

A Study on a Suitability of Sound Fire Extinguisher in Duct Environment

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Abstract

Fire is necessary for mankind, but it damages people by fire. Depending on the cause of the fire and the material, an appropriate fire extinguishing system should be used. As human civilization develops and societies become more complicated, the response to the fire must also change. It is inappropriate to apply general fire extinguishing facilities in a duct environment connecting elevator, communication line and electric line and connecting the interstices. Sound fire extinguishers can be used as fire extinguishing systems in special spaces such as ducts. In this paper, we compare the sound fire extinguishers with fire extinguishers in a duct environment with obstacles such as elevator or electric wire. As a result of the experiment, it was confirmed that the fire extinguisher of the fire extinguisher was well transmitted to the fireworks even in the structure in which the obstacle was complicated. Also, when the sound extinguisher was turned on, the long lighter did not catch fire. The sound fire extinguisher has fire extinguishing effect and fire extinguishing effect in a duct environment filled with obstacles.

Keywords: Fire, Duct environment, Sound Fire Extinguisher, Fire Extinguishing effect, Flame retardant effect

INTRODUCTION

It is a fact that everyone knows that fire has a great influence on all living spaces in modern society. This kind of fire is necessary for mankind, but it damages people by fire. There are tens of thousands of fires every year in our country, and thousands of people are killed and hundreds of billions of won are damaged every year. Although fire is a necessary necessity for mankind, it can come as a disastrous threat to mankind. There are various causes of fire and materials that cause fire are also various. Fire extinguishing equipment is usually used for water spraying, foam fire extinguishing,

powder fire extinguishing, carbon dioxide extinguishing, and halogen compound extinguishing ^{[1][2][3][4][5][10][12][17]}.

However, as human civilization develops and societies become complicated, the response to the fire must also change. As all the buildings become bigger, elevators are installed in the buildings, and communication lines and electric wires are complicatedly installed to accommodate the information communication network in the building. In a duct environment connecting the elevator and the floor and accommodating the communication line and the electric line, it is very inappropriate to apply general fire-fighting equipment. These places can lose their original function due to existing fire extinguishing materials, and there is a great risk of economic loss. The duct environment in which the elevator, communication line and electric wire are housed acts as a path for the fire to spread all over the building due to its structural characteristics when a fire occurs in the building. Especially, the covering of the communication line and the electric wire which are in the pipe ducts and the like is not easily turned off when a fire is formed with a petroleum compound material, and generates poisonous gas which is very poisonous ^{[11][12][13][14][15][16][17]}. However, there is no proper fire extinguishing facility to protect the facilities accommodated in the duct environment. In the Institute of Sound Engineering, sound fire extinguishers that suppress fire by using sound have been studied, and they can be used as a suitable fire extinguishing facility for a special space such as a duct environment. Sound fire extinguishers use sound, not digestive materials such as water or medicines, so they can be applied to all spaces and objects that can be economically damaged due to fire. Because sound fire extinguisher has low frequency sound component of 30Hz ~ 60Hz, even if there is obstacle, it has very high diffraction characteristic and can transmit sound extinguishing component well. In addition, the existing fire extinguishing facilities required a very large space and facilities. However, since the sound extinguisher can be installed anywhere as long as the modules and the

power source capable of generating sound are supplied, it is easy to install and there is no limit to the space [12][13]. In this paper, we have experimentally confirmed whether a fire extinguisher is suitable for fire extinguishing in a duct environment with elevator, electric wire, and communication line. Chapter 2 describes the principle of combustion and extinguishing, and the principle of sound extinguisher. In Chapter 3, the experiment and the result are concluded in last, and the conclusion in Chapter 4 is concluded.

THE PRINCIPLE OF SOUND FIRE EXTINGUISHER

Combustion refers to a strong oxidation reaction in which a substance generates a rapid chemical reaction with oxygen to generate heat and light. Three factors are essential for this fire to be generated and maintained, which is called the 'third element of combustion'. The three elements of combustion are shown in Table 1, and if none of them is present, they are not burned [14][15][16][17].

Table 1: Three Elements of Combustion

three elements of combustion	
Fuel (combustible material)	It is a substance that can be dehydrated in fire, divided into solid fuel, liquid fuel, and gaseous fuel. In addition, the characteristics of burning depend on the composition of the fuel.
Heat (ignition source)	In order for the substance to ignite, it must have very high heat, and the amount of heat must be moderate. The size of heat required for combustion is divided into ignition point, flash point, and combustion point. Ignition point: The minimum temperature at which the fuel starts burning Flash point: The temperature at which the fuel burns when the fuel is turned on. Burning point: Temperature at which fire continues to drain when fuel is burning
Oxygen (air)	The material must be supplied with oxygen to take heat. Most liquids are difficult to ignite when the oxygen content in the air is reduced to 15% or less.

The term "digestion" means that a combustible material is brought into contact with oxygen or oxidizing agent in the air to stop the combustion phenomenon. If there is no element among the 'three elements of combustion', combustion will not occur. Removing or interfering with the "three elements of combustion" is the principle of digestion. The general principles of digestion are as follows.

Table 2: Principles of fire extinguishing

Principle of digestion	
Removal of burning substances	Isolating, destroying, and destroying combustible materials. Blowing candles with their mouths, and logging around forests in the event of a fire.
Temperature lowering	Sprinkle water on combustible material to cool the temperature of combustible material below the flash point to turn off the fire
Oxygen block	How to reduce the oxygen concentration to 15% or less Blanket, dry sand, damp bale, CO2, etc. Especially when it is burned by oil or electricity, it is effective to turn off the fire by way of blocking with oxygen.

Students at George Mason University in USA and DARPA in early stage of sound fire extinguishers released sound power is not distributed well to flame, while Soongsil University Institute of Sound Engineering developed special sound lens technology The sound was focused on the flame and improved to turn off the fire [5-7]. Sound fire extinguishers are fire extinguishers with all three fire extinguishing principles. First, the special acoustic lens of a sound extinguisher concentrates sound to form a wind velocity of 10 ~ 14 m / s, which acts as a fire extinguisher by reducing the burning substances and fire. Second, the sound resonates with the flame molecules leading to higher fuel evaporation, which makes the flame range wider. This widened flame burns a large amount of oxygen and removes oxygen from the burning material. In addition, sound causes the vibration of the air layer to interfere with the bonding of oxygen to the surface of the fire. Third, due to the resonance of the flame molecules due to the sound, high fuel evaporation occurs, which spreads the heat energy over a large space, thus lowering the overall temperature of the flame. In other words, sound fire extinguisher is a fire extinguisher that is applied to all three principles of fire extinguishing, 'elimination of burning substance', 'oxygen block', and 'temperature lowering'.

EXPERIMENTS AND RESULTS

Experiments were conducted to verify the fire extinguishing effect and the fire extinguishing effect of the sound extinguisher by creating an environment similar to the duct environment. A PVC pipe of 15cm in diameter and 150cm of newspapers were woven inside to create an experimental environment similar to a duct space in which wires and elevators were installed inside. The experimental environment similar to the duct space is shown in Fig 1.

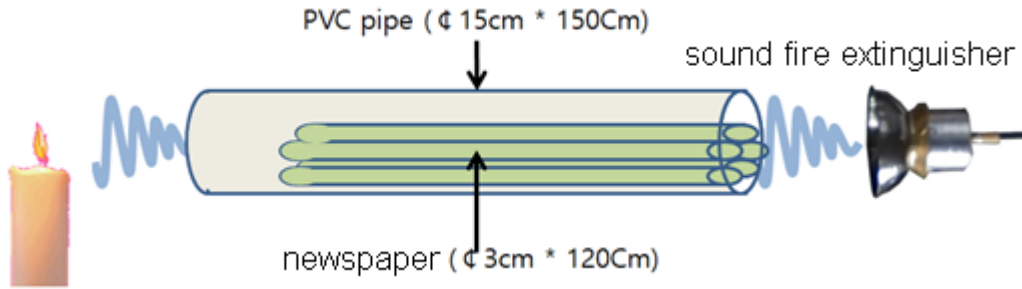


Figure 1: Sound Fire Extinguisher Experimental Environment

The candle was lit on one side of the PVC pipe, and the candle was turned off by the sound fire extinguisher and the blower on the opposite side of the candle while adjusting the amount of the newspaper in the inside of the PVC pipe. In addition, experiments were conducted with a long lighter on the opposite side of the PVC pipe while the sound extinguisher and blower were turned on. The wind speed of the fire extinguisher was about 14m / s at the sound generator and about 2m / s at the opposite side of the PVC pipe. The blower used in the experiment was BOSCH GBL800E and it was ventilated to PVC pipe about 40cm from the sound fire extinguisher for the experiment at the same wind speed condition as the sound fire extinguisher. The experimental scenes are shown in Fig 2.

The results for the candle off in the experiments in Figures 1 and 2 are shown in Table 3. As a result of Table 3, the candle light was turned off both in the sound fire extinguisher and the

blower until the filling amount of the newspaper in the PVC pipe was about 80%, but when the filling amount was 85%, the sound fire extinguisher turned off the candle, while the blower, When the filling amount was 95%, the sound extinguisher responded shakily even though the candle was not turned off, while the blower did not shake the candle or turn it off.

Table 4 shows the experimental results of turning on the long lighter. As a result of Table 4, the long lighter did not light up until the amount of newspaper in the PVC pipe was about 90%, but when the filling amount was 95%, the long lighter was well turned on in the blower, but the long lighter was not turned on well in the sound fire extinguisher.



Figure 2: Sound Fire Extinguisher Experimental Scene

Table 3: Sound Fire Extinguisher candle off experiment result

Newspaper volume	70%	75%	80%	85%	90%	95%	100%
Sound fire extinguisher	off	off	off	off	Shaking and not turning off	Shaking and not turning off	Not turned off
air blower	off	off	off	Shaking and not turning off	Shaking and not turning off	Not turned off	Not turned off

Table 4: Sound Fire Extinguisher long lighter on experiment result

Newspaper volume	70%	75%	80%	85%	90%	95%	100%
Sound fire extinguisher	Not turned off	Not turned off	Not turned off	Not turned off	Not turned off	Not turned off	off
air blower	Not turned off	Not turned off	Not turned off	Not turned off	Not turned off	off	Off

As a result of this experiment, most fire extinguishers and blowers showed the same fire extinguishing result in the candle experiment. However, when the inside of the PVC pipe is 85 ~ 95% of the newspapers, the fire extinguisher burns off the candle better than the same wind speed blower, It is confirmed that the light of the light is not turned on well.

CONCLUSION

In a building fire, a duct environment containing an elevator, a communication line, or an electric wire can cause a fire to spread all over the building. However, the facilities and lines housed in the duct environment are inadequate to apply the existing fire extinguishing facilities. In this study, we tried to confirm whether sound fire extinguisher is actively being studied in sound engineering research institute as fire extinguishing facility in duct environment. As a result of the experiment in Chapter 3, the sound fire extinguisher was able to notice that the candle was well turned off by the vibration of the sound wave in addition to the principle of blowing the fire. Especially, the sound fire extinguisher which generates sound of 30Hz ~ 60Hz has a sound diffraction characteristic, and it is understood that sound fire extinguishing component is transmitted well to the flame even in a structure in which various obstacles are intricately contained in the inside. In the experiment of turning on the long lighter, it was confirmed that there is a flame retardant effect that the lighter is not turned on when the sound fire extinguisher is turned on. The flame retarding effect of sound fire extinguishers will be a means to prevent fire from operating or to delay the expansion of fire by operating a fire extinguisher before a fire occurs. The experiment of this study is a meaningful result which confirms that the fire extinguishing element of the fire extinguisher can be transmitted well to the flame by penetrating the contents which are contained in the duct in a complicated manner, though it is somewhat different from the actual duct environment. It is hoped that sound fire extinguishers will be actively researched and utilized in environments where existing fire extinguishing systems are difficult to apply.

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