» Sound Absorption

Airborne Noise

Humans experience quickly varying pressure changes in the air as sound. Any vibrating surface, such as a loudspeaker cone or a piece of moving machinery surface, will generate some form of airborne sound.

"Noise" is essentially unwanted sound. In many cases noise will cause annoyance and discomfort. This can often lead to reduced productivity in the workplace and sleep deprivation in the home. If the noise persists, it may cause stress and other adverse health effects. If untreated, high levels of noise can lead to permanent hearing damage.

Reducing Airborne Noise

Some of the approaches which attempt to manage the levels of airborne noise include the following:

1. Modification of the noise generating device (e.g. changing the speed of a motor or fan to alter its blade pass f requency to a regime that offers a reduction in emitted sound power).
2. Positioning the noise source away from areas of high sensitivity.
3. Enclosing the noise source with acoustic barrier materials or solidly constructed walls to contain airborne noise.
4. Lining the internal surfaces of the room or enclosure with an absorptive material to dissipate the build up of sound energy.

Other approaches, such as noise masking or the use of personal hearing protection , lessen the impact of airborne noise on human health but do not treat the noise issue itself.

Sound Absorption

Materials that provide good absorption of airborne sound are typically called 'absorbers'. Absorbers are used to reduce the level of reverberant acoustic energy inside a given space and benefit the overall noise level both inside and outside this space.

Unlike sound barriers which are intended to reflect noise without necessarily dissipating the sound, absorbers serve to convert sound into other forms of energy, such as movement and heat. . In practice sound absorption materials are used in combination with barrier materials to both enclose and dissipate noise. The effectiveness of the enclosure will be affected by the absorption performance of the lining

Absorption Coefficient

The absorption coefficient α, for a material, is defined as the ratio of energy entering a material (i.e. absorbed and transmitted energy), to the incident energy, i.e:

$$\alpha = \frac{E_i - E_r}{E_i} = \frac{E_\alpha + E_t}{E_i}$$

where $\mathbf{E_i}$ is the incident acoustic energy, $\mathbf{E_r}$ is the reflected acoustic energy, $\mathbf{E_t}$ is the transmitted acoustic energy and $\mathbf{E_\alpha}$, is the absorbed acoustic energy.

The absorption coefficient is sometimes measured in an impedance (Kundt's) tube, usually in accordance with ISO 10534.

Open Cell Absorption

Airborne noise is typically absorbed through visco-thermal interactions that take place when incident sound energy causes air to oscillate inside the material structure. Generally open cell materials that allow the sound pressure waves in, and have a complex porous structure, are suitable for sound absorption over a broader frequency range.

A significant factor that affects a material's ability to absorb sound, apart from merely being open cell, is the 'Air Flow Resistance' or 'Air Permeability'. Other properties include thickness, open-cell porosity, pore tortuosity and pore size..

Generally speaking the thickness of the layer will determine how well a material performs at lower frequencies. Greater thickness gives greater low frequency absorption. Usually for highly porous, open cell materials, this is with minor sacrifice to the medium and high frequency absorption values.

The remaining material characteristics also have an effect on low frequency performance but primarily affect the shape and height of the absorption curve. Good absorbers typically have a broad absorption curve which remains above 0.65 when measured in accordance to ISO 354 (Random incidence method).

Closed Cell Absorption

Closed cell materials do not generally provide good acoustic absorption over wide frequency ranges. However, if lightweight and responsive enough, closed cell materials can provide good frame-resonance and visco-elastic absorption over narrower frequency ranges.

Although the range of frequencies at which absorption occurs is much narrower than for open cell materials, the frequency of peak absorption for a closed cell material will typically be much lower than for an open cell absorption material, making the product good for control in the lower frequencies. Armaflex is an example of a closed cell material that offers good absorption at critical frequencies. (e.g. $\alpha = 0.65$ at 1000Hz for 25mm thickness).

NRC Rating

The Noise Reduction Coefficient (NRC) is a laboratory measurement of a materials sound absorption quality. It is an arithmetic average of the materials absorption values at four key frequencies (250, 500, 1000 and 2000 Hz). This industry standard ranges from zero (perfectly reflective) to 1* (perfectly absorptive). It is always expressed as a decimal rounded to the nearest .05.

*(Based on the testing methodology, and depending upon the material's shape or surface area, it is common for products to exhibit absorption coefficients greater than 1.)

Rigid Backing and Air Gap Effects

In most cases, absorbing materials are used in combination with other materials that typically provide a barrier to the incident sound. These are usually positioned behind the absorption layer, either by choice, such as with an enclosure, or because it is a part of the physical environment, such as a wall or floor. In either case, this type of absorber is described as having a 'rigid backing'.

The acoustic performance will be different if an air gap is introduced behind the absorption layer, or is installed without a rigid layer behind it at all. Only as baffles (i.e. freely suspended panels) or as acoustic splitters in ducting do we see absorption materials typically used without any kind of barrier or containment system. Even here there will be boundary conditions that have an affect on the absorption performance and these must be considered.

For high flow resistive materials, the absorption behaves in a similar way in a free field condition to a rigid backing scenario. For lighter, less flow resistive materials, the absorption flattens out across the frequency spectrum, often with improved low frequency behaviour, but with a lower maximum absorption coefficient.

Armacell Solutions

Armacell manufactures the following products to provide effective absorption of airborne noise:

ArmaSound RD 240

ArmaSound RD 240 is a unique, high performance, dust and fibre free, elastomeric acoustic absorber. Its complex pore geometry allows for effective absorption of airborne noise across a broad frequency range. The result is a versatile acoustic absorber which can achieve significant noise reductions with reduced wall thicknesses.

Class O Armaflex

Class O Armaflex is a closed cell elastomeric rubber material which provides sound absorption via a frame resonance effect. This results in a distinctively different absorption profile, offering excellent absorption values at nuisance lower frequencies.

Class O Armaflex Punched

Class O Armaflex Punched sheet is a dust and fibre free Class O elastomeric acoustic absorber. Whilst not as effective an acoustic absorber as ArmaSound RD 240, Class O Armaflex Punched Sheet boasts an impressive absorption coefficient and an aesthetically pleasing surface finish.

armacell engineered foams

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