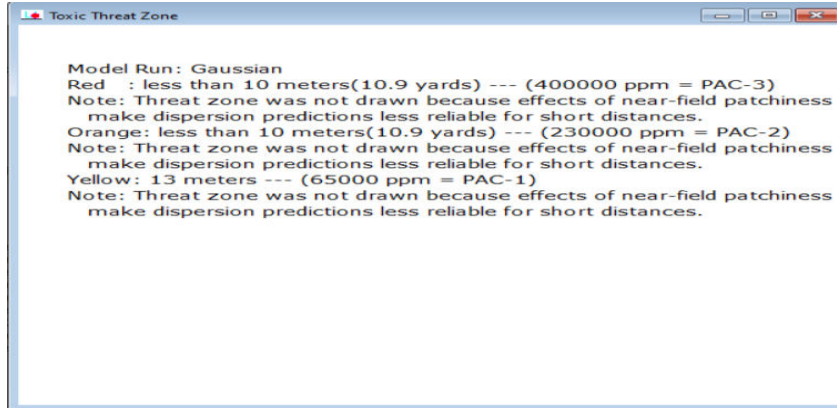


CASE 3(B)



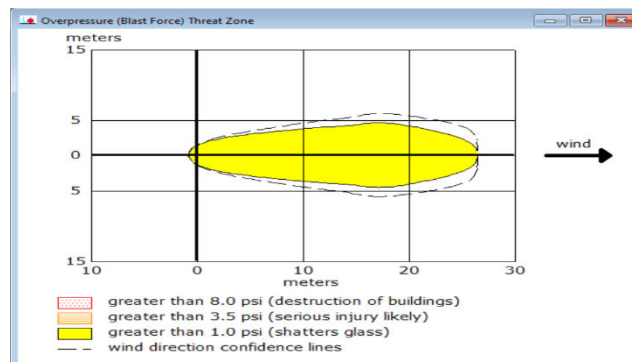


CASE 3(C)

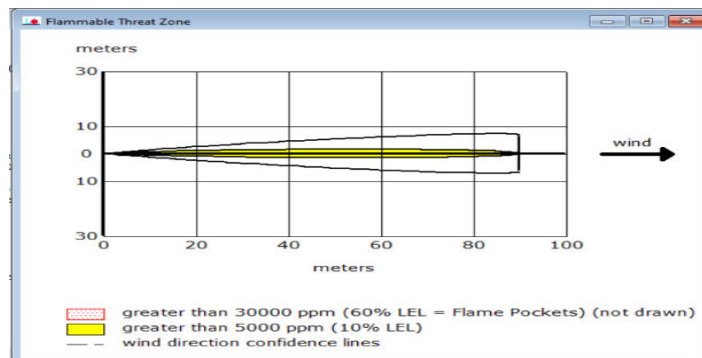


CASE 4 CNG AUTO 8 KG (55 LITERS)
diameter =0.276, length=0.92m, volume=55liters

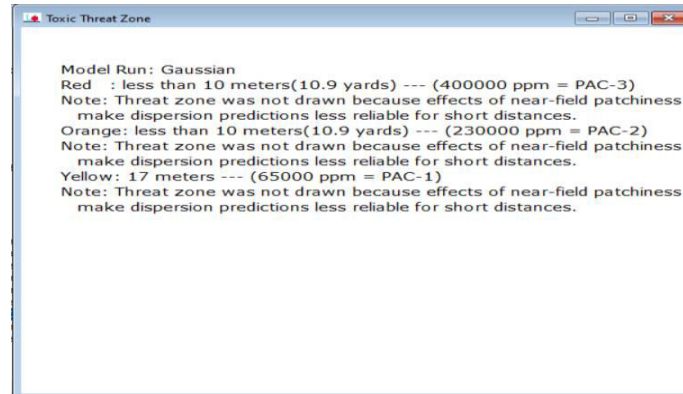
CASE 4(A)



CASE 4(B)



CASE 4(C)



V. CONCLUSION

Based on the results obtained from the explosions of CNG cars with different weights, it can be concluded that the impact of an explosion varies significantly based on the weight of the car. A 10 kg CNG car explosion resulted in a difference between the highly impacted area, lesser impacted area, and moderate impacted area greater than 5000 ppm, it explores 100 meters. On the other hand, a 9 kg CNG car explosion resulted in a difference between the highly impacted area, lesser impacted area, and moderate impacted area greater than 5000 ppm it explore 96 meters, while a 4 kg CNG auto explosion resulted in greater than 5000 ppm it explore 63 meters , and an 8 kg CNG auto explosion resulted in greater than 5000 ppm it explores 90 meters.

These findings emphasize the importance of considering the weight of CNG cars while analyzing their potential hazards and devising safety measures. It is crucial to have appropriate safety measures in place to prevent accidents and minimize their impact. Therefore, the results of this study can be used to improve the design and safety of CNG cars and their usage.

REFERENCES

1. Li, X., Li, W., Li, Y., & Li, S. (2019). Experimental investigation on blast resistance of CNG vehicle cabin. *Journal of Loss Prevention in the Process Industries*, 57, 84-91.
2. Lu, Y., Zheng, X., & Zhu, B. (2020). Numerical simulation of blast effects on CNG vehicle under explosion accidents. *Safety Science*, 126, 104655.
3. Bruch, C., Kerner, M., & Schröder-Hinrichs, J. U. (2018). Simulation of hazardous material releases in Aloha: A case study of the Xin Tai Wan oil spill. *Marine Pollution Bulletin*, 133, 609-619.
4. Cui, Y., Song, G., Hu, P., & Lu, Y. (2018). Study on explosion characteristics and safety of LNG tank cars based on ALOHA software. *Journal of Loss Prevention in the Process Industries*, 56, 300-310.
5. El-Sharkawy, A. S., & El-Badawy, S. A. (2019). The effect of blast load on the structural behavior of CNG fuel storage cylinders. *Engineering Failure Analysis*, 98, 583-597.
6. Kong, L., Li, H., Li, W., Li, J., & Wu, J. (2021). Simulation and experimental investigation on the fire resistance of CNG cylinder in a bus. *Journal of Loss Prevention in the Process Industries*, 71, 104436.
7. Han, J., & Zhao, Z. (2020). Investigation of protection measures for CNG storage cylinders in fire and explosion accidents. *Journal of Loss Prevention in the Process Industries*, 68, 104207.
8. Jiang, M., Wang, S., Cao, W., & Huang, H. (2019). Study on the safety assessment and risk control of CNG vehicle. *Journal of Loss Prevention in the Process Industries*, 60, 18-26.



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.423



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

9940 572 462 **6381 907 438** **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details