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# ANALYSIS THE DESIGN OF FIRE SPRINKLER SYSTEM USED IN INDUSTRIES

**PON.PAVITHRA SHREE[1], T. PERUMAL[2]**
**1 PG SCHOLAR, 2 ASSISTANCE PROFESSOR**
**INDUSTRIAL SAFETY ENGINEERING**
**K.S.R. COLLEGE OF ENGINEERING (AUTONOMOUS), TAMILNADU, INDIA**

## ABSTRACT

A fire sprinkler framework is a dynamic fire assurance technique, comprising of a water supply framework, giving sufficient weight and stream rate to a water circulation-channeling framework, onto which fire sprinklers are associated. Also it is utilized as a part of processing plants and substantial business structures, frameworks for homes and little structures are presently accessible at a practical cost. Fire sprinkler frameworks are broadly utilized around the world, with more than 40 million sprinkler heads fitted every year. Sprinklers might be required to be introduced by construction standards, or might be prescribed by insurance agencies to decrease potential property losses or business intrusion. Construction standards in the United States for spots of gathering, by and large more than 100 people, and places with overnight dozing convenience, for example, hotels, nursing homes, residences, and hospitals ordinarily require sprinklers under nearby building regulations, as a state of accepting State and Federal financing. In this Project, the aim is to develop a simple Fire Sprinkler, where the sprinkler can betested. The test of the sprinkler is to be by connecting the pipes and the reservoir that contains the water and how the breaking of the chemical tube is happening as if there is a real fire occurring in a building. Further studies will include the calculations of the radius and the area that one sprinkler can handle during a fire case and how many one we have to install in a building to cover the fire as a given flow rate and pressure.

**Keywords:** Fire sprinkler, mechanism & safety prospective

## 1. INTRODUCTION

This project is intended to design and manufacture a simple Fire Sprinklers, where the fire sprinkler can be inserted and tested. The test fire sprinkler is to be fitted with pipes and connections along with the tube bulb that could be exchangeable for many number of testing in which we can show it many times and change the bulb every time we test. The project is very important to the industries, as through understanding the characteristics of different types of the fire sprinklers so that we could be able to use every one in their specific location and task. This is also very important from the safety prospective as this will lead to a safe social environment to cover many areas such as operation plants, schools, hospitals gas stations and more. The project will show more details about the specifications and dimension and radius of covering the area of the intended to put the fire off of it. Also to show the students how the fire sprinklers working mechanism occurs and how does it really work. Also to demonstrate the different kinds of the distribution flow of the nozzle that could give more efficient and effective result as they could be varied with the environment and the nature of the place or building. For example, school would have different type of fire sprinklers than the chemical industry and so the flow rate and the medium used to put the fire such as Foam, Water and weather it will be wet or dry.

## 2. OBJECTIVES

Design and construct a Fire Sprinklers to show flow rate and pressure distributing for fire detected in school or hospital or chemical industry using specific type of sprinkles

Study the change in different types of the Fire Sprinklers and how they can be more efficient for their designated area and field.

Relate different type and medium used in different weather and conditions depending on the environment and needs.

Developing fire sprinklers distribution techniques to prevent huge uncontrolled fire to be put off without the need to make firefighters possess more danger and lessen their exposure to fire as much as possible.

## 3.LITERATURE REVIEW

### 3.1 STUDY OF FIRE SPRINKLER SYSTEM

Sprinkler frameworks are expected to either control the fire or to stifle the fire. Control mode sprinklers are expected to control the warmth discharge rate of the fire to counteract building structure crumple, and pre-wet the encompassing combustibles to avoid fire spread. The fire isn't smothered until the point that the consuming combustibles are depleted or manual extinguishment is affected by firefighters. Concealment mode sprinklers (in the past known as Early Suppression Fast Response (ESFR) sprinklers) are planned to bring about a serious sudden decrease of the warmth discharge rate of the fire, took after rapidly by entire extinguishment, preceding manual intercession. Most sprinkler frameworks introduced today are composed utilizing a territory and thickness approach. In the first place the building use and building substance are breaking down to decide the level of flame danger. Typically, structures are named light peril, conventional risk gather 1, common danger amass 2, additional risk bunch 1, or additional danger aggregate 2. In the wake of deciding the danger order, a plan territory and thickness can be controlled by referencing tables in the National Fire Protection Association (NFPA) models. The outline territory is a hypothetical zone of the building speaking to the most pessimistic scenario region where a fire could consume.The plan thickness is an estimation of how much water per square foot of floor territory oughtto be connected to the outline region. For instance, in an office building delegated light risk, a run of the mill outline zone would be 1,500 square feet (140 m2) and the plan thickness would be 0.1 US gallons for each moment (0.38 l/min) per 1 square foot (0.093 m2) or at least 150 US gallons for each moment (570 l/min) connected over the 1,500-square-foot (140 m2) outline zone. Another illustration would be an assembling office named conventional danger gather 2 where a regular outline zone would be 1,500 square feet (140 m2) and the plan thickness would be 0.2

US gallons for every moment (0.76 l/min) per 1 square foot (0.093 m2) or at least 300 US gallons for each moment (1,100 l/min) connected over the 1,500- square-foot (140 m2) outline zone. After the plan zone and thickness have been resolved, computations are performed to demonstrate that the framework can convey the required measure of water over the required outline territory. This figuring's represent the greater part of the weight that is lost or picked up between the water supply source and the sprinklers that would work in the plan region. This incorporates weight misfortunes because of grinding inside the funneling and misfortunes or increases due to elevation contrasts between the source and the releasing sprinklers. Once in a while force weight from water speed inside the channeling is likewise computed. Ordinarily these counts are performed utilizing PC programming yet before the coming of PC frameworks these occasionally entangled computations were performed by hand. This expertise of ascertaining sprinkler frameworks by hand is as yet required preparing for a sprinkler framework outline technologist who looks for senior level accreditation from building confirmation associations, for example, the National Institute for Certification in Engineering Technologies (NICET). Sprinkler frameworks in private structures are winding up more typical as the cost of such frameworks turns out to be more down to earth and the advantages turn out to be more self-evident. Private sprinkler frameworks more often than not fall under a private arrangement isolate from the business orders said above. A business sprinkler framework is intended to shield the structure and the inhabitants from a fire. Most private sprinkler frameworks are principally intended to smother a fire in such an approach to take into consideration the sheltered escape of the building tenants. While these frameworks willregularly additionally shield the structure from significant fire harm, this is an auxiliary thought. In private structures sprinklers are frequently excluded from wardrobes, washrooms, galleries, carports and upper rooms on the grounds that a fire in these zones would not more often than not affect the tenant's escape course in the event that water harm or water volume is of specific concern, a procedure called Water Mist Fire Suppression might be an option.

This innovation has been a work in progress for more than 50 years. It hasn't entered general utilize, however is increasing some acknowledgment on ships and in a couple of private applications. Fog concealment frameworks work by utilizing the warmth of the fire to 'streak' the water fog cloud to steam. This at that point covers the fire. Thusly, f o g frameworks have a tendency to be profoundly powerful where there is probably going to be a free-consuming hot fire. Where there is lacking warmth (as in a profound situated fire, for example, will be found in put away paper) no steam will be created and the fog framework won't douse the fire. A few tests have demonstrated that the volume of water expected to smother a fire with such a framework introduced can be significantly not exactly with a traditional sprinkler framework

### 3.2 Design Constraints and Methodology

The constraints of each manufactured part are listed in table 3.1. The manufactured parts will contain the following parameters, which are; size, geometry, weight, cost, and the effect of the environment on the design.

**Table 1 Contains the constraints and details of each manufactured part**

| Item | Size | Geometry | Environment | Weight | Cost |
|---|---|---|---|---|---|
| Room Pipe | We have chosen the size of the room that can handle two sprinklers as to replicate an actual room size, 4x4 , in a smaller scale.<br>The Dimensions are: 1m x 1m x 2m. | Cubed<br>Rectangular:<br>*Easy to manufacture. | It is applicable to be designed to be regular room with a room temperature 25 degree Celsius . | - NA | -NA |
| Sprinkler head | The size of the sprinkler head is determined bythe application that is used for. The Fire sprinkler head must have the ability to cover the area od the room desired to be equipped with it in which it covers 130-200<br>The Dimensions are: Square feet per head.<br>Diameter; 34mm length; 74.6mm | Deflector :<br>*Has the ability to distribute the water in circular pattern | The material ofthe Fire sprinkler head should not be corrosion resistant to increase the life duration and usually it is painted by chrome. | The weight of the fire sprinkler head is around 60gs. | The material must be corrosion resistant and easily installed.The Price: |
| Glass Bulb | The size of the glass bulb must be very small to ensure breaking easily and make sure it blocks the water as it resist the pressure applied upon it.<br>The length dimensions are:<br>24 mm. | Chemical inside the bulb:<br>*Chemical thermally expanding and enables significant improvement in response time | *Can be handled very easy and not hazardous for the body or environment. | The Weight is: | The glass bulb costs: |
| Elbow | ½ inch size | Circular shape | Easy to control And easy to connect other steal part together | 500 gram | 4 SR EACH |
| Seal | The size of the seal in diameter The dimensions are:Diameter: 27 mm | Cone Shape | The material ofthe Seal rubber can be recycled and safe for the environment. | - | The cost of the Seal is usually 5 SR. |

### 3.3 **Constraints**

The Fire sprinkler can be used in places all around the world as along as it can be installed in the roof. The constraints that can affect the overall design of the fire sprinkler are as follows:

I. Environments

II. Economical

III. Manufacturability

IV. Safety

V. Sustainability

VI. Geometrical constraints

VII. Engineering standards

The design constraints above will be taken into consideration in more details. The final design of the Fire Sprinkler will have to take in consideration of the effect that any changes in dimensions will

have as a result. The project will apply the engineering standards for future manufacturing to allocate the parts used in the Fire Sprinkler.

### 3.4 Design Methodology

Before starting to build our project and manufacture the parts we focused on someimportant points. The following are our important points that we focused on:

Economical.

Easy to manufacture.

Practical.

Applicable.

These points are important for us to build and manufacture our project in practical way. After we took these points into consideration we start build and manufacture the project's parts.

### 3.5 Product Subsystems and selection of Components

**Sprinkler head distribution**

Is an active fire sprinkler protection method, consisting of water supply system, providing adequate pressure and flow rate to a water piping system, and the sprinkler should be a long life material and service high humidity and not corroded easily and has a long life even if it didn't work or functioned for years

**Glass bulb**

It is the glass color that indicates at what temperature the sprinkler will work and function and every color indicates a specific temperature.

**Seal**

Is the rubber part that holds and connect the glass bulb and control the discharge of fluid water from the pipes and it works as soon as the glass bulb breaks due to detected temperature?

### 3.6 Manufacturing and assembly (Implementation)

**Sprinkler system (assembly)**

Consisting of metal sprinkler head, seal, glass bulb and gives us a fire sprinkler system. This will carry the main load as it delivers and distribute the flow equally through the rounded pieces that looks like flower petals. the screwing mechanism is to connect it to the pipes and have the mean of portable and be easy to change because they are going under quarterly of annual checking if they get rusted or corroded or damaged. They have to be decently cheap and handy so they provide many chances of the environment to make it safer and good to live in under the extreme heat circumstances like in GCC countries.

**Glass Bulb**

This glass bulb indicates at which temperature the sprinkler will activate at a detected heat temperature [11]. This heat is varying from one color to another in which each one has a different responding temperatures that cracks on.

**Seal**

This seal holds the water pressure by holding the glass bulb and as soon as the glass bulb reacts and breaks due to heat it will release the water to the sprinkler head.

## 4. SYSTEM TESTING AND ANALAYSIS

### 4.1 Experimental Setup, Sensors and data acquisition system

1- Connect the pipe to tank.
2- Connect the pipe from the tank to the pump.
3- Connect the elbow to the pipe to T joint.
4- Install the fire sprinkler on the pipe.
5- Apply heat to the fire sprinklers.
6- Record the results

**Image of the setup and the locations of the sensors:**

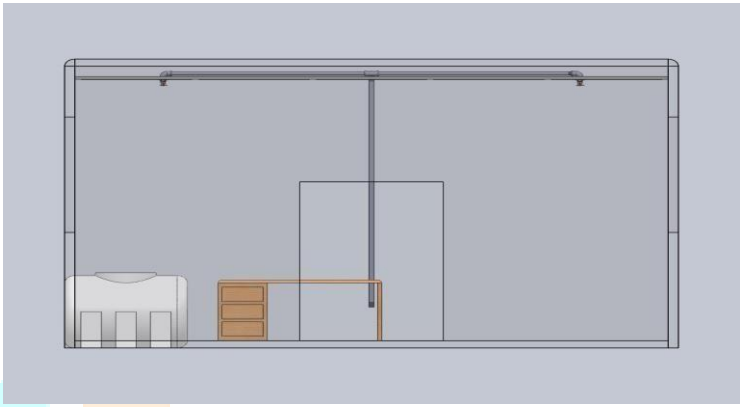

**Figure 2**

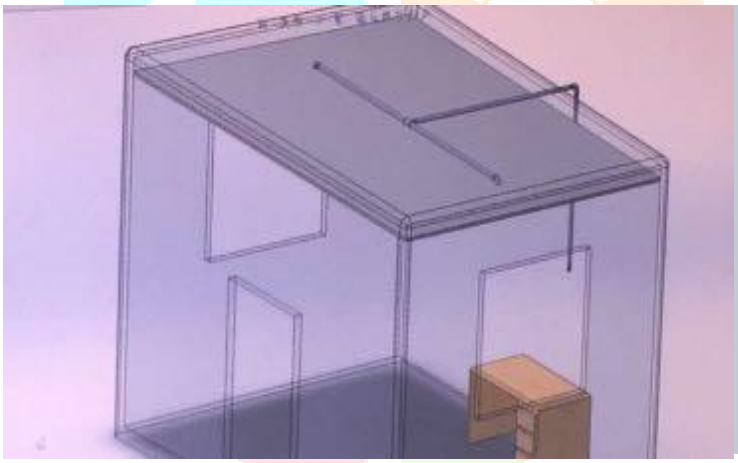

**Figure 3**

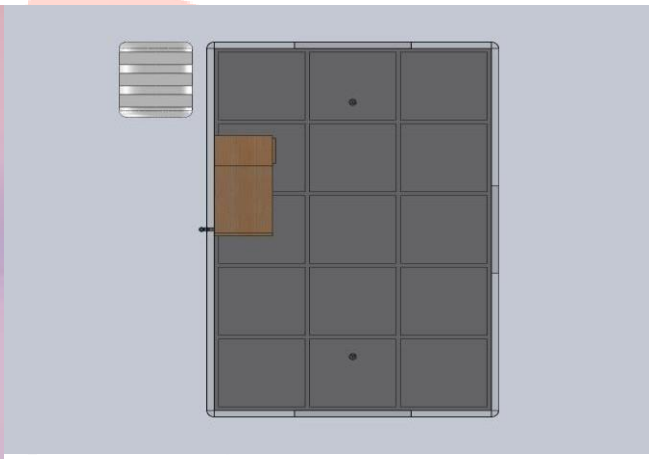

**Figure 4**

**Specification of the sensor:**

Width: 5mm
Length: 10mm
Height: 24mm
Thickness: 10mm
Break temperature at 68

### 4.2 Testing parameters

A procedure used to determine the status of a system as intended by conducting periodic physical checks such as water flow tests, and fire pump tests. These tests follow up on the original acceptance test at intervals specified in the appropriate chapter of NFPA 25.

## 5 Results, Analysis and Discussion

The goal of this experiment is to show the when sprinkler will break based on temperature on each type. Upon the experiment that we have done on the fire sprinkler on Wet Pipe System, [16] the temperature breaks on 69□. As the red bulb standard will break at the temperature of 68 degrees Celsius we have only one degree as the difference between the standard and the experimental in which could be considered as human error. The most important factor that have been found theoretically is the velocity in

which it has been foundto be 23.5 m/s and the experimental measurement we found using the pressure gauge is 23.1 m/s. the velocity we found experimentally has some minor losses in which they are represented in the 90 degree elbows and the Tee Joints that have the KL= 0.9 and KL=1.05 respectively. Constructing the project without the help of pump was our first plant to check whether the system will run properly or not. Obviously, it has found to be running poor without the pump; so in order to compensate the minor /major losses through the pipes we should add the pump to get the expected results in which the fire sprinklers will work accordingly and operate within the acceptable limit and afford the sufficient flow and velocity to extinguish the fire. In most cases, there will be a desperate need to the pump because there is the fire sprinkler will not work and have the completed radius of fire water in order to put the fire off. If we stay on the same elevation in which we lifted the tank 3 meters the flow will not be distributed in full radius of 8 meters square, so the pump is essential to get the proper flow and pressure to put the fire off. In another words, the fire should have very reliable pressure and flowrate to protect the souls and prevent the loss. So the pump compensated the loss in the friction and elevation constrains in which if we want to get the same pressure without the pump we must elevate the tank almost 3 times its original place which is almost not practical and not safe to be practiced for college demonstration and illustration. The easy and suitable way to bring the demo to school and share with others and find and observe the different variations in parameters is to bring the pump and start to calculate and measure and have the standard met.

Also as we were doing the survey in PMU, we have found some misconstruction of the fire sprinkler system in some of the mechanical engineering classes where the sprinklers are covered by plastic protection. This plastic protection is what they used to protect the glass of the fire sprinkler to break during the shipping and transportation, but they did not remove the plastic cover while installing thinking that it is part of the fire sprinkler. This may lead to a tremendous loss and disaster in which the sprinkler will not work as the plastic cover is on it and the heat will not touch the glass to break up and release the water. So that is one of the most important standard in which it should be known and be familiar with. Along with the possibility of the fire to happen in which the department is full of the laboratory materials andheat experiments and many coils that are used for test and to be experimented. So as to make this clear we have continued our journey to survey for more of misconstruction of the fire sprinklers and we found only 4 rooms in the ground floor of PMU's engineering classes.

## 6.CONCLUSION

Safety is always a main concern where the lives of people who are using the fire sprinkler have to take into consideration. The main one is the corrosion of the piece in which it will reduce its efficiency and it might not work at all. The other thing is that to when there is some maintenance in the building, which the fire sprinkler system could be shut off, and then forgetting to out the system back online which might lead to disastrous results. So to solve that, there were a standard developed to recover this and reduce the time of the interruption of the system brought by NFPA. Also if the system is inappropriate for the hazardous in which the wrong type is installed in the wrong place for example if we are a very cold area we shall go for a Dry System not to make the water inside the pipe be frozen and leading to failure of the fire sprinkler system. Another thing to mention is that the fire sprinkler is not intended to be used many times; means that one fire sprinkler can handle only one fire a time. So we have o make sure that the fire sprinklers are changed and replaced if fire had happened to ensure the functionality of the system. And after testing the Fire Sprinkler we have achieved the following:

Successfully designed and construct a Fire Sprinklers to show flow rate and pressure distributing for fire detected in school or hospital or chemical industry using specific type of sprinkles

We studied the change in different types of the Fire Sprinklers and how they can be more efficient for their designated area and field.

We chose the right type and medium used in specific weather and conditions.

Developing fire sprinklers distribution techniques to prevent huge uncontrolled fire to be put off without the need to make firefighters possess more danger and lessen their exposure to fire as much as possible.

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