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Unconventional Methods for Reduction in Aerodynamic Noise in Aircrafts

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Abstract

The number of products that include a low noise level design increases daily. The noise level reduction in the field of aviation has been always a tedious part. However, apart from the design itself it is frequently necessary to use techniques that lower the level of aerodynamic noise in the aircraft. The aerodynamic noise in an aircraft is mainly due to the various aerodynamic forces exerted by various parts of the aircraft. The main absurd factor is the drag formation which contributes maximum in production of aerodynamic noise. As a result there is a severe discomfort and increase in decibel level of sound resulting in noise pollution. This paper deals with the various techniques that can be employed for acoustic absorption through materials and acoustic absorption mechanisms. The acoustic absorption materials are broadly classified as Porous and Non-Porous members. Porous members include glass fibres, aerated polyesters, wool filaments, etc. Non porous members include panel absorbers and resonators which is being widely used in aviation industry today. The ultimate objective of this paper is to deliver a new unconventional concept that involves the usage of Porous and Non-Porous members in the design of aircrafts for reducing the noise level by absorbing them.

Keywords: Acoustic Absorption, Porous Members, Non-Porous Members, Aerated Polyester, Glass Fiber, Panel absorbers, Resonators.

1. Introduction

Sound absorption is defined as the incident sound that strikes a material that is reflected back. Acoustic absorption is that property of any material that changes acoustic energy of sound waves into another form, often heat, which to some extent retains as opposed to that sound energy that material conducts or reflects. There are two basic categories of sound absorbers, Porous absorbers and Non-Porous Absorbers. Common porous absorbers include spray applied cellulose, aerated plaster, fibrous mineral wool, glass fibers, open cell foam and felted or cast porous ceiling tile. Porous absorbers are the most commonly used sound absorbing materials. Thicker materials exhibit more sound absorption property and damping. Resonators typically act to absorb sound in a narrow frequency range. Resonators include some perforated materials and materials that has holes. The best example is the Helmholtz resonator. Typically, perforated materials absorb only mid-frequency range acoustics. Panel absorbers are non-rigid, non-porous materials which are placed over an airspace that vibrates in a flexural mode.

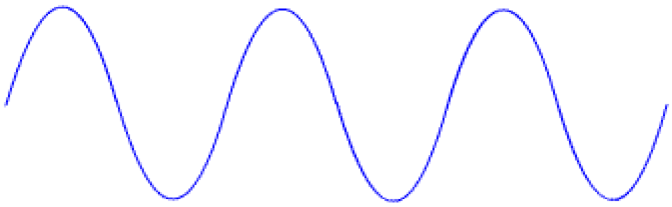
2. Sections

2.1 Active and Passive Noise Control Methods:

The name Active Noise Cancellation differentiates "active" from traditional "passive" methods for controlling unwanted sound and vibration. Passive noise control treatments include insulation, silencers, vibration mounts, damping treatments, absorptive treatments such as ceiling tiles, and conventional mufflers like the ones used in today's automobiles. Passive techniques work best at middle and high frequencies, and are important to nearly all products in today's increasingly noise-sensitive world. However, passive treatments can be bulky and heavy when used for low-middle and low frequencies. Active noise control using elements such as sensors and actuators makes it possible to change the acoustics of a room according to the special requirements at hand. Passive sound control does not always provide effective sound attenuation. Active noise cancelling is best suited for low frequencies. For higher frequencies, the spacing requirements for free space and zone of silence techniques become prohibitive. In acoustic cavity and duct based systems, the number of modes grows rapidly with increasing frequency, which quickly makes active noise control techniques unmanageable. Passive treatments become more effective at higher frequencies and often provide an adequate solution without the need for active control.

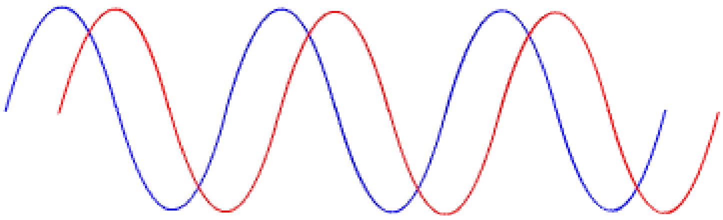
3. Simple Wave Cancellation:

Although sound is a compression wave, each tone or frequency can be represented by a sine wave of a given wavelength.



Simple sine wave for single sound frequency

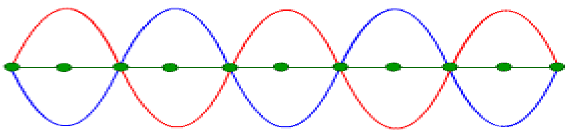
Suppose another pure sound of the same frequency was emitted, but just a fraction of a second later. That means it is slightly out of phase from the first sound or sine wave. The visual representation of the two waves would be as in the next illustration.



One pure sound a fraction of a second after the next

3.1 Sound Cancellation:

Finally, if the sound waves were 180° or one-half a wavelength out of phase, the sum of the waveforms would be zero. They would cancel out each other and there would be no sound.



Sum of waves equals zero sound

Although it is difficult to accept that adding two sounds can result in zero sound, you need to remember that sound is a compression wave in air or other media. That means the wave first compresses to an amount greater than normal air pressure. This is the positive part of the sine wave graphic. Then the air expands to a pressure less than normal air pressure. This is the negative part of the sine wave—the part below the zero centreline. Adding the positive pressure and negative pressure will give you the normal air pressure.

3.2 Basic Mechanism for the Actuator in Short:

Certain actuators are being developed which employs a process where wavelength and amplitude of sound waves are picked by an instrument receiver installed in the actuator and the unwanted sound is cancelled by opposite flowing waves against the original sound wave.

4. Space Satellite Antennas:

Some space satellites have long antennas. If such an antenna would start to vibrate wildly, it could throw the satellite out of orbit and out of control. By detecting the waveform or any vibration in the antenna, it can be suppressed in the same way that noise is suppressed. A piezoelectric device creates an electrical signal when it detects a vibration. It also will vibrate according to an electrical signal it receives. Putting piezoelectric devices on the antenna can result in vibrating the antenna in an opposite phase, thus eliminating the dangerous motion.

4.1 Piezo Electric Actuator:

When piezoelectric smart structures are used for the cabin noise problem, the actuators control the structures so as to reduce the radiated sound fields at a certain region, the so-called silent zone, in the cavity. The overall reduction, however, is influenced by the location and size of the piezoelectric sensors and actuators as well as the control gain. Hence, it is necessary to design the configuration of the structure optimally.In designing piezoelectric structures for noisecontrol, many factors affect the performance of the system. Thus, efforts to optimize these parameters are essential to achieving high performance of the system.

5. Conclusion

Through this paper we are able to identify the optimum materials and mechanisms that can be used to reduce the noise in aircrafts by unconventional methods. It is also evident reduction of noise in an aircraft is always a tedious issue though many new techniques emerge out. So it is very essential that the unconventional method employed for acoustic absorption must meet the requirements of the framework of the aircraft.

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