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Design and Development of gun type fire extinguisher

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Abstract—Fire is the type of hazard which is very dangerous that cause severe damage to the property or leads to fatal. In order to control the fire different fire protection system are namely as fire extinguisher, sprinkler system, fire hydrant system etc. Out of these fire extinguisher is one type of system which is used as extinguishing media to extinguish the fire at incipient stage and also very effective. However, there is lots of difficulty found in handling of fire extinguisher in case of large fire due to high radiation and holding the extinguisher for long period of time. Therefore this paper aims to describe the design and development of a fire extinguisher with fire gun. In this type, fire ball can be used as media which will cover the long and safe distance as compare to the conventional cylinder type extinguisher.

Keywords—Fire,extinguisher,

I. INTRODUCTION

Fire can be described in many ways - here are a few:"A rapid oxidation process, which is a chemical reaction resulting in the evolution of light heat and radiation in varying intensities.Fire also can be defined as "A fire is an exothermic chemical reaction that emits heat and light"Fire can also be explained in terms of the Fire Tetrahedron - a geometric representation of what is required for fire to exist, namely, fuel, an oxidizing agent, heat, and an uninhibited chemical reaction.Fire is totally depending upon the three factors heat fuel and oxygen combinely known to be as fire triangle.Fire will not occur if any one of these is not present or taking away any of them at the time of fire.There is another term with addition of chemical chain reaction know to be as fire tetrahedron.

Fig1.1 Fire Triangle

Fire tetrahedron:-

In more recent years, a fourth component – the uninhibited chain reaction – has been added to explain fire. This chain reaction is the feedback of heat to the fuel to produce the gaseous fuel used in the flame. In other words, the chain reaction provides the heat necessary to maintain the fire. The addition of this fourth component (which forms what is called the "fire tetrahedron ") more accurately describes the mechanism for fire suppression by clean agent halon replacements which break up the uninhibited chain reaction of combustion.

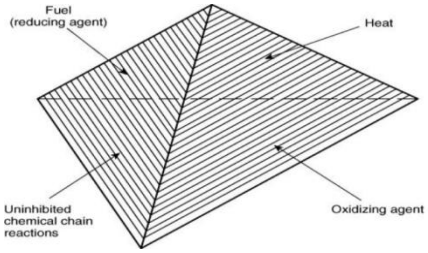


Fig1.2 fire tetrahedron

Classes of fire:-This classification of fire is based on the National Fire Protection Association(NFPA)

Class A:

Ordinary combustible: It consist of a wood, paper, fabric, plastic and most trash

Class B:

Flammable liquid and flammable gas:-Such as Gasoline, Diesel, L.P.G, Methane, Propane etc.

Class C:

Electrical fire:-Electrical fire includes the fire in Transformer, home appliances, cable gallery etc.

Class D:

Metal fire:-Fire consist of metal fire such as magnesium.

Class K:

Kitchen fire:-This class consist of cooking fire such as high temperature fats and oil.

Stages of fire

Incipient: This first stage begins when heat, oxygen and a fuel source combine and have a chemical reaction resulting in fire. This is also known as "ignition" and is usually represented by a very small fire which often (and hopefully) goes out on its own, before the following stages are reached. Recognizing a fire in this stage provides your best chance at suppression or escape.

Growth: With the initial flame as a heat source, additional fuel ignites. Convection and radiation ignite more surfaces. The size of the fire increases. Hot gases collecting at the ceiling transfer heat, allowing all fuels in a room to come closer to their ignition temperature at the same time.The *growth stage* is where the structures fire load and oxygen are used as fuel for the fire. There are numerous factors affecting the growth stage including where the fire started, what combustibles are near it, ceiling height and the potential for "thermal layering". It is during this shortest of the 4 stages when a deadly "flash over" can occur; potentially trapping, injuring or killing firefighters.

Fully developed: Fire has spread over much if not all the available fuel; temperatures reach their peak, resulting in heat damage. Oxygen is consumed rapidly.When the growth stage has reached its max and all combustible materials have been ignited, a fire is considered *fully developed*. This is the hottest phase of a fire and the most dangerous for anybody trapped within.

Decay (Burnout): Usually the longest stage of a fire, the *decay stage* is characterized a significant decrease in oxygen or fuel, putting an end to the fire. Two common dangers during this stage are first – the existence of non-flaming combustibles, which can potentially start a new fire if not fully extinguished. Second, there is the danger of a back draft when oxygen is reintroduced to a volatile, confined space. The fire consumes available fuel, temperatures decrease, fire gets less intense.

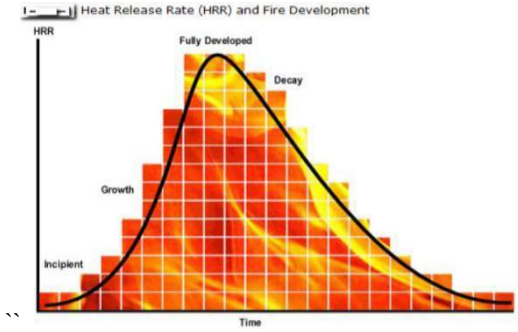


Fig 1.3Graphical representation of stages of fire

Hazard:-A hazard is a situation that poses a level of threat to life, health, property, or environment. Hazards can be dormant or potential, with only a theoretical risk of harm; however, once a hazard becomes "active", it can create an emergency. A hazardous situation that has come to pass is called an incident. Hazard and possibility interact together to create risk.Some common fire hazards are:-

(1)Kitchen fires from unattended cooking, such as frying, broiling, and simmering.(2)Electrical systems that are overloaded, resulting in hot wiring or connections, or failed components.(3)Combustible storage areas with insufficient protection.(4)Combustibles near equipment that generates heat, flame, or sparks.(5)Candles and other open flames.(6)Smoking (Cigarettes, cigars, pipes, lighters, etc.).(7)Equipment that generates heat and utilizes combustible materials.(8)Flammable liquids and aerosols.(9)Flammable solvents (and rags soaked with solvent) placed in enclosed trash cans.(10)Fireplace chimneys not properly or regularly cleaned.(11)Cooking appliances - stoves, ovens.(12)Heating appliances - fireplaces, wood burning stoves, furnaces, boilers, portable heaters.(13)Household appliances - clothes dryers, curling irons, hair dryers, refrigerators, freezers.(14)Chimneys that concentrate creosote.(15)Electrical wiring in poor condition.(16)Leaking Batteries.(17)Personal ignition sources - matches, lighters(18)Electronic and electrical equipment(19)Exterior cooking equipment.

Moving out from the hazard and their severity there is need of proper method and principles to defeat the fire with proper manner.

Principles of Fire Extinguishing:

Starvation: Starvation is achieved by removal of the fuel burning in the fire. Sometimes combustible can be removed by shutting of gas valve or flue flow.Starvation is the process of depriving the fire of fuel, i.e. combustible materials. Cooling is the process of depriving the fire of heat, e.g. by applying a substance such as water that will absorb heat from the fire and thereby reduce the fire's temperature below the critical level needed to sustain the fire.

Smothering:By excluding the oxygen in the surrounding atmosphere, the fire will be extinguished.Smothering can be achieved by using sand, blanketing, foam application or by the use of chemical extinguishers.

Stop chain Reaction: stopping or interrupting the chain reaction between the fuel heat and oxygen will extinguish the fire.By removing out the source or provide shield a which will not burn or move up to that part of the source to continue the chain reaction is the way to stop the chain reaction.

(B)Methods of fire protection:-

(I)Passive fire protection:-

Passive fire protection is applied at the time of design and before the construction of the building. Passive fire protection is an integral component of the three components of structural fire protection and fire safety in a building. Passive Fire Protection attempts to contain fires or slow the spread, through use of fire-resistant walls, floors, and doors.

Passive Fire Protection in a building can be described as a group of systems within systems. An installed fire stop, for instance, is a system that is based upon a product certification listing. It forms part of a fire-resistance rated wall or floor, and this wall or floor forms part of a fire compartment which forms an integral part of the overall fire safety plan of the building. The building itself, as a whole, can also be seen as a system.

(II)Active fire protection:-

Active Fire Protection is a group of systems that require some amount of action or motion in order to work efficiently in the event of a fire. Actions may be manually operated, like a fire extinguisher or automatic, like a sprinkler. Active Fire Protection includes

fire/smoke alarm systems, sprinkler systems, and fire extinguishers. Fire/smoke alarm systems are used to detect whether there is fire and/or smoke in a building. Sprinkler systems are used to help slow the growth of the fire. Fire extinguishers are used to extinguish the fire at incipient stage.Some system which are included in the Active Fire Protection they are:-

I. Fire Sprinkler system
II. Fire Hydrant system
III. Fire Extinguisher

(I)Fire sprinkler system:-A fire sprinkler system is an active fire protection method, consisting of a water supply system, providing adequate pressure and flow rate to a water distribution piping system, onto which fire sprinklers are connected.Over 96% of fires were controlled by fire sprinklers alone.Each closed-head sprinkler is held closed by either a heat-sensitive glass bulb or a two-part metal link held together with fusible alloy. The glass bulb or link applies pressure to a pipe cap which acts as a plug which prevents water from flowing until the ambient temperature around the sprinkler reaches the design activation temperature of the individual sprinkler head. A sprinkler activation will do less water damage than a fire department hose stream, which provide approximately 900 liters/min (250 US gallons/min).types of sprinkler system are:-

(a)Dry pipe system(b)Wet pipe system (c)Deluge system (d)Pre-action system (e)Foam water sprinkler(f)Water spray.

Fig 1.4 sprinkler

(II)Fire Hydrant:-A fire hydrant is an active fire protection measure, which provides a source of water from the municipal water system or other source.Building located near fire hydrant may qualify for special insurance rate reduction on the basis of the proximity of the hydrant.Fire hydrant are color coded to indicate their specific water flow rate.

Fig 1.5 Hydrant

(III)Fire Extinguisher:-A fire extinguisher is an active fire protection device to extinguish or control the small fire in emergency situation. It is not intended for use on an out-of-control fire, such as one which has reached the ceiling, endangers the user (i.e., no escape route, smoke, explosion hazard, etc.), or otherwise requires the expertise of a fire department.Fire extinguisher is a portable device that discharges a foam, gas, jet of water, and other material to extinguish the fire. A fire extinguisher is an active fire protection device used to extinguish or control small fires, often emergency situations. A fire extinguisher consists of a hand held cylindrical pressure vessel containing an agent which can be discharged to extinguish fire.There are two main types of fire extinguishers: stored-pressure and cartridge-operated.In which they are classified in to different types,they are:-

(a)water type (b)co2 type extinguisher (c)foam type (d)dry chemical powder type

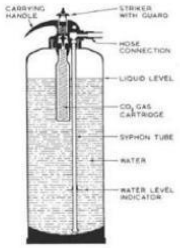


Fig 1.6 Fire extinguisher

Parts of a fire extinguisher:(1)Handle and operating lever (2)Locking pin Pressure gauge (3)Discharge nozzle(4)Siphon tube(5)Safety pin(6)Discharging tube(7)Co_2 cartridge

Drawbacks of fire extinguisher are:-

(1) It's hard to hold because of its heavy weight.(2) The powder residue can cause damage to sensitive electronic equipment such as circuit boards, computers.(3)Not applicable for the fire which is in growth and developed stages.(4) It causes irritation on contact with skin;(5)It causes irritation and discomfort on contact with eyes.(6)It causes breathing discomfort on inhalation.(7) Person who is operating extinguisher discomfort by heat and radiation(8) Requires skills in using the fire extinguishing.(9) If not operating properly it can cause harm to operator.(10) Periodic maintenance required.

Therefore, to move out from this many problem of fire extinguisher and to provide advance and better system of extinguishing fire this paper discuss on the design and development of fire extinguisher with gun type.

Fire extinguishing gun:-Fire extinguishing gun is advance and better which is covering having enough strength throw out the fire ball with high velocity and requires enough speed to travel the distance as more as possible.It should have the capability to cover at least 120 meter.For this portable extinguishing equipment fire ball is used as a extinguishing media which is easily available in market in which dry chemical powder with two reactant are used as media for extinguishing inside the fire ball.

Fire ball:- When fire ball comes in contact with fire, it will activate within 3-10 seconds and effectively disperse-extinguishing chemicals.Fire Extinguishing Ball will self-activate when it comes into contact with fire and give a loud noise. No inspection and maintenance are required for the fire ball up to 5 years.extinguish the fire of class A,B,C.

Fig 2.2

2.METHODLOGY

Construction and working

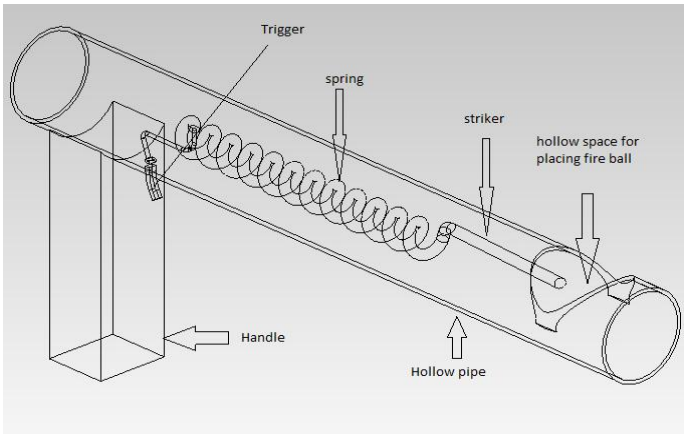


Fig 2.1 fire extinguishing gun

The outer structure of the Fire extinguisher gun is made up of poly vinyl chloride(PVC) material which is 3mm thick and 20 cm long hollow pipe is used,The material for handle of the gun is also made up of PVC which is 15cm long.the spring and striker used in the fire gun are used according to their strength to hit the ball.The mass of the fire ball is 3gm.Force required to hit the ball from fire gun is found through this equation

F=m*a (1)

Where,

F=force

m=mass of the fire ball

a=acceleration

Considering a fire ball is fired from the fire extinguishing gun it travels the 50 m long distance and it deflects from its path 3cm.For calculating the velocity below equation is used:-

$V_{xi}=X_f/t$ (2)

V_{xi} = Velocity of the Fire Ball

X_f = Final Distance the Ball reach

t = Time of Travelling

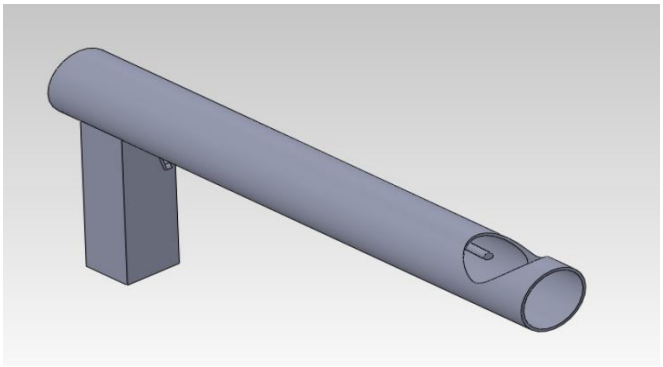
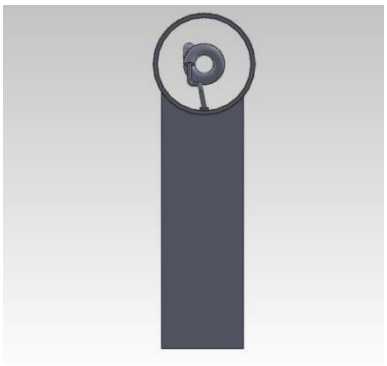


Fig 2.3 3d view of fire extinguishing gun



Fir 2.4 3d view of fire extinguishing gun

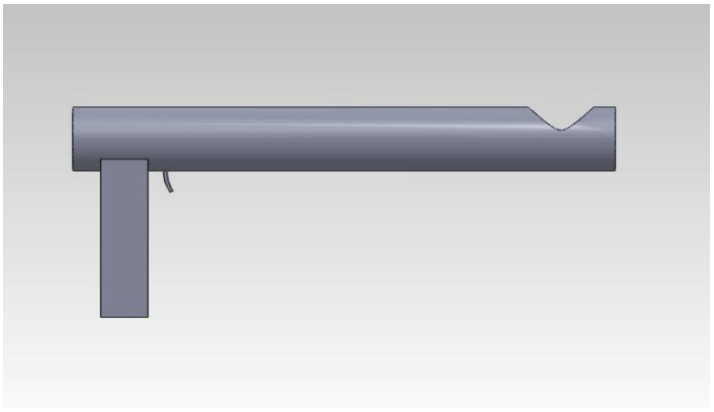
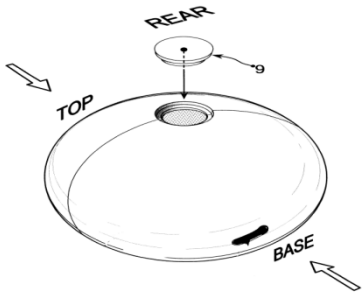


Fig 2.5 3d view of fire extinguishing gun

Fire ball is made up of rigid plastic foam or other suitably frangible material, with an abrasion-resistant, thin plastic, protective, exterior sheathing for outer structure.Explosive yield detonator is located at or near the center of mass, and is actuated by fuse cord extending from the detonator. Including dry powders, two-part reactants, liquid components or others, singly or in combination.



Fire ball

The working of a fire extinguishing gun is simple in which the fire ball is to be placed in fire extinguishing gun the ball is triggered through fire extinguishing gun it will reach to the source and extinguish the fire.As it already mentioned that it is suitable for all classes of fire,after reaching to the source of fire with in 3-10 sec the fire ball is activating while it reaches to the source and with the sound up to 140db it extinguish the fire with the media dry chemical powder present in it.

3.Conclusion

It aims to establish technology innovation not only to achieve a responsible but also useful outcome.This fire extinguishing gun successfully performs the task of a firefighter to extinguish the fire,which is suitable for Fire department Factory, High explosion area, Chemical industrial Petrol station, Small business stores or restaurants,confined space. This design and development of gun is for protect fireman from risk ,provide facility to fire station to extinguish the fire with advance technology. The simple design of it allows minimum of maintenance work. There is no risk of hazard due to fire extinguishing gun,no leakage problem,no handling problem,no effect of heat and radiation at the time of extinguishing. Advanced technologies are replacing the older versions which is keep enhancing the system efficiency.

References

[1] Safety Professional's Reference and study Guide,W.DAVID YATES
[2] NATIONAL FIRE PROTECTION ASSOCIATION
[3] IS-2190-2010, Selection,Installation and maintenance of first aid fire extinguisher.
[4] Fire Protection Handbook