

Noise Reduction Through Vibration Isolation

Vibration is the oscillation of a rigid or elastic body that is created by the transfer of energy from one body to another. Transportation vehicles, portable devices and consumer electronics all contain parts that are constantly in motion and subject to vibration. The movement of these parts creates energy that radiates audible noise in the form of vibration. Vibration can damage sensitive equipment and reduce the reliability of an otherwise durable product. To avoid the possibility of damage and ensure proper performance for the long term, sensitive components should be isolated from vibration energy.

Vibration isolators, such as BISCO® Silicone Foam, can significantly reduce the transmission of energy from one body to another by providing an elastic and resilient connection between them. Isolators act as springs that deflect energy as vibrations impact their surface and then rebound to return the vibration energy back towards the source. Reducing structure-borne excitation can extend the life of transportation vehicles, portable devices and consumer electronics and prevent performance problems.

The amount an isolator deflects, rebounds or absorbs energy is characterized by the material's stiffness, elasticity and loss modulus. Materials with a high storage modulus, or modulus of elasticity, can isolate more energy. It is crucial to optimum product performance that a proper isolator be selected; otherwise, an incorrect material choice could exacerbate performance problems. A poor isolator may reduce vibration at high frequencies, but will amplify vibration at low frequencies, which is where most vibration tends to occur in vehicles. Materials with high stiffness may experience vibration amplification while

products are in use. The region of vibration amplification occurs around the resonant of natural frequency as demonstrated in Figure 1 below. The natural frequency is based on material stiffness, system loads and damping performance.

Vibration Isolation

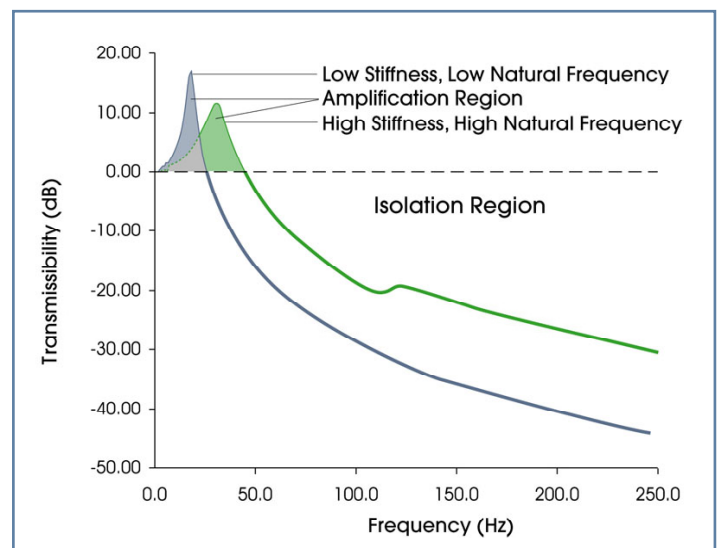


Figure 1 – Vibration Isolation or Transmissibility Curve

Transmissibility curves are logarithmic graphs that indicate the amount of energy transfer (vibration) an isolator can block as a function of frequency. Typically, isolators block more vibration as the frequency increases. Their performance is measured as a ratio of energy transmitted out of the system versus energy transmitted into the system. The value is listed in units of decibels (dB). Negative dB values indicate vibration is being reduced, while positive dB values indicate vibration is being amplified.

Continued on reverse.

BISCO[®] Silicones

Tutorial

Natural frequency (f_n) is the frequency at which a system will freely oscillate if it is displaced from its static position by a given load. All mounting systems have a region of vibration amplification at their natural frequency, f_n , so it is important to determine it and design around it. Use this equation to help:

$$f_n = \frac{1}{2\pi} \sqrt{\frac{k}{M}}$$

The natural frequency, f_n , is dependent upon the stiffness of the spring, k , and the mass of that load that is supporting, M . This equation demonstrates how isolators with a low stiffness will help create a system with a low natural frequency. Since most vehicle vibration takes place between 20-100 Hz, low natural frequencies are desired to reduce the extent of vibration amplification in a mounting system.

Adding damping to an isolator mount greatly improves its response to amplification by reducing the amplitude of its vibrations. Most elastomeric vibration isolators use a visco-elastic mechanism to dissipate energy transfer through a combination of vibration isolation and damping. Damping reduces the amplitude of resonant vibration by converting a portion of the energy into low-grade heat. When these visco-elastic materials are deformed, internal friction causes high-energy losses to occur. The mechanical loss factor (η) is the ratio of energy dissipated from the system to the energy stored in the system for every oscillation. This mechanical loss factor, (η), is used to quantify the level of damping of a material.

A loss factor of 0.1 is generally considered as a minimum value when selecting vibration isolators. Compared to this value, most commonly used materials, such as steel, aluminum, and most rubbers, do not have a high level of damping. See Figure 2 for some materials and their approximate loss factors.

MATERIAL	APPROXIMATE LOSS FACTOR
Aluminum	0.005 - 0.007
Steel	0.05 - 0.10
Neoprene Foam	0.10 - 0.20
BISCO L3-A Foam	0.35 - 0.40

Figure 2 – Approximate Loss Factor

BISCO silicone foams demonstrate extremely low stiffness, excellent elasticity, and optimal damping for continuous vibration isolation. Their stability in a wide range of environments minimizes degradation due to material stress relaxation and makes them ideal for use in demanding applications.

BISCO Silicones' full line of cellular, solid and specialty materials are ideal for use as vibration isolators, acoustic barriers, gaskets, heat shields, cushions and insulation for a wide variety of aerospace, industrial, medical and transportation applications. They exhibit outstanding performance properties and are resistant to extreme temperatures, UV, ozone, humidity and compression fatigue. The BISCO L3-A foam family is designed to meet the unique performance requirements of railcar flooring systems. By consistently demonstrating low stiffness and excellent elasticity, BISCO L3-A ensures maximum vibration isolation under all travel conditions.

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