Ergonomic Design Of Mechanical Foam Fire Extinguisher

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ABSTRACT:

Fire extinguishers are predominantly found almost in all places since it has been made a mandatory provision. Fire extinguisher is an active fire protection device used to extinguish or control small fires, during emergency situations. It is not intended for use on an out-of-control fire, such as one which has reached the ceiling, endangers the user, or otherwise requires the expertise of a fire brigade. Typically, a fire extinguisher consists of a hand-held cylindrical pressure vessel containing an extinguishing agent which can be discharged to extinguish a fire. They can be of two types, stored-pressure type and cartridge operated type. Aqueous Film Forming Foam (AFFF) Fire Extinguishers are suitable to fight burning liquid fires such as burning petrol, diesel and other flammable liquid hydrocarbons. Foam fire extinguishers can be used on Class A and B fires. They are most suited to extinguish liquid fires such as petrol or diesel and are more versatile than water jet extinguishers because they can also be used on solids such as wood and paper as well. In this work a foam generating fire extinguisher is designed and fabricated. Features and components are added for easy operation and maintenance such as refilling and draining. The high pressure air obtained from the outlet of an air compressor helps to produce foam. The wheels and the lever rod attached with the cylinder makes the cylinder easily movable.

IndexTerms –Ergonomic, Foam, Fire extinguisher

1. INTRODUCTION:

Mechanical foam extinguishers work on the basis of cartridges to produce foam. When cartridge seal is broken fire extinguisher delivers foam at the outlet nozzle. Cartridge type foam extinguishers are single use type and it cannot be reused again. Hence Cartridge type extinguishers are expensive as they have to be replaced after their usage. Mechanical (cartridge) type foam extinguishers are available only for usage during prescribed time period (expiry dates). Thus by implementation of the proposed type of fire-fighting foam generator the need for replacement of cartridge type foam extinguishers can be reduced. The foam generator can be used several number of times and its maintenance cost is relatively less when compared with the conventional cartridge type mechanical foam extinguisher. The foam

generator is designed referring articles [1-4] of design of foam generator The diagram of the fabricated foam generator is shown in figure 1.

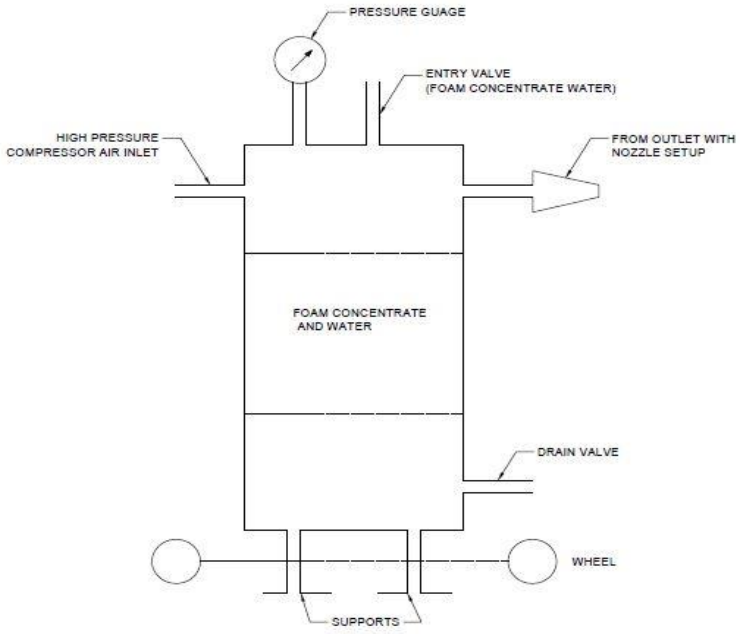

Figure 1. Schematic layout of Mechanical Foam Extinguisher

The fabricated fire extinguisher consists of the following components.

- Cylinder
- Pressure Gauge
- Entry valve for foam concentrate and water
- Inlet valve for compressor air
- Foam outlet hose and nozzle
- Drain valve
- Wheels and supports

2. Description of the mechanical fire extinguisher:

The fire extinguisher consists of a cylinder, pressure gauge, an entry valve for foam concentrate and water, inlet valve for compressor air, foam outlet hose and nozzle setup, drain valve along with a pair of wheels and two supports. The valves are fit to the cylinder by means of welding. The cylinder plays major role in the foam generator setup. The cylinder is made of mild Steel which can withstand the high pressure

air coming from the compressor. It does the work of holding the foam concentrate, water and on exposure to compressed air, foam is produced.

Pressure gauge is provided on the top of the cylinder to make note of the pressure developed inside the cylinder due to the application of high pressure compressed air. The pressure inside the cylinder will increase with the incoming compressed air. Thus the pressure gauge helps to identify the pressure at which the foam is developed inside the cylinder due to entry of compressed air inside the cylinder.

A valve is provided at the top of the cylinder for the purpose of allowing the entry of water and the Foam concentrate into the cylinder. The valve can be manually operated so that it can be opened and closed. The provision for entry of high pressure compressed air into the cylinder is provided by means of a valve. With the help of this valve the compressed air can be fed into the cylinder at the required pressure. It can be manually opened and closed. In the cylinder foam is developed due to the impact of high pressure compressed air in the foam solution already present in the cylinder. The foam can be delivered with the help of hose and nozzle setup provided. The hose and the nozzle setup can be moved in the desired direction to direct the foam at the fire. Nozzle helps to increase the rate of flow of foam from the outlet valve. The outlet valve provided at the hose and nozzle setup can be manually operated to regulate the flow of foam from the cylinder to the hose. The drain valve is provided at the bottom of the cylinder to drain out the water and the foam concentrate mixture present inside the cylinder. This valve is designed for the purpose of cleaning the tank and refilling the cylinder with a fresh mixture of water and foam concentrate. Thus drain valve can be operated with the help of a handle provided in the outlet pipe to open and drain out the foam solution present inside the cylinder. A pair of wheels is provided to the setup to enable the movement of the cylinder from one place to another. Two supports are provided at the bottom of the tank to help maintain the vertical position of the tank. A lever rod is also provided to manually pull the tank to the desired place. These additional features help to move the setup to the desired place with less effort and easy handling. Figure 2.1 shows the views of fabricated fire extinguisher.

Figure 2.1 Views of Fabricated Fire Extinguisher.

3.Foam chemical and componenets of fire extinguisher.

Foam concentrate is the essential component in the foam generator setup. It is referred to as Aqueous Film Forming Foam (AFFF). AFFF is a specially formulated, synthetic, aqueous film forming foam concentrate. A vapor suppressing aqueous film is formed by the foam solution draining from the expanded foam blanket. The commercial name of the AFFF foam used in this work is FIRECHEM shown in figure 3.1.

Figure 3.1 FireChem Foam Concentrate

- Low-expansion foams such as AFFF, have an expansion rate less than 20 times and have very low-viscosity, mobile, and can quickly cover large areas.
- A fire fighting foam is simply a stable mass of small air-filled bubbles, which have a lower density than oil, gasoline or water. Foam is made up of three ingredients - water, foam concentrate and air. When mixed in the correct proportions, these three ingredients form a homogeneous foam blanket.

- This synthetic foam has a low viscosity and spreads rapidly across the surface of most hydrocarbon fuels. A water film forms beneath the foam, which cools the liquid fuel, stopping the formation of flammable vapors. AFFF works by creating a film that stays on top of the flammable liquid to suppress vapors and a foam substance that helps cooling, insulates and separates other ignition sources or hostile fire from reigniting the vapors.
- The proportions in which the foam concentrate and water must be mixed is that for every 9 litres of water 250 ml of foam concentrate must be added to get the desired quality of foam at the outlet.
- The cylinder used in this work is made of mild Steel and its capacity is 18 litres. The cylinder plays an important role of receiving and storage of foam concentrate and water. The above mixture is retained by the cylinder and the compressed air is fed into the cylinder. The cylinder is designed in such a manner that it can bear the high pressure air inlet through the compressor. Hand operated valves for the compressor air inlet, foam concentrate and water inlet, foam outlet hose, nozzle, and drain valve are all welded to the cylinder. The cylinder has a valve at the top for the purpose of feeding foam concentrate and water mixture. The drain valve is provided at the base of the tank to drain or release the mixture of foam concentrate and water. This valve can be manually operated thereby allowing the desired opening and closing of the drain valve.
- Pressure gauge is mounted on the top of the cylinder to note the pressure developed inside the cylinder due to the supply of high pressure compressed air. The pressure at which the foam is delivered can be noted. The pressure inside the cylinder would be ideally 30bar to 50bar during the foam delivery.

The foam generated inside the cylinder due to the action of compressed air on the mixture of foam concentrate and water must be delivered in an efficient manner for the proper working of the fire fighting foam generator. The outlet valve is connected to the hose and the nozzle setup to ensure the effective delivery of the fire fighting foam. The nozzle is connected to the hose. Hose tube is made of treated fibre which is fit to the outlet valve of the cylinder. The wheels and supports are provided to the fire fighting foam generator for easy handling since the cylinder capacity is around 18 litres. The wheels and supports enable to maintain the vertical and upright position of the foam generator. In addition to that the wheels enable the foam generator to move to the desired place by simply dragging it with the help of lever rod.

4.Tests conducted:

Tests were conducted to check the working of the fire extinguisher. A small fire was made using Diesel fuel on the ground and it was put off successfully using the extinguisher.

5. CONCLUSION

The proposed design and fabrication of fire extinguisher can be used to extinguish class A and class B fires in emergency situations. The main advantage of this extinguisher is its mobility and the ergonomic design to handle with less effort. The design also incorporates easy refilling of foam concentrate and thus it can be used where it is frequently used such as during fire demonstration or fire training.

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REFERENCES

[1] Brian Harding, Bin Zhang, Yi Liu, Hao Chen, M.Sam Mannan, Improved research- scale foam generator design and performance characterization, Journal of loss prevention in process industries, volume 39, Januray 2016, pages 173-180.

[2] E.K.Spiridonova, D.F. Khabarova, Foam Fixer Hydrodynamics and Design Calculation, Procedia Engineering, volume 150, 2016, pages 204-209.

[3] A.Bourgeois, J.Bergendahl, A.Rangwala, Biodegradability of fluorinated fire-fighting foams in water, Chemosphere, Volume 131,July 2015, pages 104-109.

[4] Shuaijun dong , Deming Wang, Xinxiao Lu, Experimental investigation of the fire-fighting characteristics of aqueous foam in underground goaf, Process safety and environmental protection, volume 106. Feb 2017, pages 239-245.