A PROJECT REPORT

ON

"APPLICABILITY OF ACOUSTIC WAVES IN EXTINGUISHING FIRE"

Submitted by

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In partial fulfilment for the award of the Degree

Of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

UNDER THE GUIDANCE

Of

Prof. AFAQ AHMED JAMADAR

DEPARTMENT OF MECHANICAL ENGINEERING

ANJUMAN-I-ISLAM

KALSEKAR TECHNICAL CAMPUS NEW PANVEL,

NAVI MUMBAI – 410206

UNIVERSITY OF MUMBAI

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ANJUMAN-I-ISLAM'S KALSEKAR TECHNICAL CAMPUS NEW PANVEL

(Approved by AICTE, Recognized By Maharashtra Govt. DTE, Affiliated to Mumbai University)

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CERTIFICATE

This is to certify that the project entitled

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To the Kalsekar Technical Campus, New Panvel is a record of bonafide work carried out by him under our supervision and guidance, for partial fulfilment of the requirements for the award of the Degree of Bachelor of Engineering in Mechanical Engineering as prescribed by **University Of Mumbai**, is approved.

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APPROVAL OF DISSERTATION

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Date: ___________

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SYNOPSIS

The need for fire fighting techniques is crucial because fire accidents are catastrophic in nature and result in irreparable losses. The current fire fighting has many different limitations. Current techniques are not environmentally friendly. The need for new fire fighting techniques is critical because fire accidents cause deaths and injuries. Sound waves can be one of the potential alternatives to fire extinguishers. Low frequency sound waves emitted from the speaker tend to extinguish the flame.

The present study aimed to develop research on portable extinguishers and to analyse the effect of different frequencies of sound waves on the flame. Experiments were carried out to study the frequency range of sound waves suitable for extinguishing the flame and to analyse the sound-flame interaction by observations using a portable and innovative approach to reduce costs. In addition, research is carried out to study the critical parameters such as the ratio of the length and diameter of the vortex tube to the speed, pressure of the wave discussed. Mobile sensors are used to record the data.

The combination of different high and low pressures and with high gas flow velocities then causes disturbances in the air-fuel ratio at the flame limit (resulting in thinning of the flame limit), is one of the possible explanations for the flame to go out.

Chapter-1

INTRODUCTION

1.1 Introduction to Fire

Fire is a series of self-sustaining chemical reactions with varying degrees of light and heat. The visible part of the fire is called flame. Fire occurs when flammable and/or combustible material, combined with an appropriate amount of oxidizing agent, for example, gaseous oxygen is exposed to a heat source or an ambient temperature above the flash stage. Combustible to the fuel/oxidizer mixture and can withstand the rapid oxidation that creates a chain reaction. Fire is made up of four components: fuel, oxygen, heat, and a chain of chemical reactions. This is often called the fire tetrahedron (Figure 1.1). Fire cannot exist without all of these elements in the right place and the right proportions.

Figure 1.1: A flame tetrahedron

Fire extinguishers are divided into 4 categories, primarily based totally on distinctive varieties of fire. Each extinguisher additionally has a category variety that serves as a manual to the quantity of fire the extinguisher can handle. The better the variety, the extra the fire combating energy. Here's a brief manual to selecting the proper kind of fire extinguisher.

Class A fires are fires in typically flammable materials inclusive of wood, paper, fabric, waste, and plastics.

Class B fires are fires in flammable drinks inclusive of gasoline, petroleum, and paint. There also are flammable gases inclusive of propane and butane. Class B fires do now no longer consist of fires related to cooking oils and greases.

Class C fires are fires related to motorized electric devices inclusive of motors, transformers, and family appliances. Remove the energy and the Class C flame turns into one of the different training of fir.

Class D fires are fires of flammable metals inclusive of potassium, sodium, aluminium, and magnesium.

1.2 Sound Waves

A sound is a form of energy, like electricity, heat, or light. When you ring the bell, it will make a loud chime. Now, instead of just hearing the bell, put your finger on the bell after you hit it. Can you feel it shaking? This movement or jerk i.e. forward and backward movement of the body is known as vibration. Sound travels through a medium by alternately contracting and expanding the parts of the medium it passes through. This compression and expansion create a very small pressure difference that we perceive as sound.

Sound is the vibration that propagates as a perceptible mechanical wave of stress and displacement, via a medium that includes air or water. Sound travels via compressible media which include air, water, and solids as each longitudinal and transverse wave (in solids). Sound waves are generated through a sound supply, which includes a speaker's vibrating diaphragm. The sound supply produces oscillations withinside the surrounding environment. As the supply keeps to oscillate withinside the medium, the oscillation propagates far from the supply at the rate of sound, forming a sound wave. At a hard and fast distance from the supply, the stress, speed, and displacement of the medium range with time. At any given time, the stress, speed, and displacement are unique in space.

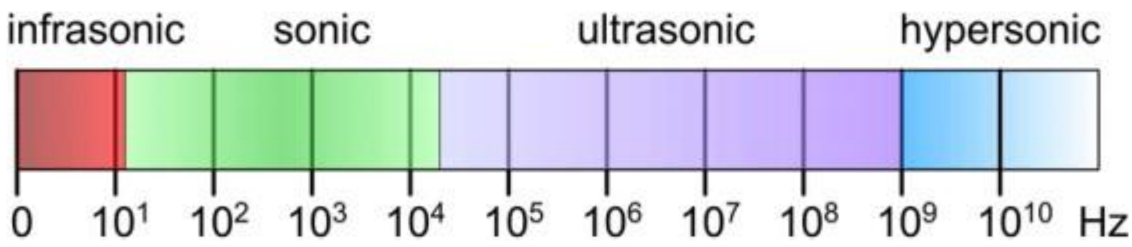


Fig. 1.2 Frequency range of sound wave

Particles in a medium do not travel with sound waves the oscillations of particles in a liquid or gas oscillate, while the average position of the particles over time does not change. Waves can be reflected, refracted, or attenuated by the medium during propagation. The material that carries sound is called the medium, and sound cannot travel in a vacuum. Sound is transmitted by gases, plasmas, and liquids in the form of longitudinal waves. Longitudinal sound waves are alternating pressure waves that move away from the equilibrium pressure, causing regions of compression and local scarcity, while transverse waves (in solids) are alternating perpendicular shear stress waves to the direction of propagation. Alternatively, sound waves can simply be observed with parabolic mirrors and sound-producing objects. Regular sound waves are simplified to be described as flat sine waves, characterized by the following general properties: frequency, wavelength, wave number, amplitude, sound pressure, sound intensity, speed of sound, and direction. The sound that humans can perceive has a frequency of 20 Hz to 20,000 Hz. In air at normal temperature and pressure, the corresponding wavelength of the sound wave varies from 17 mm to 17 mm.

In real life you hear all kinds of noises, screaming, shouting, laughing and it's not just limited to humans. Animals also make noises, and these noises are distinctly different from human voices. To understand this, we will learn some basic properties of sound waves.

When sound waves are represented as waves, we immediately notice some basic characteristics. The waveform is a visual representation of the change in air pressure transmitted as sound. These waves alternate as regions of high pressure and low pressure. Thanks to the waveform, sound waves now look very similar to light and other electromagnetic radiation.

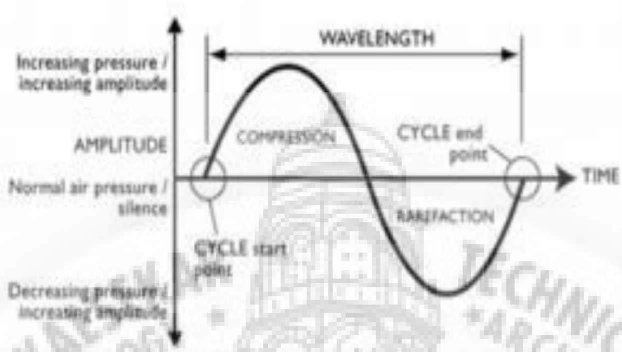


Fig.1.3 Sound Waves in Waveform Amplitude

This in light refers to the quantity of electricity in an electromagnetic wave and that means is identical here. The amplitude is the space among the maximum longitudinal displacement of the wave and its average position. The more the amplitude, the better the strength. In audio, amplitude refers back to the pressure of compression and enlargement of the medium via which the sound wave travels. This amplitude is perceived with the aid of using our ears as a quantity. High amplitude equates to loud sound.

Fig. 1.4Shows the different between sound waves with high and low amplitude wavelength

The waveform representation converts the pressure variations of sound waves into an easier to understand visual graph. Sound waves are generated from an area of high pressure interspersed with an area of low pressure. Areas of high pressure are shown as peaks on the graph. Low pressure areas are described in the valleys. The physical distance between two consecutive peaks or peaks in a sound wave is called the wavelength of the sound wave. It is tagged in the image above.

1.2.1 Frequency/ Pitch of the Sound Waves

The frequency of a sound wave is the oscillation speed of sound traveling through the air. This parameter determines whether the perceived sound is high or low. In auditory terms, frequency is also known as pitch. The frequency of an oscillating sound source is expressed in cycles per second. The SI unit for frequency is hertz and its definition is "1/T" where T is the duration of the wave. The period of time is the time it takes for a wave to complete a cycle. The wavelength and frequency of a sound wave are mathematically related as follows:

Velocity of Sound = Frequency * Wavelength

The figures below can be used to learn more about sound. The first graph represents the sound wave of the drum while the second graph represents the sound wave of the whistle. You may already know the difference in sound, but look at their difference in frequency.

Fig. 1.5 shows the difference between sounds waves with high and low frequencies and their corresponding pitches.

1.3 Back ground of the study

Fire extinguishers are trying to eradicate one of the elements in the pyramid (a flame tetrahedron) to eliminate the flame. Fire fighting in an enclosed space has always been a problem, other than the accessibility for the fire-fighter to access the place, accessing the water (H_2O), carbon dioxide (CO_2), or other fire extinguisher technology to the closed space is a major challenge. A compact, independent and reliable fire extinguisher is required to overcome this problem. The space station and submarine are the main examples of the application that highly required new fire extinguisher technology that can be used in a confined space.

Controlling flames with sound isn't a brand new technique. The interaction between sound and fire was first reported by John LeConte in 1858, who noticed that flames in an orchestra react to the rhythm of the music. German physicist, Heinrich Rubens in the 1900s, demonstrated this technique using a piece of pipe with holes punched along the top. One end is sealed with an audio speaker connected; the other is sealed and attached to a gas supply. Then, by igniting the gas escaping from one of the holes and varying the frequency of the sound emitted, it was possible to adjust the pitch of the flame, an effect known as a Rubens tube.

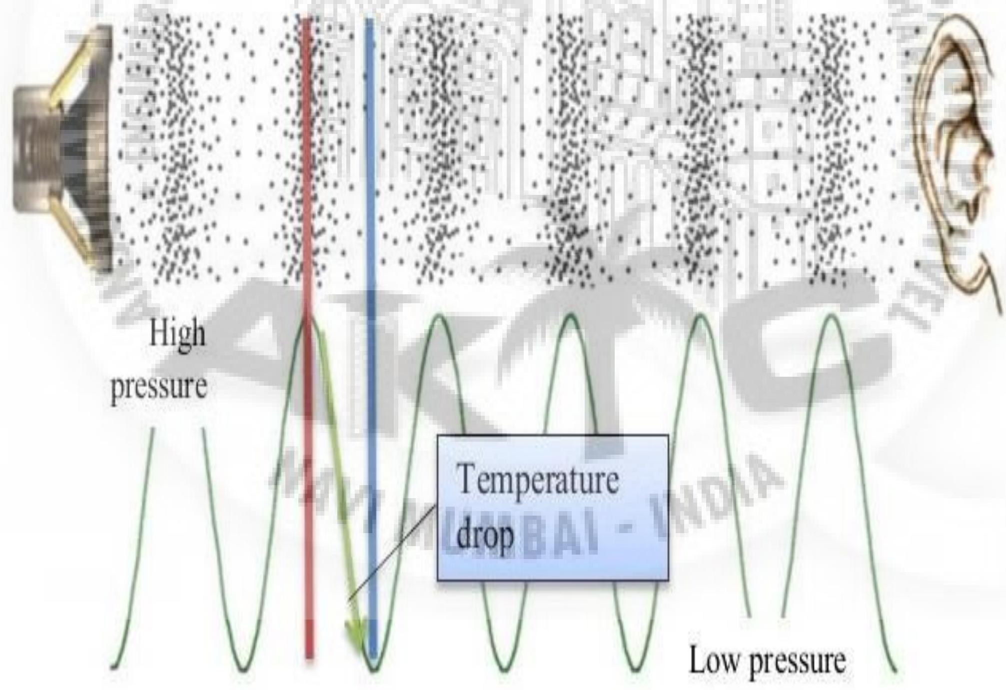
1.4 Conventional fire extinguishing techniques

There are 4 common strategies used in the termination of fire. Cooling the combustible material is the most common method of extinguishing a fire. Water is generally readily available and is the best coolant to use, especially in fires involving solid materials. As it vaporizes when exposed to fire, the water also envelops the flame, cutting off the oxygen supply. However, do not put water on fires involving hot cooking oil or grease as this can cause the fire to spread. Second, it is through the exclusion of oxygen from the fire. Asphyxiates are substances used to extinguish a fire by shutting off the oxygen supply. Foam, which is a component of some extinguishing agents, can help to cool and insulate fuel surfaces from the air, reduce combustion, and can withstand disturbances from wind and drafts. However, the foam should never be used on powered electrical devices, as it is a conductor. Other extinguishing agents include carbon dioxide, found in some extinguishers and ideally used in electrical equipment and sand, which is only effective on small fire areas. Another method of extinguishing a fire is to remove the fuel supply by disconnecting the power, isolating the flow of flammable liquids, or removing solid fuel, such as wood or fabric. In forest fires, a cut of hot ice around the fire helps isolate more fuel. In the event of a gas fire, closing the main valve and shutting off the gas supply is the best way to extinguish the fire. Flame inhibitors are substances that react chemically with combustible material, thus extinguishing the flame. Dry chemical extinguishers work this way and may contain mono-ammonium phosphate, sodium and potassium bicarbonate, and potassium chloride. The vaporized liquid also has a flame-suppressing effect. In contrast, most of these substances have been eliminated due to their high toxicity levels.

1.5 Sound-Flame interactions & using sound wave as flame extinguisher

Sound waves grew to become out to be one of the options to create a new technique in fire extinguishing technology. Some aspects of combustion can be affected by sound waves. The air-fuel ratio of a flame at the lower end of fuel combustion can be affected by sound waves by changing the speed of its medium (air). In addition, the variable air velocity will also affect the fuel flow around the heat source, increase heat transfer due to convection from the heat source, and decrease the average flame temperature. These effects are similar to the flame-blowing characteristic.

Figure 1.6: The physiology of sound



The dominant analysis of the effect of sound waves on the flame is shown in Figure 1.6. Pressure fluctuations due to the propagation of sound waves will cause a significant change in the temperature profile near the flame. High pressure to low pressure and vice versa will cause an instantaneous temperature change according to the first law of thermodynamics. The combined effects of fluctuations in temperature, pressure and air-fuel ratio on the flame will affect the behaviour of the flame in the modulated acoustic wave environment. Pressure disturbances are known to affect the burning rate of materials and cause instability during combustion, which can eventually lead to extinction (Hood and Frendi) [11].

On the other hand, it has been shown that the ultrasonic frequency affects the chemical kinetics of the reaction (Ultrasonic in Organic Chemistry). High-frequency excitation for a reaction will be able to enhance combustion as well as delay and promote the chemical reaction, which depends on the binding affected for each particular chemical compound, at certain frequencies. However, the application of ultrasound for flame suppressors has not yet been studied because the results of an earlier experiment showed an optimal frequency of 60 Hz [1].

Chapter-2

LITERATURE SURVEY

2.1 Introduction

The minimization of losses resulting from the conduct of fire fighting operations, both at the level of disintegration emergency and the level of permanent fire extinguishing equipment, also requires the use of modern and "clean" technologies. . "[13-18] to rehabilitate the plant environment [19] after having been completely inactive for the shortest possible time. Therefore, special attention is paid to technologies such as the efficient use of agents wetting dew [18] [16] [17] or sound waves [20-25] being published.

The experiments of Law and Axelbaum [26] verified the theoretical hypotheses which prolong the characteristic of the flame mainly because the action of the turbo vortex significantly affects its aerodynamic deformation, leading to its extinction.

Studies of combustion show that under certain circumstances it can be intermittently frequent. Unstable combustion has been observed in older equipment such as industrial burners, smoker jet engines, jet engines, and rockets, with fluctuating current parameters significantly. [26-28].

2.2 Hypothesis of sound as fire extinguishers

Sound waves are created by changing the pressure of the medium. The energy of the vibrator moves towards the air particles in a pattern of high and low-pressure zones. Extinguish because the sound wave changes the air pressure reducing the pressure can lower the temperature if the maximum and minimum pressure caused by the sound wave are different enough, the flame will go out.

2.3 Problem Statement

Existing fire extinguishing methods have significant limitations such as being toxic to humans and leaving residue (for dry chemical-based extinguishers) while freezing water techniques in cold climates and conductive electricity. Using sound waves with a certain frequency as a fire extinguishing agent will have significant advantages such as leaving no residue and being non-toxic.

Fig.2.1.A. Photographic view of residue released during use chemical foam for fire extinguisher

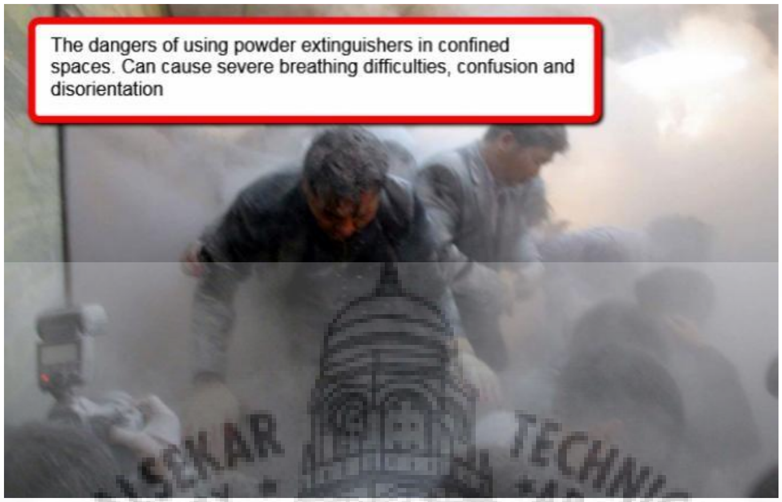


Fig.2.1.B.Photographic view of residue released during use chemical foam for fire extinguisher

2.4 Objectives

Our goal is to develop an environmentally friendly and safe way to remove fire using acoustic settings.

1. Identifies the frequency range that can remove open flames.
2. Identify the optimal frequency range to achieve minimal sound energy when digesting fire.
3. To analyse the physics of the interactions of sound flames.
4. To analyse the physics of the interactions of sound flames.

Chapter -3

METHODOLOGY AND EXPERIMENTATION

3.1 Introduction

Sound is a mechanical wave. The development of portable fire extinguishers began with the basic design method shown in the figure. Important components include a tone generator, which generates the audio signal. The sound generator is interfaced with a subwoofer, which converts low-frequency waves into sound waves, which are amplified using an amplifier. The sound waves are generated by traveling towards the vortex tube. The subwoofer with the vortex barrel is designed to produce extremely low frequencies which are used to conduct sound waves. The waves are further tuned into a frequency generator until they extinguish the fire.

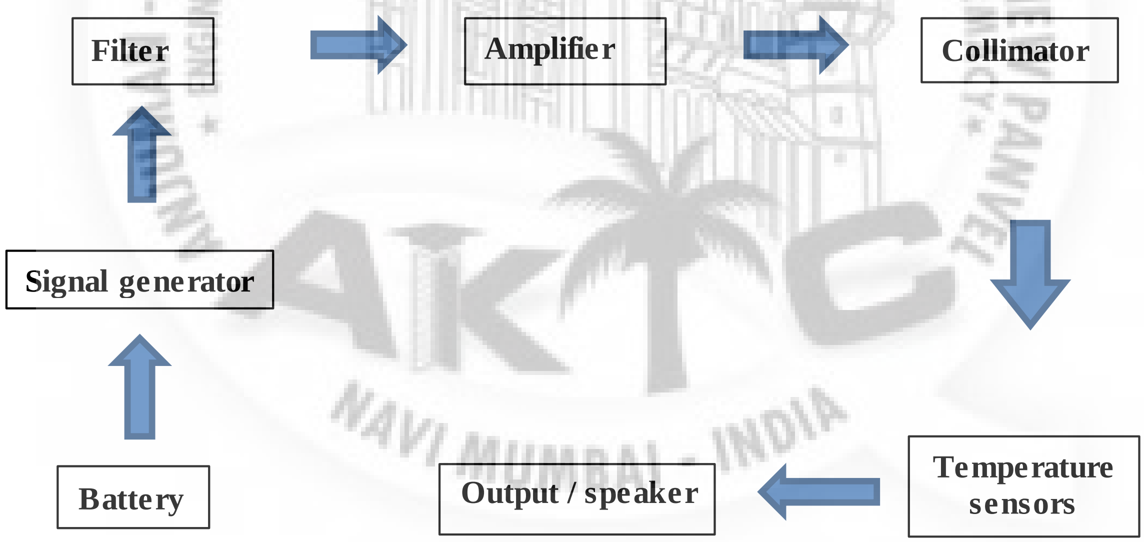


Fig.3.1. Design of portable fire extinguisher

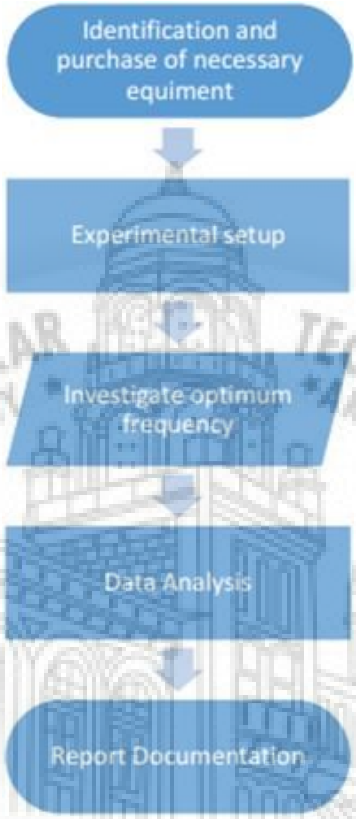


Fig3.2 .Methodology

The methodology for the development of a portable fire extinguisher system is shown in the figure critical equipment required for the development of portable fire extinguishers is identified and purchased. The experimental setup was developed to study the optimal tipping frequency followed by data analysis and reporting documents.

3.1.1 Signal generator

Sound generators, also known as signal generators, are described as testing and configuring electronic and acoustical audio equipment, or information signals, commonly associated with telephone systems.

In each case, electrically generated audio pulses are sent to the specific components. In the case of testing of audio equipment, the frequency response and audio rating are noted, and the characteristics are Acoustic properties of the studio or room can be determined. In telephone systems, dial tones, busy signals, and ring tones are the result of generating this pulse tone.

These devices not only produce sound but can also be used to reproduce certain electronically generated or recorded audio signals. The resulting signal is described differently as white noise or pink noise, depending on the energy level of the audio pulse.

The audio pulse can be viewed on an oscilloscope as a sine wave, an audio waveform generated at 20 Hz to 20 kHz, and the fundamental range of audio frequencies.

Variations in the highs and lows of the sine wave, as well as the distance between them, help in determining the efficiency of the audio device, both for receiving and producing certain sounds with predetermined points in an audio frequency range.

Other representations of timbre and frequency-generating pulses include saw tooth waves, triangle waves, square waves, and many others. These specific representations indicate the volume, harmonics, and/or decreasing or rising energy levels of the audio pulses.

These pulses, having a specific tonal quality and energy, can be visually interpreted on an oscilloscope through the representation of a particular sample.

One model that combines harmonics and impulse energy will look like a series of triangles, another will look like a saw tooth pattern, other squares, and so on.

Fig.3.3 Tone Generator

3.1.2 Generating sine wave sound with Android

In the subsequent article, we will introduce and provide an explanation for a way to create sine wave sound in Android. A sine wave is a mathematical curve that describes a regular repeating oscillation. Sine wave sound can be used in many fields, one of which is robotics.

The sine wave formula is:

$$Y(t) = A \sin(2\pi ft + \rho) = A \sin(\omega t + \rho)$$

The above formula can be explained in sound terms as follows:

y = amplitude X sin (2π (velocity of rotation in cycles per second))

Increasing the amplitude of the sine wave increases the height of the peak and trough, and the volume of the wave increases. Cycle rate increase or decrease, number of cycles per distance/time, increase and decrease in pitch of sound - how high or low the pitch is.

3.1.3 WORKING METHODOLOGY

By focusing low sound waves in a particular direction, we were capable of control both oxygen & burning matter. Since sound is a pressure wave that oscillates between areas of high and low pressure, the oscillation can be harnessed to create a vacuum that separates air molecules from the sound of a flame, extinguishing a fire. This concept teaches the physics, engineering and electronics approach so as to suppress a flame. Firstly, to get the knowledge of acoustical properties of sound waves which are longitudinal waves that moves backward and forward creating vibrating motion, as a result of which molecules moves away from the flame. So when pressure is exerted at the flame source it will get decreased and temperature will also get decreased.

We have used a mobile application to generate a 95 Hz bass frequency and transfer this signal to an amplifier via a Bluetooth module. We have used here a 500-watt amplifier with an 8-inch speaker. The mechanical arrangement we have used is a 300 mm length cylinder with an 8inch diameter.

3.2 Mobile as a computing Tool

Mobile Computing is a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device without having to be connected to a fixed physical link. The main concept involves:

1. Mobile hardware
2. Mobile software

3.2.1 BILL OF MATERIAL

Material Particular	Price
8 inch speaker:	₹ 800
230 v ac supply wire.	₹ 30
Step down transformer:	₹ 50
7805 regulator:	₹ 20
Bluetooth module:	₹ 550
Potentiometer:	₹ 50

Mobile to operate project	
Display:	₹ 650
Volume control potentiometer:	₹ 60
Power on led:	₹ 2
Temperature sensor:	₹ 850
Relay 5v:	₹ 20
7805 regulator:	₹ 20
Electronics cabinet:	₹ 450
PCB: Design and assembly:	₹ 1250
MS cylinder (Length: 300mm, diameter: 8 inch):	₹ 2500

3.2.2 CIRCUIT DIAGRAM

Portable software is the actual program that runs on mobile hardware (Figure 3.5). It deals with the characteristics and requirements of mobile applications. It is the engine of the mobile device. In other words, it is the operating system of the device. It is an essential component that makes mobile devices work.

Since portability is essential, this type of computer ensures that the user is not bound or pinned to a single physical location, but can operate from anywhere. It combines all aspects of wireless communication.

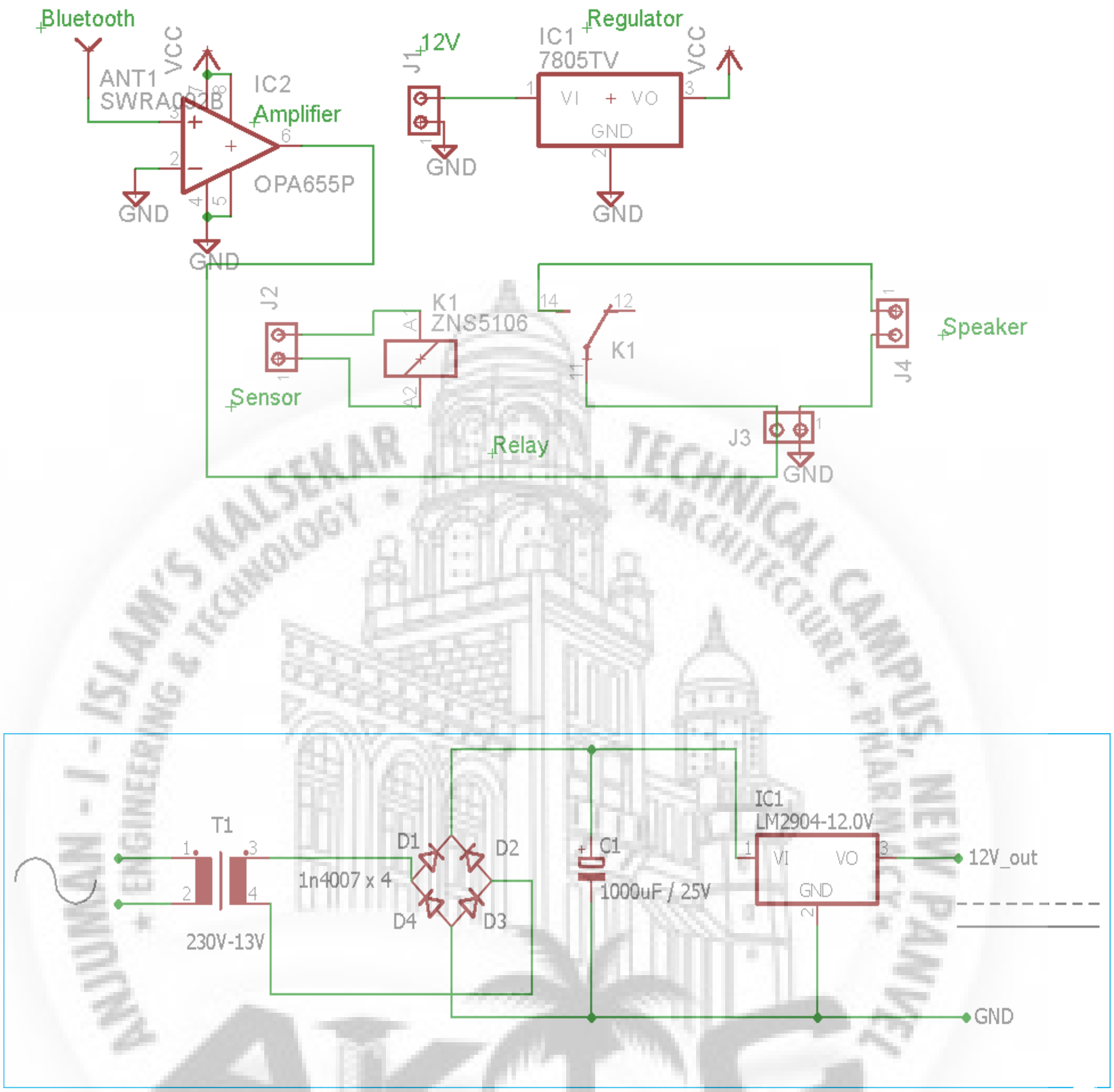


Fig. 3.5 Mobile software

3.2.3 BODY

Frame

The frame is usually made of mild steel. It is strong enough to withstand all kinds of loads under operating conditions. All other parts are mounted on the frame. The frame helps to support various light-duty carriers. Frame displays precise aesthetic curvature. Every machine needs to have a good frame design. The frame material must have high strength since the frame is balanced against other machine loads. In our project, the framework plays an important role. The vertical pulley and gear are mounted on the vertical support of the frame. The main assembly of the whole project is mounted on a frame. Selecting the right material for the different parts of a machine is a key goal in machine building. A design engineer needs to have a clear understanding of the influence of manufacturing and heat treatment processes on material properties. The choice of material for engineering purposes depends on the following factors:

1. Availability of materials.
2. Suitability of the material to the operating situations throughout use.
3. Cost of raw materials.
4. Physical, chemical & mechanical properties of the materials.

The mechanical properties of metals are the properties associated with the ability of the material to resist mechanical forces and loads. We will now discuss these properties as follows:

1. Strength: It is the ability of a material to resist the externally applied forces.
2. Stress: Without breaking or yielding. The internal exerted offered by a part to an externally applied force is called stress.
3. Stiffness: It is the ability of a material to resist deformation under stress. Elastic modulus of the durometer.

4. Elasticity: It is the property of a material to return to its original shape after being deformed by an external force. This property is desirable for materials used in tools and machines. It can be noted that steel is more elastic than rubber.

5. Plasticity: It is the property of a material, which retains the deformation produced under load permanently. This property of the material is necessary for forging, stamping images on coins, and ornamental work.

6. Ductility: It is the property of a material that allows it to be drawn into a wire under the effect of a tensile force. Ductility is generally measured in terms, percent elongation and percent area reduction. Ductile materials commonly used in engineering practice are mild steel, copper, aluminium, nickel, zinc, tin, and lead.

7. Brittleness: It is the property of a material which is the opposite of ductility. It is the property of the materials to break with little permanent deformation. The material is brittle when subjected to tensile forces without producing reasonable elongation. Cast iron is a fragile material.

8. Malleability: This is a special case of ductility, allowing the material to be rolled or forged into thin sheets, the ductile material having to be plastic but not necessarily too hard. Common ductile materials used in engineering practice are lead, mild steel, wrought iron, copper, and aluminium.

9. Toughness: It is the property of a material to resist the fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of absorbed after being stressed up to the point of fracture. This property is desirable in parts subjected to shock and impact loads.

10. Resilience: It is the property of a material to absorb energy and resist rock and impact loads. It is measured by the amount of energy absorbed per unit volume within the elastic limit. This property is essential, especially for spring material.

11. Creep: When a part is subjected to constant stress at a high temperature for a long period, it will undergo a slow and permanent deformation called creep. This property is considered in designing internal combustion engines, boilers, and turbines.

12. Hardness: A very important property of metals and has many meanings. It includes various properties such as resistance to abrasion, scratches, deformation and machinability, etc. It also means the ability of one metal to cut another metal. Hardness is usually expressed numerically, depending on how the test is performed. The hardness of the metal can be determined by the following test.

    a) Brinell hardness test

    b) Rockwell hardness test

    c) Vickers hardness (also called diamond pyramid) test

    d) Share scaleroscope

Metal science is specialized and although it spills over into the realm of knowledge, it tends to be closed to the general reader. Knowledge of materials and their properties is of great importance to a design engineer. Machine parts shall be made of materials with properties suitable for the operating conditions. In addition, a design engineer needs to be familiar with the manufacturing and heat treatment processes for material properties. When designing different parts of a machine, it is necessary to know how the material will behave during use. For this, certain mechanical properties or properties are mainly used in mechanical engineering, the practice is usually determined from standard tensile tests. In practical engineering, machine parts are subjected to many different forces, which may be due to one or more of the following reasons.

- Energy transmitted
- Weight of machine
- Frictional resistance
- Inertia of reciprocating parts
- Change of temperature
- Lack of balance of moving parts

The choice of material depends on the different types of stresses established during operation. The selected material should hold firmly. Other criteria for selecting metal depend on the type of load because a machine part is more easily loaded than loaded and live loads more easily than shock loads.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors.

- Reliabilities of properties
- Reliability of applied load
- The certainty as to exact mode of failure
- The extent of simplifying assumptions
- The extent of localized
- The extent of initial stresses set up during manufacturing
- The extent loss of life if failure occurs
- The extent of loss of property if failure occurs

Material used

- Mild steel

Reasons:

1. Mild steel is readily available in market.
2. It is economical to use.
3. It is available in standard sizes.
4. It has good mechanical properties i.e. it is easily machinable.
5. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure.
6. It has high tensile strength.
7. Low co-efficient of thermal expansion.

Properties of Mild Steel:

M.S have a carbon content of 0.15% to 0.30%. They are easy to handle and can therefore only be hardened. They are similar to wrought iron in properties. The ultimate tensile and compressive strengths of these steels increase as the carbon content increases. They can be easily gas or electric or arc welded. With an increase in the percentage of carbon, the weld ability decreases. Mild steel is used for this purpose and has therefore been selected for this purpose.

MS SHEET METAL:

These MS plates and mild steel plates comply with various standards such as ANSI, API, MSS, BS, DIN, JIS and IS. We can supply these MS plates and mild steel plates in different qualities, thicknesses, lengths and weights upon request. Sheet metal is metal that is formed during an industrial process into thin, flat pieces. Sheet metal is one of the basic shapes used in metalworking, it can be cut and bent into many different shapes. Countless everyday objects are made from sheet metal. Thickness can vary considerably; extremely thin plates are considered to be plates or sheets, and parts larger than 6 mm (0.25") are considered plate or "structural steel".

Sheet metal is available in flat sheets or in coils. The coils are formed by passing a sheet of metal continuously through a roller cutter.

In most countries of the world, sheet thickness is always specified in millimetres. In the United States, sheet thickness is usually determined by a traditional non-linear measurement called a gauge.

Gauge	Thickness mm	Weight kg/sq.m
8	4	31.4
9	3.55	27.9
10	3.15	24.75
11	2.8	22
12	2.5	19
13	2.25	17.6
14	2	15.7
15	1.8	14.15
16	1.6	12.55
17	1.4	11
18	1.25	9.8
19	1.12	8.8

20	1	7.85
21	0.9	7.05
22	0.8	6.3
24	0.63	4.95
26	0.5	3.9

3.3 Subwoofer

A subwoofer (or sub) is a woofer, or full-range speaker, used to reproduce additional audio frequencies known as bass. The typical frequency range of a subwoofer is around 20 to 60Hz for consumer products below 100Hz for professional live sound and below 80Hz in THX approved systems. The subwoofer aims to increase the low frequency range of the speaker to cover the higher frequency range. (Figure 3.7) A subwoofer consists of one or more woofers mounted in a cabinet - usually made of wood - that is able to withstand air pressure while resisting warping.

Subwoofer enclosures come in a variety of designs, including bass-reflex (with ports or passive radiators in the enclosure), limitless cabinet designs, horns, and pass band, representing unique compromises unique in terms of efficiency, bandwidth, size and cost. Passive subwoofers have drivers and subwoofer boxes, and they are powered by an external amplifier. The active subwoofer includes a built-in amplifier.

Fig. 3.7 Subwoofer

3.4 Vortex cannon

Air vortex guns work basically with the aid of using applying pressure fast and successfully to air molecules contained in a semi-enclosed space. When the expandable surface of the balloon at the back of the barrel shoots forward, it directly collides with the air molecules, propelling them toward the mouth of the barrel and causing a high-speed collision chain reaction with other air molecules and the barrel wall of the cannon. The only way for all of these high-speed collisions to escape is to escape through the opening in the bottom of the barrel. The rapid leakage of air molecules forms a stream, or jet, of air flowing directly from the barrel.

When a stream of air escapes from the gun's opening whirls the air into the static outside air, it forms a steady, donut-shaped air projectile. This flying air donut is called a torus or vortex, hence the name air vortex cannon. A toroidal vortex is caused by the friction of the gas jet with the opening edges and the slow air outside the air gun. Figure. 3.8. When the jet's fast jets collide with the hard circular hole of the barrel and the slow air outside, its edges slow down and curve away from the centre of the jet, forming a donut shape, aka. Is a torus.

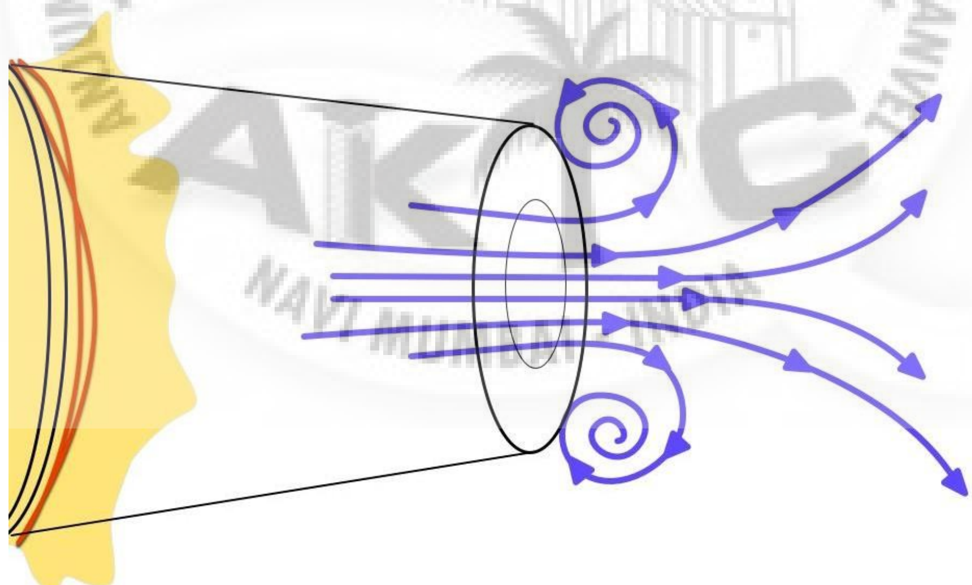


Fig. 3.8 Air vortex

The still air around the vortex has a relatively high pressure that stabilizes the ring as it moves forward, helping it stay in shape. To see the torus vortex created by your cannon, have an adult fill the bucket with some mist from a fog generator or with CO2 obtained from dry ice in room temperature water. Vortexes can occur nearly any time a jet of liquid is thrown into a mass of still liquids, whether those liquids are gaseous or liquid.

Vortexes like those created by your cannon are created by something like a helicopter wing or foam that helps disperse their spores by pulling them out. You can observe swirls in liquids by dropping food colouring directly into a glass of cold water. Whales and dolphins even blow bubbles underwater!

Fig. 3.9 Photographic view of Potable fire extinguisher

A portable fire extinguisher is shown in figure 3.9. It consists of a mobile phone. The function of the mobile is to generate the sine signal. These generated sine signals are given to the subwoofer. The subwoofer is interfaced with the amplifier. The output from the subwoofer is made to flow through the optimized vortex cannon.

CAD MODEL

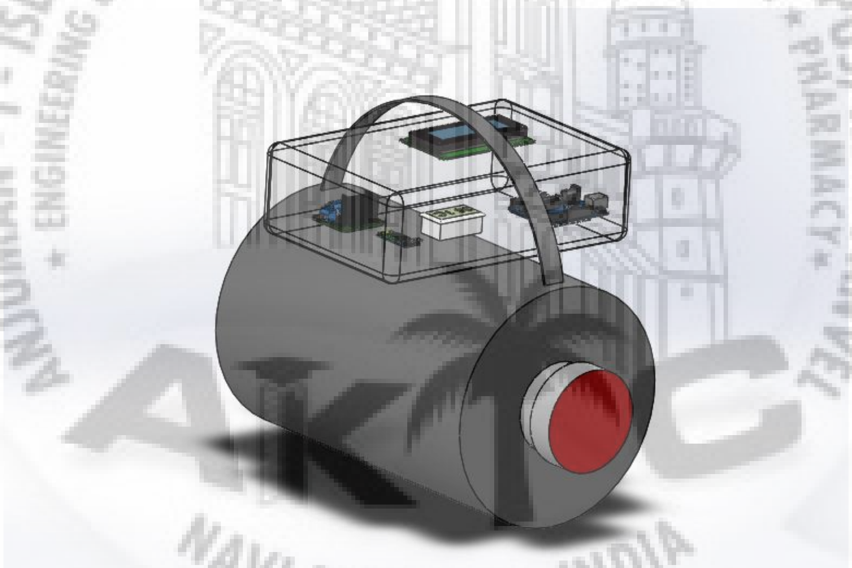
Procedure

- The entire model is designed using powerful structural design software.
- Using the colour function, colours are provided for the entire model.

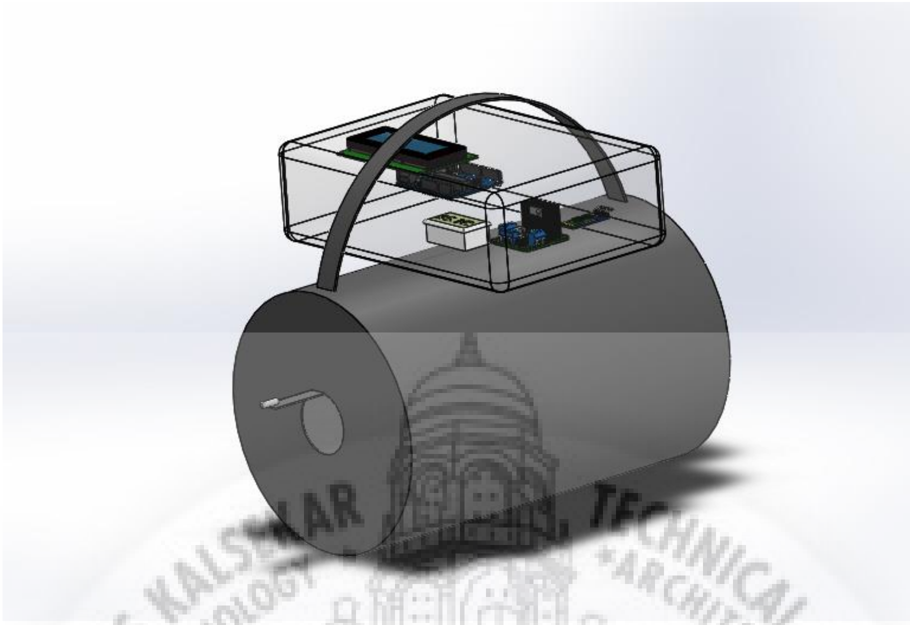
Cad model of the assembled project is designed on Solid works 2018 software

SOLID MODELING

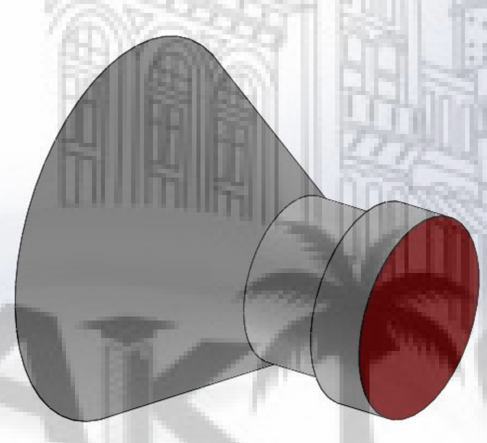
The entire model has been designed with the help of designing software solid works.



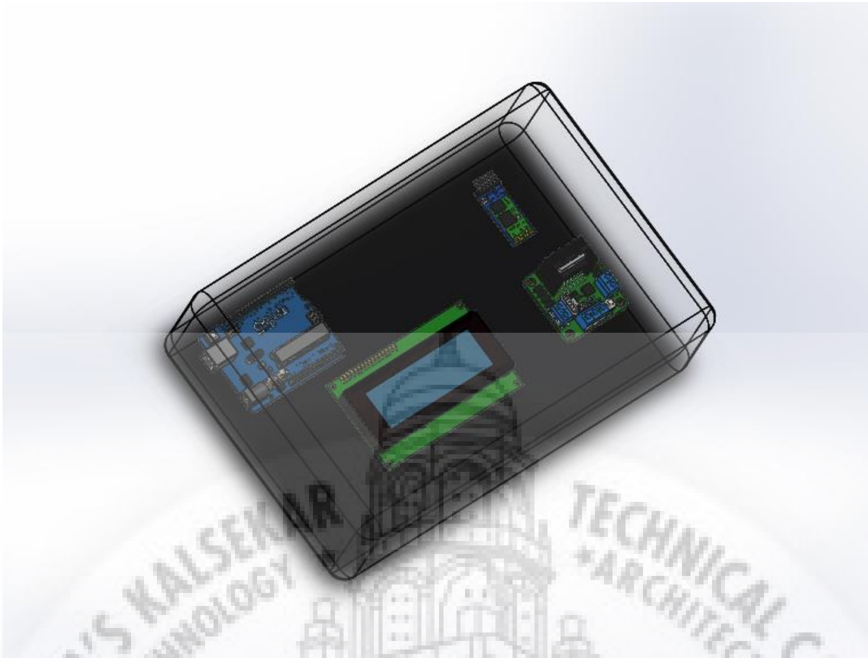
Isometric view1



Isometric view2

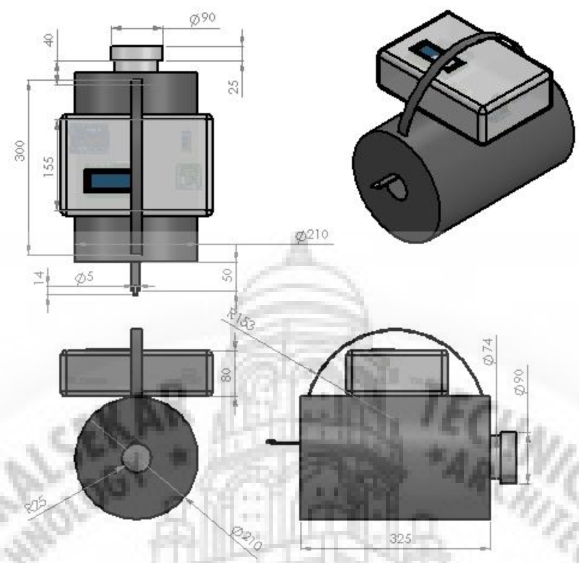


Speaker



Circuit

Body



Drafting

Chapter-4

RESULTS AND DISCUSSION

"I throw more power into my voice, and now the flame is extinguished,"

Irish scientist John Tyndall

4.1 Optimization of vortex cannon

In the present research, an attempt has been made to investigate the effect of the geometry of the vortex to optimize critical parameters such as pressure, sound, and acoustic velocity. Fig shows the variation of pressure, velocity, and sound for varied lengths from 100 to 400 mm and varied diameters of 50 and 100mm.

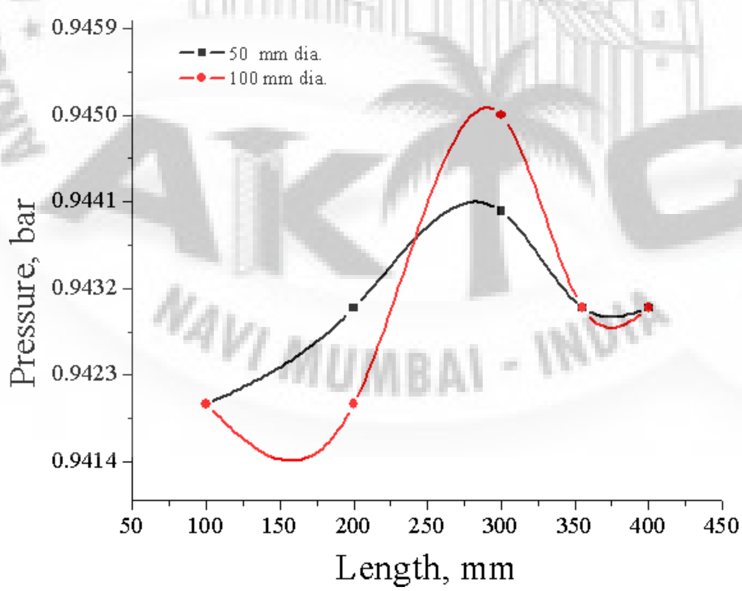


Fig. 4.1 Effect of Vortex geometry on Pressure

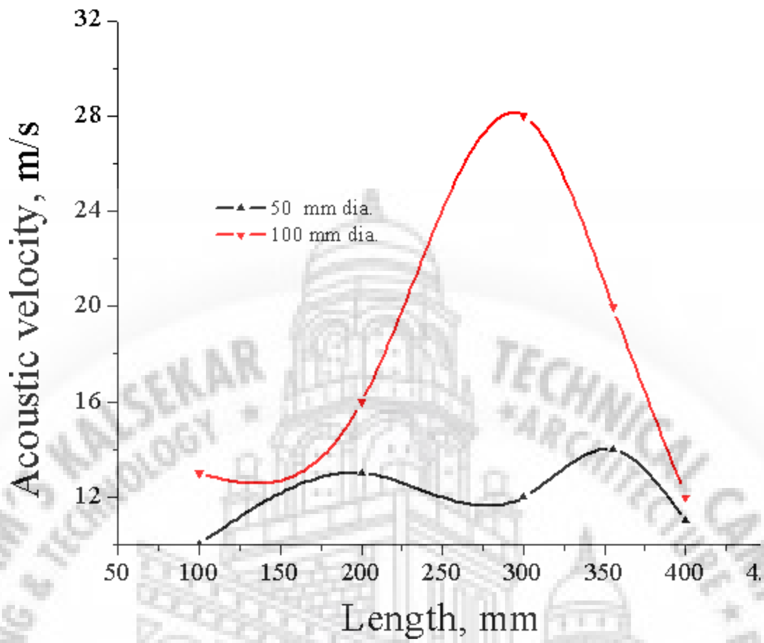


Fig. 4.2 Effect of Vortex geometry on Acoustic velocity

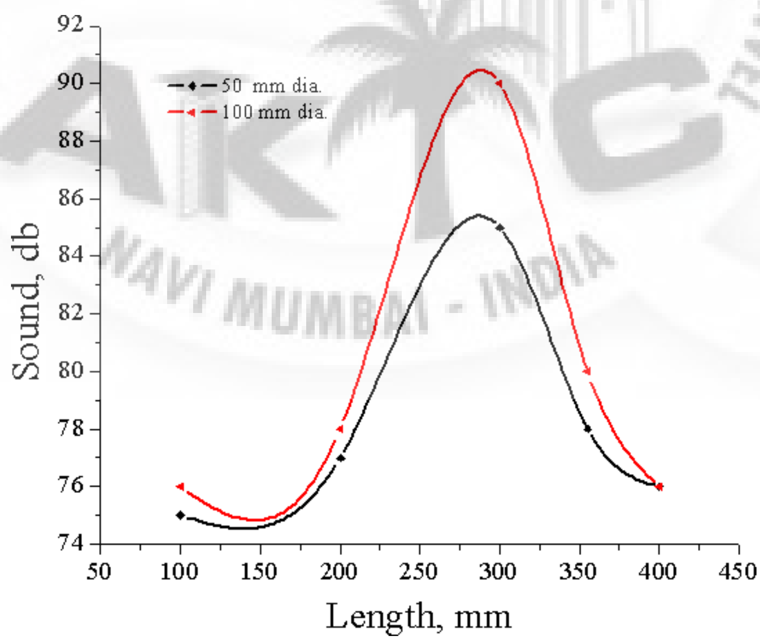


Fig. 4.3 Effect of Vortex geometry on Sound

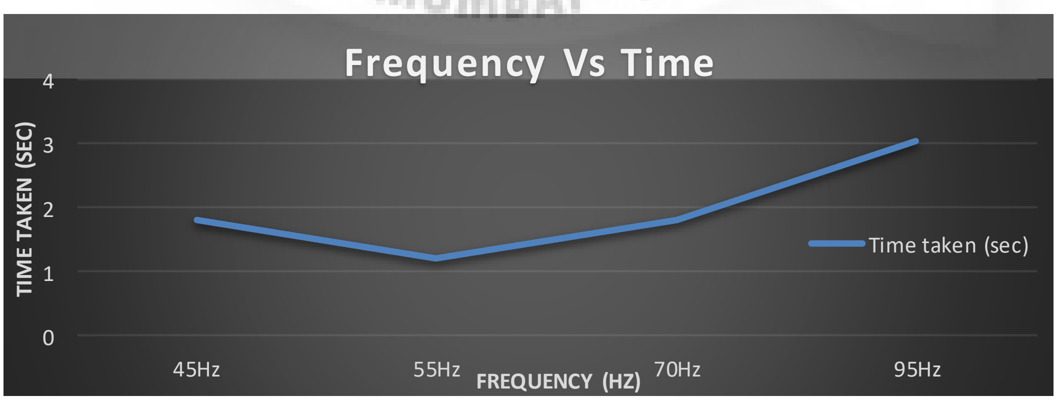
From the result it is found the length of 300 mm and diameter of 100 shows the optimum pressure, velocity and sound for fire extinguisher.

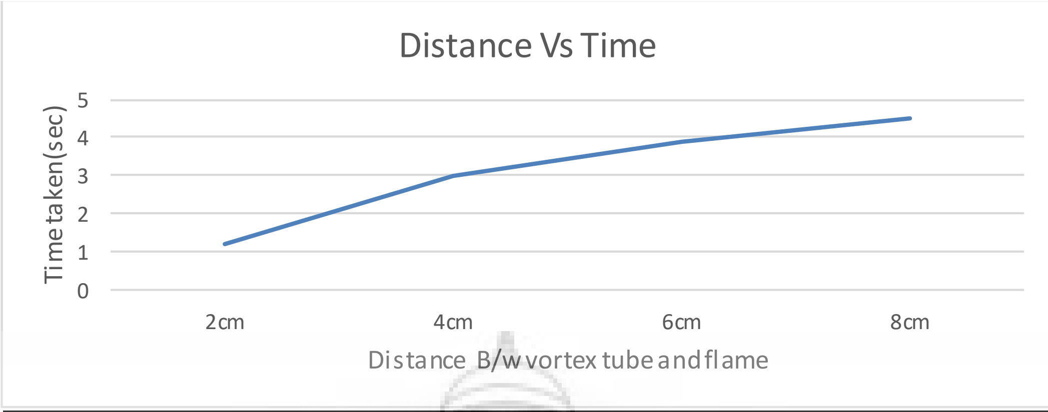



Fig. 4.4 Testing images of fire extinguisher

Testing on different frequency	Time taken in second at different frequency at different distance			
	2cm	**4cm**	**6cm**	**8cm**
45H	1.80	2.4	2.93	4.8
55Hz	1.21	3	3.86	4.95
70Hz	1.80	3.02	3.98	5.1
95Hz	3.03	3.06	4	5.94

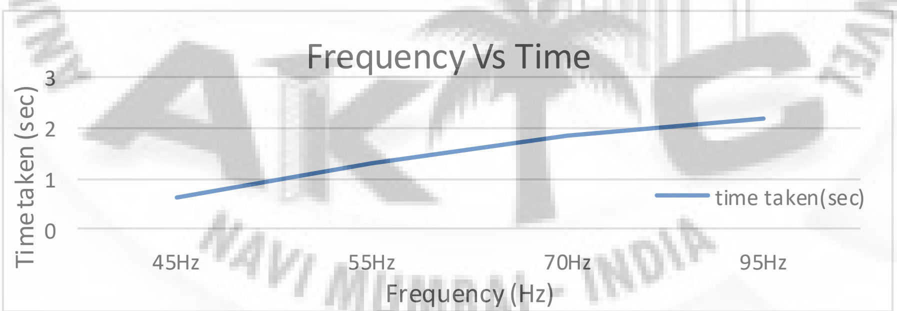
<u>Testing on candle</u>

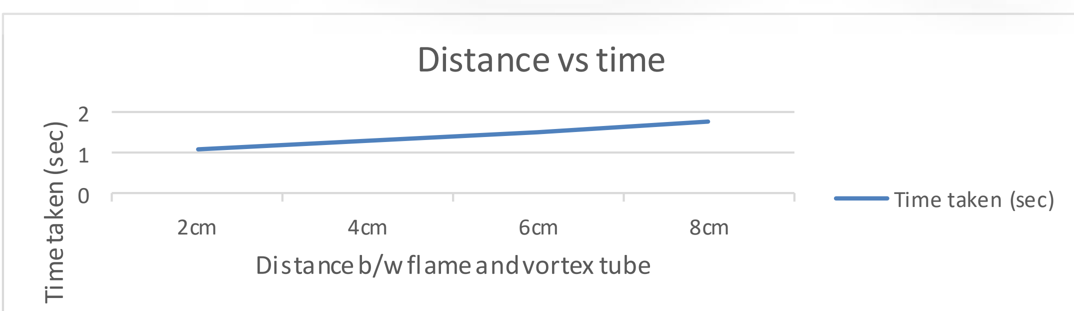




Testing on different frequency	Time taken in second at different frequency at different distance			
	2cm	**4cm**	**6cm**	**8cm**
45Hz	0.643	0.64	0.68	0.74
55Hz	1.11	1.31	1.51	1.79
70Hz	1.72	1.84	2.04	2.36
95Hz	1.96	2.20	2.52	3.93

Testing on mustard oil





4.2 Mechanism of fire extinguishers

We believe that the main acoustic mechanism for partial gas fuel removal is the blow mechanism; where the sound wave imparts kinetic energy to the reactants of the flame, such that the propagation speed of the reactants is greater than the propagation speed of the flame. In the figure, the flame oscillates around the fuel under acoustic stimulation. The flame separates from the flame in the bowl before extinguishing after about 1.7 seconds. Initially, the total flame undergoes oscillations around the source. Immediately after the sound of excitement, the flame burst out of the burner but did not go out. The flame appears to undergo turbulent mixing in the rising state as it oscillates in the sound field; this mixed state represents the induced changes in the gradient between the fuel and the oxidant. In the end, the sonic turbulence extinguished the flames in the rising state. Since the flame exists in a rising state, we can conclude that the current mechanism works effectively to extinguish the flame.

4.3 Characteristics of Portable Fire Extinguisher

- No residue compared to chemical fire Extinguisher.
- Lighter material weight
- Less damage to surroundings
- Nontoxic
- No expiration date
- No refilling date

4.4 Applications

Special Instantaneous Fire Suppression Systems use new ways to fight fires in enclosed spaces, such as aircraft cockpits and ship holds, kitchens, hospitals and shopping centres, industry and railroad where the fire was clearly devastating and extremely difficult to control.

It is used in small fires and can be used in fires of domestic origin.

Generally, when a fire occurs in the electrical panel, water cannot be used because water conducts electricity, so the use of sound waves to put out the fire is one of its main applications.

It can be used in place of chemical and water extinguishers because sonic extinguishers leave no residue and are non-toxic to humans and the environment.

Chapter -5

CONCLUSIONS

The idea of sound fire fighting is new and has a wide range of applications in today's world.

With knowledge of the resonant behaviour of a room or enclosure, current research helps to incorporate one (or more) speakers within it to achieve the speed of sound in the specific areas of your interest. A specific airspeed can be generated using different combinations of pressure and frequency. This suppression technique requires knowledge of the geometry of the acoustic cavity so that optimal placement of the speaker(s) can be achieved, as well as excitation with the optimum resonant frequency for the room.

This study solves the fire in the room by local mobilization of tools. This is effectively achieved by combining the mobile device with the resonance modes of an acoustic cavity, to extinguish flames at long distances or at defined locations such as buttons.

To extinguish large area flames using a current setting, larger or more powerful speakers (higher SPL output) should be used. Directly increase the output power of the speaker, will cause signal clipping; distortion of the output signal. Loudspeakers can be coupled to achieve greater flame suppression, however, the practicality of such a system remains questionable. Therefore, more investigation is needed to try to find the large extinguishers.

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