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Perspective

Significance of Membrane Absorbers in Sound-Absorbing Techniques

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DESCRIPTION

Based on a resonance membrane made of polymeric nanofibers layer that is constrained by a frame, where the sound-absorbing techniques work by absorbing sound waves. Following the forced vibrations caused by the force of the sound waves striking the resonance membrane, the membrane's kinetic energy is transformed into thermal energy by friction with nearby nanofibers, the surrounding air, and possibly additional layers of material. Additionally, some of the membrane's kinetic energy is transferred to the frame, to which it is firmly attached, and some of it is converted into thermal energy as a result of increased friction in its inner structure. This increased friction is brought on by the possibility that the membrane's neighboring parts, which are at least partially separated by the frame or its components, may vibrate with mutually dissimilar periods and/or deviations. To achieve homogeneous qualities over the entire area of the sound-absorbing material, the frame is made of a grid mesh that can be regular. The size and shape of the mesh have an effect on how the materials absorb sound, or more specifically, how they behave when they resonant. The resonance membrane is linked to the frame with positive, zero, or negative tension to provide the necessary sound-absorbing properties.

A thin plate or foil that is far from the fixed wall and has very little bending stiffness is referred to as an "oscillating membrane." The behavior of such membrane is comparable to that of a body of a specific weight coupled to a spring using an elastic band (represented by a membrane). A porous substance fills the space between the membrane and the back fixed wall, dampening the vibrations of the air particles in this space and the system as a whole. The membrane is often chosen from a fabric whose flexural stiffness is significantly lower than that of an air cushion. To muffle low-frequency sounds, membrane absorbers are employed. The membrane is placed parallel to the stiff wall at a specific distance to maximize sound absorption. This spacing creates an air gap between the wall and the membrane.

The sound absorption coefficient, which ranges from 15% to 20%, significantly affects how well the parts work together. Large glass portions of many modern buildings are typical examples because they ensure that the reverberation time for bass tones does not significantly increase. The acoustics of the space are balanced by these glass regions. The frequency range makes the glass absorbent. Basis weight, tension, and airflow resistance level at higher frequencies (Rh), and air flow resistance (R) has an impact on the sound absorption coefficient. The sound absorption coefficient is zero at extreme levels. When all sound energy travels through the membrane, which has very low air flow resistance. When the Rh value is extremely high, the membrane is rendered impermeable and all sound energy is reflected. The ideal Rh value depends on the membrane's basic weight and sound frequency. Particularly at lower frequencies, the basic weight's effect can be seen. The value is nearly constant for higher sound frequencies. Because only Rh dominates at higher frequencies, and the base weight loses its influence.

The permeability of the membrane with ideal air flow resistance improves absorption properties in the high sound frequency range. The mass of the first permeable membrane affects the sound absorption coefficient at low frequencies, whereas the mass of the second solid membrane affects the opposite. At frequencies higher than 2 kHz, the effect of membrane mass on the sound absorption coefficient is absent. At low frequencies, the properties depend less on the air cavity between the two membranes. At high frequencies, they resemble a permeable membrane with an air-filled back cavity and a hard back wall. It is well known that structures in water have lower base frequencies than those in the air because water increases the system's overall kinetic energy.

When the sound absorption of nanofibrous layers covering grids of various mesh sizes was measured, it was discovered that the nanofiber layer applied to smaller mesh achieves better sound absorption, with two absorption peaks occurring at roughly 1500 Hz and 3500 Hz, whereas the nanofibrous membrane applied to the larger mesh grids does not sufficiently absorb the sound of these frequencies. As a last point, it's important to remember that because membrane absorbers only work with bass tones, they frequently reflect high-frequency noises. Additionally, wooden floors can create percussion sounds, while glass windows can provide echoes.

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