MEASUREMENT OF SOUND IN DIFFERENT SHAPE OF NOZZLES BY USING SENSORS

R.SARWESWARAN , Dr.P.MANIVANNAN
Assistant professor aeronautical department Hindustan university Chennai,
professor aeronautical department Hindustan university Chennai.

ABSTRACT: This project aims to measure the sound in different shapes of nozzles by using sensors. It comprises a hollow wooden rectangular box, wooden plates with different shapes, microphone, micro controller, Matlab software.The wooden box is closed with differently drilled plates and then a compressor is placed on the drilled plates. A microphone and micro controller are placed in the wooden box which in turn connected to the system which is installed with Matlab software. Total three shapes, i.e., circle, triangle, oval are tested by the equipment. Finally, we found circular shape is producing less sound compared to other shapes.

INTRODUCTION
OVERVIEW

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe.

A nozzle is often a pipe or tube of varying cross sectional area, and it can be used to direct or modify the flow of a fluid (liquids and gases). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

As the cruise speed increases the noise of the jet also increases and due to the flow instability the turbulence is created which lead to the noise in the exhaust nozzle of the aircraft, but the problem is not associated with the time of cruising, the main problem occurs at the time of ground run, climbing and descent of the aircraft when it is more closer to the population. Now the suppression has become the one of the most challenging research topics in the aviation industry in order to minimize its effects on people around the airport and the important breakthrough is the use of modern aircraft with various experimental designs.

Air compressor

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e.,compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

Classification of air compressors:

Compressors can be classified according to the pressure delivered:

Low-pressure air compressors (LPACs), which have a discharge pressure of 150 psi or less
Medium-pressure compressors which have a discharge pressure of 151 psi to 1,000 psi
High-pressure air compressors (HPACs), which have a discharge pressure above 1,000 p

Embedded system:

An embedded system is typically a design that uses the power of a small microcontroller, like the Microchip PIC microcontroller (MCU) or dsPIC digital signal controller (DSC). These microcontrollers combine a microprocessor unit (like the CPU in a personal computer) with some additional circuits called peripherals, plus some additional circuits on the same chip to make a small control module requiring few other external devices. This single device can then be embedded into other electronic and mechanical devices for low-cost digital control.

Differences between an Embedded Controller and a Personal Computer:

The main difference between an embedded controller and a personal computer is that the embedded controller is dedicated to one specific task or set of tasks. A personal computer is designed to run many different types of programs and to connect to many different external devices. An embedded controller has a single program and, as a result, can be made cheaply to include just enough computing power and hardware to perform that dedicated task. A personal computer has a relatively expensive generalized central processing unit (CPU) at its heart with many other external devices (memory, disk drives, video controllers, network interface circuits, etc.). An embedded system has a low-cost micro-controller unit (MCU) for its intelligence, with many peripheral circuits on the same chip, and with relatively few external devices. Often, an embedded system is an invisible part, or sub-module of another product, such as a cordless drill, refrigerator or garage door opener. The controller in these products does a tiny portion of the function of the whole device. The controller adds low-cost intelligence to some of the critical sub-systems in these devices. An example of an embedded system is a smoke detector. Its function is to evaluate signals from a sensor and sound an alarm if the signals indicate the presence of smoke. A small program in the smoke detector either runs in an infinite loop, sampling the signal from the smoke sensor, or lies dormant in a low-power "Sleep" mode, being awakened by a signal from the sensor. The program then sounds the alarm. The program would possibly have a few other functions, such as a user test function, and a low battery alert. While a personal computer with a sensor and audio output could be programmed to do the same function, it would not be a cost-effective solution (nor would it run on a nine-volt battery, unattended for years!). Embedded designs use inexpensive micro-controllers to put intelligence into the everyday things in our environment, such as smoke detectors, cameras, cell phones, appliances, automobiles, smart cards and security systems

Types of Embedded System:

Embedded System is broadly categorized as

Stand alone embedded system

Example: Washing Machine,

Networking embedded system

Example: Network Printer

Characteristics:

Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reason such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs.

Embedded systems are not always separate devices. Most often they are physically built-in to the devices they control.

The software written for embedded systems is often called firmware, and is stored in read-only memory or Flash memory chips rather than a disk drive. It often runs with limited computer hardware resources: small or no keyboard, screen, and little memory.

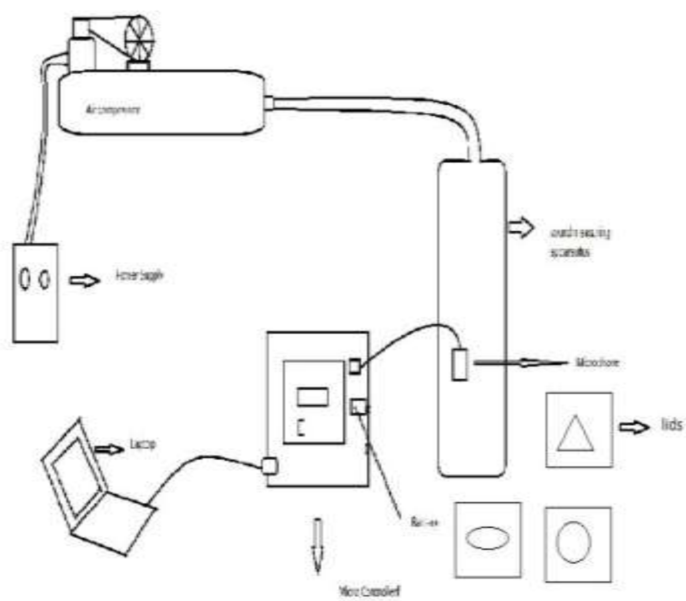
Application of embedded system:

In real life we are using so many embedded systems for example

Home application (micro oven, washing machine, security system DVD, Mp3 player etc,)

Air craft, missles, automotive, nuclear research, personal use (mobile phone, I pod)

BLOCK DIAGRAM



OBJECTIVE OF THE PROJECT:

The objectives of this project are;

To measure jet noise in different shape of nozzles.

To reduce sound pollution

NOZZLES

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe.

A nozzle is often a pipe or tube of varying cross sectional area, and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

Types of nozzles:

Jet

A gas jet, fluid jet, or hydrojet is a nozzle intended to eject gas or fluid in a coherent stream into a surrounding medium. Gas jets are commonly found in gas stoves, ovens, or barbecues. Gas jets were commonly used for light before the development of electric light. Other types of fluid jets are found in carburetors, where smooth calibrated orifices are used to regulate the flow of fuel into an engine, and in jacuzzis or spas.

Another specialized jet is the laminar jet. This is a water jet that contains devices to smooth out the pressure and flow, and gives laminar flow, as its name suggests. This gives better results for fountains.

The foam jet is another type of jet which uses foam instead of a gas or fluid.

Nozzles used for feeding hot blast into a blast furnace or forge are called tuyeres.

Jet nozzles are also used in large rooms where the distribution of air via ceiling diffusers is not possible or not practical. Diffusers that uses jet nozzles are called jet diffuser where it will be arranged in the side wall areas in order to distribute air. When the temperature difference between the supply air and the room air changes, the supply air stream is deflected upwards, to supply warm air, or downwards, to supply cold air.

Convergent nozzle:

Convergent nozzles are used on many jet engines. If the nozzle pressure ratio is above the critical value (about 1.8:1) a convergent nozzle will choke, resulting in some of the expansion to atmospheric pressure taking place downstream of the throat (i.e. smallest flow area), in the jet wake. Although jet momentum still produces much of the gross thrust, the imbalance between the throat static pressure and atmospheric pressure still generates some (pressure) thrust.

Divergent nozzle:

The supersonic speed of the air flowing into a scramjet allows the use of a simple divergent nozzle.

Convergent-divergent (C-D) nozzle:

Engines capable of supersonic flight have convergent-divergent exhaust duct features to generate supersonic flow. Rocket engines — the extreme case — owe their distinctive shape to the very high area ratios of their nozzles.

When the pressure ratio across a convergent nozzle exceeds a critical value, the flow chokes, and thus the pressure of the exhaust exiting the engine exceeds the pressure of the surrounding air and cannot decrease via the conventional Venturi effect. This reduces the thrust producing efficiency of the nozzle by causing much of the expansion to take place downstream of the nozzle itself. Consequently, rocket engines and jet engines for supersonic flight incorporate a C-D nozzle which permits further expansion against the inside of the nozzle. However, unlike the fixed convergent-divergent nozzle used on a conventional rocket motor, those on turbojet engines must have heavy and expensive variable geometry to cope with the great variation in nozzle pressure ratio that occurs with speeds from subsonic to over Mn3.

Non-afterburning subsonic engines have nozzles of a fixed size because the changes in engine performance with altitude and subsonic flight speeds are acceptable with a fixed nozzle. This is not the case at supersonic speeds as described for Concorde below.

Afterburner nozzle or Variable area nozzle:

The afterburners on combat aircraft require a bigger nozzle to prevent adversely affecting the operation of the engine. The variable area nozzle consists of a series of moving, overlapping petals with a nearly circular nozzle cross-section and is convergent to control the operation of the engine. If the aircraft is to fly at supersonic speeds, the afterburner nozzle may be followed by a separate divergent nozzle in an ejector nozzle configuration, as below, or the divergent geometry may be incorporated with the afterburner nozzle in the variable geometry con-di nozzle configuration, as below.

Early afterburners were either on or off and used a 2-position clamshell, or eyelid, nozzle which gave only one area available for afterburning use

Ejector nozzle:

Ejector refers to the pumping action of the very hot, high speed, engine exhaust entraining (ejecting) a surrounding airflow which, together with the internal geometry of the secondary, or diverging, nozzle controls the expansion of the engine exhaust. At subsonic speeds, the airflow constricts the exhaust to a convergent shape. When afterburning is selected and the aircraft speeds up, the two nozzles dilate, which allows the exhaust to form a convergent-divergent shape, speeding the exhaust gasses past Mach 1. More complex engine installations use a tertiary airflow to reduce exit area at low speeds. Advantages of the ejector nozzle are relative simplicity and reliability in cases where the secondary nozzle flaps are positioned by pressure forces. The ejector nozzle is also able to use air which has been ingested by the intake but which is not required by the engine. The amount of this air varies significantly across the flight envelope and ejector nozzles are well suited to matching the airflow between the intake system and engine. Efficient use of this air in the nozzle was a prime requirement for aircraft that had to cruise efficiently at high supersonic speeds for prolonged periods, hence its use in the SR-71, Concorde and XB-70 Valkyrie.

A simple example of ejector nozzle is the fixed geometry cylindrical shroud surrounding the afterburning nozzle on the J85 installation in the T-38 Talon. More complex were the arrangements used for the J58(SR-71) and TF-30(F-111) installations. They both used tertiary blow-in doors (open at lower speeds) and free-floating overlapping flaps for a final nozzle. Both the blow-in doors and the final nozzle flaps are positioned by a balance of internal pressure from the engine exhaust and external pressure from the aircraft flow field.

On early J79 installations (F-104, F-4, A-5 Vigilante) actuation of the secondary nozzle was mechanically linked to the afterburner nozzle. Later installations had the final nozzle mechanically actuated separately from the AB nozzle. This gave improved efficiency (better match of primary/secondary exit area with high Mn <Mach number> requirement) at Mach 2 (B-58 Hustler) and Mach 3 (XB-70).

Variable-geometry C-D nozzle:

Turbofan installations which do not require a secondary airflow to be pumped by the engine exhaust use the variable geometry C-D nozzle. These engines don't require the external cooling air needed by turbojets (hot afterburner casing).

The divergent nozzle may be an integral part of the afterburner nozzle petal, an angled extension after the throat. The petals travel along curved tracks and the axial translation and simultaneous rotation increases the throat area for afterburning, while the trailing portion becomes a divergence with bigger exit area for more complete expansion at higher speeds. An example is the TF-30 (F-14)

The primary and secondary petals may be hinged together and actuated by the same mechanism to provide afterburner control and high nozzle pressure ratio expansion as on the EJ200 (Eurofighter) Other examples are found on the F-15, F-16, B-1B.

Magnetic:

Magnetic nozzles have also been proposed for some types of propulsion, such as VASIMR, in which the flow of plasma is directed by magnetic fields instead of walls made of solid matter.

Vacuum:

Vacuum cleaner nozzles come in several different shapes. Vacuum Nozzles are used in vacuum cleaners.

Shaping:

Some nozzles are shaped to produce a stream that is of a particular shape. For example, extrusion molding is a way of producing lengths of metals or plastics or other materials with a particular cross-section. This nozzle is typically referred to as a die.

MATERIALS AND METHODS

Nozzle exits used in experiment:

Circle shape nozzle exit

circular shape

Triangle shape nozzle exit:

triangle shape

Oval shape nozzle exit:

oval shape

AIR COMPRESSORS

An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank 1158ressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank.

Classification:

Compressors can be classified according to the pressure delivered:

Low-pressure air compressors (LPACs), which have a discharge pressure of 150 psi or less

Medium-pressure compressors which have a discharge pressure of 151 psi to 1,000 psi

High-pressure air compressors (HPACs), which have a discharge pressure above 1,000 psi

They can also be classified according to the design and principle of operation:

Rotary-screw compressor

Turbo compressor

MICRO PROCESSOR AND MICRO CONTROLLER

Power Supply:

A power supply provides a constant output regardless of voltage variations."Fixed" three-terminal linear regulators are commonly available to generate fixed voltages of plus 3 V, and plus or minus 5 V, 9 V, 12 V, or 15 V when the load is less than about 7 amperes.

Microcontroller Overview:

Circumstances that we find ourselves in today in the field of microcontrollers had their beginnings in the development of technology of integrated circuits. This development has made it possible to store hundreds of thousands of transistors into one chip. That was a prerequisite for production of microprocessors, and the first computers were made by adding external peripherals such as memory, input-output lines, timers and other. Further increasing of the volume of the package resulted in creation of integrated circuits. These integrated circuits contained both processor and peripherals. That is how the first chip containing a microcomputer, or what would later be known as a microcontroller came about.

As we have separate lines for receiving and sending, it is possible to receive and send data (info.) at the same time. So called full-duplex mode block which enables this way of communication is called a serial communication block. Unlike the parallel transmission, data moves here bit by bit, or in a series of bits what defines the term serial communication comes from. After the reception of data we need to read it from the receiving location and store it in memory as opposed to sending where the process is reversed. In order for this to work, we need to set the rules of exchange of data. These rules are called protocol. Data goes from memory through the bus to the sending location, and then to the receiving unit according to the protocol.

MATLAB:

MATLAB (matrix laboratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. A proprietary programming language developed by Math Works, MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, C#, Java, Fortran and Python.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing abilities. An additional package, Simulink, adds graphical multi-domain simulation and model-based design for dynamic and embedded systems.

Structures:

MATLAB has structure data types. Since all variables in MATLAB are arrays, a more adequate name is "structure array", where each element of the array has the same field names. In addition, MATLAB supports dynamic field names (field look-ups by name, field manipulations, etc.). Unfortunately, MATLAB JIT does not support MATLAB structures, therefore just a simple bundling of various variables into a structure will come at a cost.

Functions:

When creating a MATLAB function, the name of the file should match the name of the first function in the file. Valid function names begin with an alphabetic character, and can contain letters, numbers, or underscores. Functions are also often case sensitive.

Function handles:

MATLAB supports elements of lambda calculus by introducing function handles or function references, which are implemented either in .m files or anonymous/nested functions.

Classes and object-oriented programming:

MATLAB supports object-oriented programming including classes, inheritance, virtual dispatch, packages, pass-by-value semantics, and pass-by-reference semantics. However, the syntax and calling conventions are significantly different from other languages. MATLAB has value classes and reference classes, depending on whether the class has handle as a super-class (for reference classes) or not (for value classes).

Introduction about Image Processing:

In imaging science, image processing is processing of images using mathematical operations by using any form of signal processing for which the input is an image, a series of images, or a video, such as a photograph or video frame; the output of image processing may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a twodimensional signal and applying standard signal-processing techniques to it. Images are also processed as three-dimensional signals with the third-dimension being time or the z-axis.

Image processing usually refers to digital image processing, but optical and analog image processing also are possible. This article is about general techniques that apply to all of them. The acquisition of images (producing the input image in the first place) is referred to as imaging.

Closely related to image processing are computer graphics and computer vision. In computer graphics, images are manually made from physical models of objects, environments, and lighting, instead of being acquired (via imaging devices such as cameras) from natural scenes, as in most animated movies. Computer vision, on the other hand, is often considered high-level image processing out of which a machine/computer/software intends to decipher the physical contents of an image or a sequence of images (e.g., videos or 3D full-body magnetic resonance scans).

Applications:

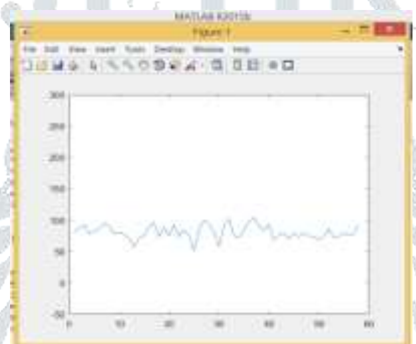
- Electronic imaging
- X-ray imaging
- Photography
- Eye-glasses

MRI : Magnetic resonance tomography

RESULTS and DISCUSION

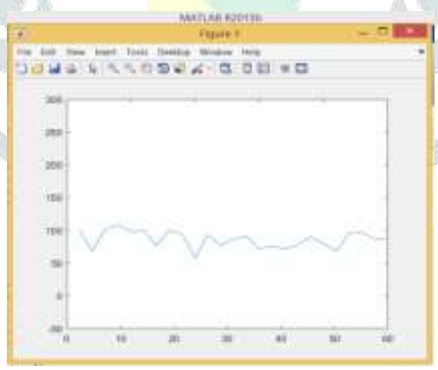
In the experiment on each shape we have applied different amount of pressure like 60bar, 80bar, 100bar. In each shape we plotted different graphs(x-time,y-decibel)

7.1 CIRCLE SHAPE:



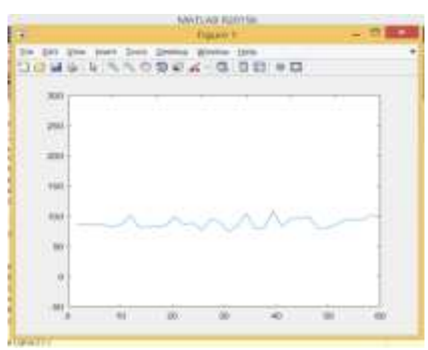
60bar pressure(x-time,y-decibel)

TRIANGLE SHAPE:



60bar pressure(x-time,y-decibel)

OVAL SHAPE:



60 bar pressure(x-time,y-decibel)

CONCLUSION

Finally, with the help of microprocessor, micro controller, micro phone and MAT lab, plotted graphs and we observed that exhaust jet can be reduced by using various shapes circle,triangle and oval.concluded that:

- Shape: circle shape is giving less noise compared with triangle and oval shape. Because circle shape is having smooth surface and without cross sections inside, so it is producing less turbulence eddies.
  But in triangle and oval having cross sections. So here more turbulence eddies are forming and giving more noise.
- When we are increasing the pressure gradually noise also increasing.
- Area increases noise production decreases.
- There are possible methods to reduce noise by using Chevron nozzles,nano technology,engine configuration, acoustic linears and increasing the bypass ratio in turbo fans.

REFERENCE

[1] Saurabh Shriwas , Sachin Shah, Prashant Singh , Kalpit P. Kaurase, REDUCTION OF JET NOISE IN THE AIRCRAFT NOZZLE, international journal of research in aeronautical and mechanical engineering, Vol.3 Issue.3, March 2015.

[2] Steven Martens, JET NOISE REDUCTION TECHNOLOGY DEVELOPMENT AT GE AIRCRAFT ENGINES, ICAS 2002 CONGRESS

[3] Mohammadreza Azimi and futileEmmy, SUPERSONIC JET NOISE: MAIN SOURCES AND REDUCTION METHODOLOGIES ,Journal of Engineering Science and Technology Review 7 (2) (2014) 95 – 98

[4] T. Ishii , H. Oinuma, K. Nagai, EXPERIMENTAL STUDY ON A NOTCHED NOZZLE FOR JET NOISE REDUCTION, GT2011-46244,June 6-10, 2011, Vancouver, British Columbia, Canada.

[5] Haukur Elvar Hafsteinsson, Study OF SUPERSONIC JET NOISE REDUCTION USING LES, applied mechanics, Sweden 2014

[6] Dimitri Papamoschou* and Rebecca S. SHAPE EFFECT OF NOZZLE GEOMETRY ON JET NOISE REDUCTION USING FAN FLOW DEFLECTORS, University of California, Irvine, Irvine, CA, 92697-3975

[7] By J. W. Nichols, F. E. Ham, S. K. Lele AND P. Moin , PREDICTION OF SUPERSONIC JET NOISEFROM COMPLEX NOZZLES , Center for Turbulence ResearchAnnual Research Briefs 2011