

## On a Fire Extinguisher using Sound Winds

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**Abstract:** Sound fire extinguisher is developed based on principle of quenching fire by lowering its temperature with contacting vibration energy from low frequency sound under 100 Hz to fire and then, blocking inflow of oxygen with a sound wind. The one researched by American students are at very basic level to be commercialized. It concentrates a sound beam through special sound winds and increases sound energy performance 10 times more to put out the fire. This is because it utilizes basic theory of making sound and as sound has a tendency of dispersing, big sound and energy have to be created to extinguish fire. That is even if 100 W is produced, it just makes a big noise but only 1/10 of it can be used for putting out fire. This special sound wind has convex shape which concentrates all the sound into one place to increase effectiveness by more than 10 times. Even 1~2 m away, initial control can be done. As a result, size of battery as well as amplifier can be made small to have minimized size and weight, making it more practical.

**Key words:** Sound fire extinguisher, vibration energy, sound energy performance, size of battery, minimized size and weight, amplifier

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### INTRODUCTION

There is a variety of fire extinguishers available on the market including powder/fluid-dispersers, gas-dispersers and water-dispersers. There has been little advancement in technology in fire extinguishers in the past 50 years. Furthermore, some issues may arise when using any of these types of extinguishers at the time of use during an emergency and hinder its smooth implementation. For example, powder, fluid or gas get solidified and may be stuck inside of containers or batteries get discharged due to neglected management. Inevitably, there is a need for developing a new kind of fire extinguisher that can be operated right on the spot at the beginning stage of fire without having any implementation issues in its use. The answer may be the sound fire extinguisher. Fire has a characteristic that the extent of damage increases as time goes by. In Winter, fire is more frequent and firefighters become more busy. The principle of fire on an object is that when the object rubbes, kinetic energy is converted into thermal energy. The stronger the frictional force, the more heat it generates. The minimum temperature at which the substance burns is different and the ignition point is different. Some objects ride at temperatures as low as 60°C and some objects do not burn at temperatures above 1000°C. If the temperature is above the ignition point, it does not ignite (Anonymous, 2015b). Burning of objects is combustion. To burn an object, it is necessary to have deaerated substances, temperatures above the flash point

and sufficient oxygen. When burning wood, it is better to build a lot of space for air into the building by stacking it in a zigzag rather than just stacking firewood. In Winter, the atmosphere is dry and the humidity in the air is low. If there is a large amount of moisture in the air, the ignition point of the object becomes higher.

On the contrary if the air is dried, the ignition point of the object becomes lower. The 3 conditions are required for combustion. When the fire is extinguished, i use a method to block three conditions. The fire extinguishing method, the cooling fire extinguishing method and the extinguishing fire extinguishing method are available (Anonymous, 2015b). When the oxygen is cut off the pyrolysis method does not generate combustion. Cooling extinguishes the ambient temperature below the flash point. The way to spray water is representative. But when the hot water is sprayed, the fire goes out well. The hotter the water, the faster it turns into steam. The elimination fire extinguishing method is a method of eliminating the debris and further preventing the fire from spreading. This is the best way to do when there is no equipment to turn off the lights. It is the first method to be used when a fire occurs. I found a fire but if it is close to explosive or flammable material such as gasoline that is easily ignited at low temperatures, it must be removed before it can be prevented from leading to a large fire. The most important thing in suppressing a fire is 'quick action' (Anonymous, 2015b).

Seasonally, when the humidity is the lowest, the probability of occurrence in the order of Winter, Spring,

Autumn and Summer is lower (Eun-Young and Myung-Jin, 2015). There are many reasons for the fire and the materials that cause the fire are also very diverse. As the cause of the fire varies widely, the method of extinguishing it must be different. Therefore, applying the wrong method of extinguishing at the beginning of the fire can be very dangerous. Previous studies related to flame have been based on the type of flame used in fireworks display and there have been studies on lifecycle related to the generation, growth, aging process and extinction of non-particles moving by computer simulation (Cho *et al.*, 2014). The use of a fire extinguisher is somewhat difficult to use because there are disadvantages such as pulling the safety pin, pulling the handle and lever, releasing the remaining gas immediately after use (Anonymous, 2018). In fact, there is no trace of using a hydrator or an indoor fire hydrant at the fire scene. New countermeasures against existing fire extinguisher problems are required. On July 27, 2015, Seth Robertson and Viet Tran, engineers at Fairfax George Mason University, Virginia, confirmed the technology development announcement of the US department of defense in July 2012. It opened the possibility of suppressing the fire by sound through the image of fire extinguisher (Anonymous, 2015a).

The sound fire extinguisher has been in development, since, the DAPRA, Defense Advanced Research Projects Agency of the United States, publicized the result of its project in 2012, suggesting that a fire can be put out by surrounding it with two large sound speakers. Speakers were enormously large in size then because they needed to have enough sound power to extinguish fire. As a follow-up in 2015 a couple of American Graduate students introduced a portable sound extinguisher and demonstrated it on YouTube. But it was still too heavy (9 kg) and too weak in power and had long cables. In August of 2015, we, the Sori Sound Engineering Research Institute (SSERI) introduced an improved device, a sound extinguisher using a sound lens in a speaker to produce more focused power of sound, roughly 10 times stronger in its power than the device introduced by two graduate students (Anonymous, 2012). However, the device still has some problems such as its heavy weight (over 2.5 kg) and its obligatory vicinity from the flame. This study introduces a further improved sound extinguisher in order to increase the efficiency rate of the device by utilizing the sound-wind.

## MATERIALS AND METHODS

**The mechanism of the sound fire extinguisher:** Figure 1 and 2, the sound fire extinguishers do not use any water or chemical fluids like a conventional one but just sound. When the sound extinguisher produces low frequency



Fig. 1: The first sound fire extinguisher by SSERI: the mop type



Fig. 2: The improved extinguisher by SSERI: the portable type

sound of 100 Hz, its vibration energy touches the flame, scatters its membrane and blocks the influx of oxygen, so, the flame subdues.

The first version of extinguisher introduced by the research team of SSERI (Fig. 1) used a sound lens in a speaker to produce more focused power of sound, roughly 10 times stronger in its power than the previous ones. It was very light, weighing only 2.5 kg, 1/3 of the previous one and thus, could be carried around with one hand without any connecting cables. It was also small in size measuring 40 cm in length. With an easy on-off switch, anybody could use it anywhere up to 1~2 m distance from the flame. It could be continuously used for 1 h when fully charged (Park *et al.*, 2015; Ahn *et al.*, 2016).

**New sound-wind fire extinguisher:** This study introduces a further improved version of the sound fire extinguisher (Fig. 2). The most important improvement to be found in our new fire extinguisher from the previous one is the utilization of wind.

As we blow out the candle light by the air from our mouth, the fire can be put out by wind if its speed is over 5 msec at the flame. In order to acquire the power/speed

enough to put out the fire, we developed a way to increase the speed of wind by using low-powered speakers: a method of magnifying the power of sound wind.

Wind generally creates white noise but we covered wind with sound of certain frequency. When wind acquires certain sound frequency, the resonance magnifies it and creates an amplified sound-wind. Figure 3 illustrates the mechanism of a fire extinguisher with sound-wind amplifier. A speaker produces the sound of low frequency 100 Hz and creates sound-wind, resonates it by utilizing the horn-effect to magnify 15 times larger in power. The magnified sound-wind touches the flame and instantly put out the fire.

### RESULTS AND DISCUSSION

The new improved sound-wind fire extinguisher works just like the previous one but with more power and less weight the vibration energy of sound-wind with low frequency touches the flame, scatters its membrane and then blocks the influx of oxygen, so, the flame goes down and eventually the fire gets suppressed. When we conducted an experiment to confirm how the new one functions, we acquired the following results with the sound-wind amplifier, it increases the efficiency as much as 10 times of the previous one, its weight has been reduced to <1 kg and its battery uses less power as little as 1/5 of the previous one, it can be operated for 5 h.

The sound-wind fire extinguisher may be either a mop type or a portable type as we already saw in Fig. 1

and 2. With a few of parts, we can assemble it through a simple process. Since, it consumes little power, it does not need any thermos limiter against overheating. Batteries can be installed inside of the handle in a mop type. Wind is covered with sound and thus the pressure of sound-wind stays at 100 dB within 1 m distance. The speed of sound-wind reaches at 5 m sec within 1 m distance. These specifications fit well to extinguish the fire at its beginning stage. Figure 3 illustrates the mop-typed sound-wind extinguisher.

The sound-wind fire extinguisher as shown in Fig. 4, does not emit/diffuse the flame but suppresses it. Therefore, even non-professionals can operate it without causing any damage to household goods if any. It is easy to carry and light, so that, it can be conveniently used as the 911 first-aid equipment.



Fig. 3: The mop-typed sound-wind fire extinguisher

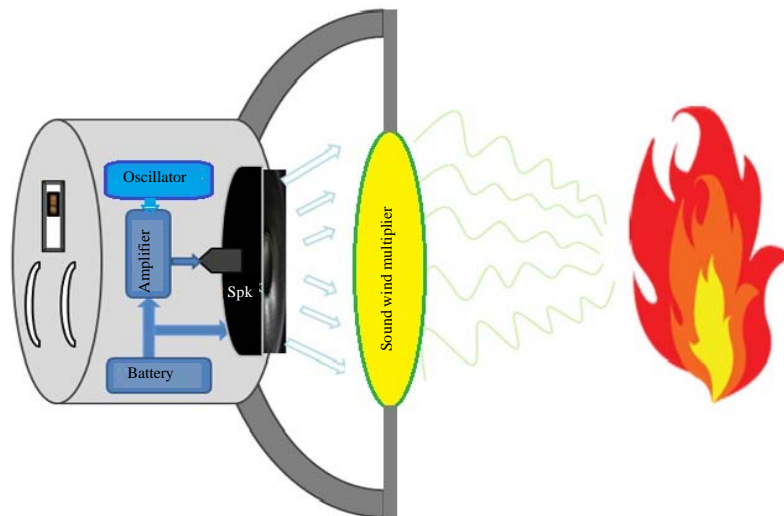


Fig. 4: The mechanism of a sound-wind fire extinguisher

## CONCLUSION

The sound fire extinguisher has a lot of benefits. With a few of parts, we can assemble it through a simple process. Since, it consumes little power, it does not need any thermos limiter against overheating. Batteries can be installed inside of the handle in a mop type. Compared to the first sound extinguisher, the second one, the sound-wind fire extinguisher is lighter (<1 kg) and consumes low power from battery for longer life. Most of all, the efficiency rate has been improved for 10 times better than the previous one.

In summary with these improvements, the sound-wind extinguisher is fit best for the beginning stage of a fire. It can be used at home, at work on board in aircrafts, vessels and cars.

## RECOMMENDATION

In the future, we continue to further improve the functions of the sound-wind fire extinguisher, so that, it can be available for a popular use.

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