International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 04 | Apr-2018 www.irjet.net p-ISSN: 2395-0072

Design, Fabrication and Testing On Fire Suppression System

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Abstract- *During recent times we have read articles of cars are getting fired up due to heat or any other reason. Similarly after accident many a times there are chances that a car may set of to hazardous and death or injury causing fire explosions. Thus we may understand, now days, one of the serious problems of automobiles is engine fire. There is no such mechanism as if now to avoid such problem. Therefore in this study, an automatic extinguishing system structure is proposed for car fires in commercial automobiles. Especially, the applicability of the automatic extinguishing system was investigated through evaluation of the system in a simulated lab environment.*

***Key Words*: Fire Compartment1, Dry CO22, T valve3, fire detection4, fire protection5, etc**

1. INTRODUCTION

As the role of the engineer has evolved, many have become responsible for the engineering of safety of a car they design. It is also their responsibility to be knowledgeable about the applicable fire protection system types, design methods, relevant adopted codes, insurance regulatory requirements, and general installation methods. The two main purposes for fire protection systems within vehicle environments are life safety and property protection. Equal consideration must be given to attempt to contain a fire while a car sets on fire and thus till all passengers are evacuated the fire must not lead to any explosions. Absolute safety from fire is not attainable, but means must be provided to minimize the potential for fire and the damage done by fire. The systems and methods used today are constantly changing and improving to meet the requirements of project variations and challenges.[1]

1.1 Traditional Fire Suppression System

Automatic sprinkler systems are the most common type of fixed fire protection system and are a long established technology with acknowledged reliability. However, they should not be used for certain risks including live electrical equipment, fires of flammable liquids and any risk that would react violently with water. For shielded fires, in computer cabinets or in switch gear housing, water cannot penetrate in the same way as gaseous agents and sprinklers would not provide the necessary fire protection.

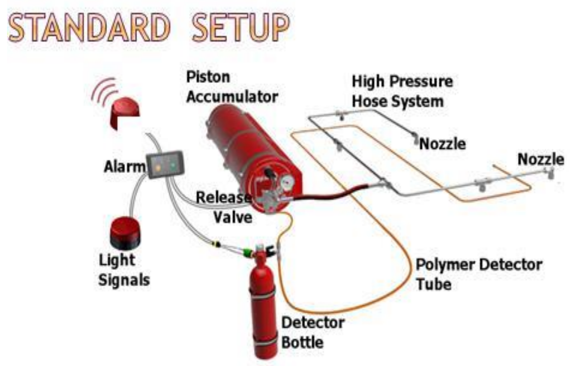
Carbon dioxide is stored at high pressure, and high concentrations are required for effective extinguishment. As a result, such systems involve bulky and heavy hardware and are not suitable for use where space and weight are important considerations. The use of low and medium expansion foam systems is most suited to liquid pool fires. The foam forms a barrier between the fire and the supply of oxygen and also cools the fuel. Foam systems are not generally effective against running or spray fires. Some liquid fuels, such as alcohols, can destroy a foam blanket by chemical reaction and care must be taken to ensure that an appropriate foam compound is chosen. Since foams are aqueous solutions, they should not be used to protect any risk that would react violently with water.

1.2 Proposed Fire Suppression System

To satisfy the need of finding suitable fire suppression systems to replace halon, several fire suppression systems have been developed recently or gained renewed interest. Most attention was focused on inert and halocarbon gaseous agents, water mist systems, compressed-air-foam systems, and solid gas and aerosol generators.

In this system, we are using compressed CO2 to suppress fire by extinguishing process. The whole process is being conducted with relay control unit and solenoid valve to control stroke of the pneumatic cylinder. Also in addition with that one smoke sensor used to detect fire with adequate range of performance. This system is being used in Canada as well as in other countries like USA and South Korea. Blaze cut means to reduce or completely shut off the fire flame by using suitable extinguisher gas. It is used in mall, multiplexes, residential buildings, commercial safety purposes etc.

The simple and practical concept is described here with practical example as shown in following figure. It's a great achievement to have such efficient system. Only performance varies with gas being used. Besides of that general system is same for all cases.



1.2.1 Fire Suppression System

2. Methodology

2.1 Survey of Project:

After studying literature we choose this topic in order to explore knowledge concerned to fire safety. While we were searching for project topic, we got that automotive fire safety is a new problem now a days. Therefore we read various papers and council report of this system which is being developed in Canada.

2.2. Find the problem:

The problem is that sudden fire in automobile compartment due to fuel leakage and high temperature of exhaust. In order to overcome this problem we adapted fire suppression system.

2.3. Find the solution for problem:

According to stated problem, there should be simple system which will fulfill our requirement. Various steps in problem solving are as follows:

a) Literature study

b) CAD modeling

c) Parameters and specifications Calculations (analytical)

d) Fabrication of the model

e) Experiments carried on the system

2.4. Actual Implementation of Work:

After problem solving, there is actual implementation of system for further testing and results. It consist implementation of the concept into practical model for further testing and results. This stage is the result of the analytical work to be done for system installation.

2.5. Assembly and Testing:

After implementation next step is to assemble components in a systematic way and develop system for testing.

3. Analytical Work

3.1 Design Calculations of the System

While creating any system the design calculation phase is most important part to get final result and to increase system capacity as well. According to standard table the force energy required to operate extinguisher with CO2 gas is,

Fire Extinguisher Operating Calculations:
FROM THE STANDARD IS 15683: 2006 (Clause9.10)
Force energy required to operate extinguisher.

Type Of Operation (1)	Maximum Force N (2)	Energy J (3)
With one finger	100	-
With full hand	200	-
With impact(strike knob)	-	2

Table 3.1 Amount of force required to operate extinguisher

Pneumatic cylinder is used to develop required amount of force to open extinguisher pin. Standard procedure to design the pneumatic cylinder for force requirement is to select any one cylinder from standard catalogue and check its output force. When the output force is greater than the required force, then the design is safe.

Specifications of the Pneumatic cylinder:

Cylinder bore diameter: 25 mm
Stroke length: 100 mm
Cylinder rod diameter: 10 mm
Operating pressure: 0 – 10 bar
Taking operating pressure: 5 bar
Force developed by cylinder: pressure * area
F = 5*100000*3.1416*0.025*0.025*0.25= 245.44 N
So the force is sufficient to operate fire extinguisher.

Design of the system:

Frame dimensions original dimensions= W*L*H= (1040*810*770) mm.

For the purpose of effective area we will calculate a smaller area i.e.
W*L*H = (1000*800*750) mm or (1*0.80*0.750) m.

Determination of the Hazard Volume:

The first step is to calculate the total volume of the hazard being protected.

The volume is determined by multiplying: length x width x height.

Volume = (1 m x 0.80 m x 0.750 m) = 0.6 m3
Amount of CO2 required to occupy hazard volume is calculated flooding factor.

Flooding factor gives exact amount of quantity of CO2 gas per unit volume.

Both the minimum Carbon Dioxide concentration and flooding factor are based on the specific hazard being protected. For this example, a miscellaneous dry electrical hazard requires:

- Minimum Carbon Dioxide concentration = 50%.
- Flooding factor = 1.33 kg CO2/m3

Calculate the minimum amount of co2 required.
0.6 m3 x 1.33= 0.798 kg, CO2

Determination of Discharge Duration And Flow Rate

Deep-Seated hazard systems are discharged at a slower flow rate and for a longer duration to counter-act the characteristics of a smoldering fire. For Deep-Seated fires, the design concentration shall be achieved within 7 minutes, but at a flow rate that will provide a concentration of 30% within (2) minutes.

Quantity of co2 for 30% concentration
0.6 m3 kg x 0.688 (30% concentration) = 0.4128 kg/ 2 min.
Minimum flow rate requirements
0.4128 kg. ÷ 2 minutes = 0.2064 kg/min. (flow rate) in Reference: NFPA 12, Section 2-5.2.3
The total system discharge must be completed in 7 minutes.

4. Modeling of the System

4.1 Modeling by Using CAD Software:

It consists of CAD modeling of the system and its component in proper arrangement. The following fig shows different views. It is the previous phase of actual fabrication in order to minimize error and increase feasibility. CAD modeling involves creation of models by defining geometrical parameters. These models typically appear on a computer monitor as a three-dimensional representation of a part or a system of parts, which can be readily altered by changing relevant parameters. CAD systems enable designers to view objects under a wide variety of representations and to test these objects by simulating real-world conditions.

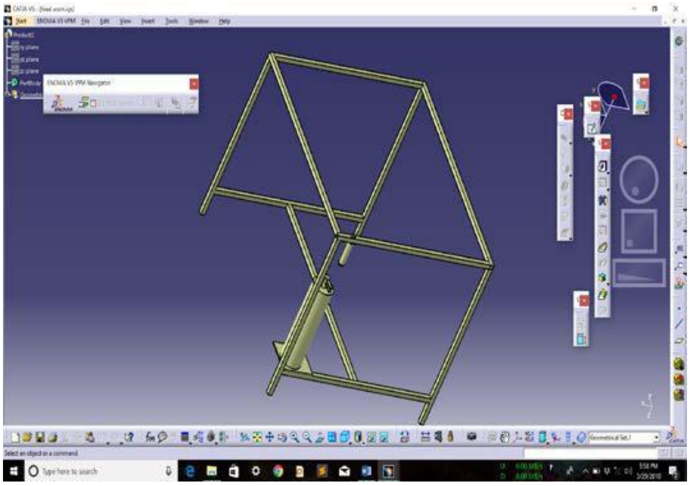


Fig 4.1 Cad File

5. Fabrication of the System

Metal fabrication is the building of metal structures by cutting, bending, and assembling processes. It is a value added process that involves the creation of machines, parts, and structures from various raw materials. A fabrication shop will bid on a job, usually based on the engineering drawings, and if awarded the contract will build the product.

Large fabrication shops employ a multitude of value added processes in one plant or facility including welding, cutting, forming and machining. These large fab shops offer additional value to their customers by limiting the need for purchasing personnel to locate multiple vendors for different services. Metal fabrication jobs usually start with shop drawings including precise measurements, then move to the fabrication stage and finally to the installation of the final project.

After successful modeling of the system, there is actual fabrication of the system to evaluate performance of the installed system. With design data and referring modeling, we fabricated present system with some standard manufacturing processes. In which basic processes are cutting, welding, grinding.

5.2 Result and Discussion:

After fabrication and assembly we carried out testing on the system. The results are recorded as follows

Testing No.	Actual CO_2 Used (kg)	Time Consumed (sec)	Remark
1.	0.82	14	Successful
2.	0.85	17	Successful
3.	0.83	16	Successful

Table 5.1: Testing Result

After successful fabrication of system we further took testing's to obtain results. As stated above purpose of the system, we got required results. By taking various allowances like atmospheric conditions while taking first testing, we fired flame for 15 seconds and at the result it got suppressed in 16 seconds, while taking testing there was flame with constant intensity. Similarly we performed one more testing to check whether performance is valid or not, but there was not much variations in results. Also the time for controlled execution of the program throughout all the testing was same.

6. CONCLUSIONS

In this paper, a system that automatically extinguishes fires in commercial automobiles was proposed. And we have successfully developed automatic fire suppression system.

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