G. Diadchenko, T. Nosova, N. Kaliberda

ACOUSTICAL BIMATERIALS AND PROSPECTS FOR THEIR APPLICATION IN THE ROCKET INDUSTRY

The design of modern engines and modernization of aircraft structures requires up-to-date solutions in the creation and use of new materials. In this work, it is proposed to pay primary attention to the materials used in the sound insulation of the structure. The main focus of the work is to study and investigate the combination of materials in order to create a bimaterial with improved sound insulation properties.

The turbulent aerodynamic flow and high noise levels (160-170 decibels) generated by the aircraft engine cause severe vibration of the launch vehicle structure, payload, and ground launch equipment [1]. One of the primary tasks of modern rocketry is the need to reduce the acoustic pressure from the outgoing flow. Resonance-type structures or resonant sound absorbers (RSAs) are the most promising types of sound-absorbing structures that are widely used in aviation and rocketry. A simplified model of a sound absorber is a perforated panel consisting of a rigid wall and a porous material. The design of the sounding board can also be characterized as an oscillating system in which the air filling the space behind the panel plays the role of an elastic element, and the air plugs filling the panel holes act as an inertial element. As the frequency of the sound wave incident on the surface of the sound absorber approaches the natural frequency of the resonator, the air velocity in the panel openings increases dramatically. This increases the loss of sound energy caused by the action of viscous friction forces. By changing the parameters of the RSA, the resonant frequency of the absorber coincides with the fundamental frequency of the sound that hits its surface. This achieves high values of the sound absorption coefficient and a significant reduction in sound level when reflected from the surface of the RSA. One of the main disadvantages of the classical design of the RSA is the impossibility of its use for broadband noise suppression.

To achieve the required sound absorption, the priority is mostly to change the size, location, and geometric characteristics of the holes in the panel, while the characteristics of the materials are considered secondary. To ensure a vibroacoustic environment, holes are usually selected under the spacecraft main unit at a level that corresponds to the design level so that the acoustic pressure over the entire surface of the spacecraft increases by no more than 10% at all spectral frequencies. At the same time, the spacecraft equipment located directly near the holes is checked for higher vibration levels corresponding to increased levels of acoustic load [1].

According to the results of current research, it has been found that soundproofing materials for railroad vehicles have improved properties when combined (layered) with other materials. Taking into account these observations, to solve the problem of low noise absorption and destructive vibrations, it is proposed to prioritize the creation of a material whose structure will have a large number of small externally open, air-filled and interconnected pores. The physical and mechanical properties of such a material should include: high strength, heat resistance, plasticity, adhesion, and most importantly, low density, which will ensure its lightness.

Currently, the soundproofing layer most often consists of several layers of carbon fiber glass (CFG) and polyurethane foam (PUF) of different thicknesses. The combination of these materials doubles their properties, which means they increase the level of sound insulation. A promising direction may be the creation of a bimaterial based on a composition of materials with the same properties. This method of combination will make it possible to adjust the thickness of the coating without losing the required properties, achieving its effective value while maintaining lightness and strength.

Conclusions: The creation of a bimaterial by combining different materials used in structures can contribute to a significant increase in dissipative sound wave energy losses and an increase in the sound absorption coefficient. It is no exception that a careful approach to the development of the matrix and special porous fillers of such a bimaterial will provide additional thermal insulation for the structure, reduce the level of vibrations, and increase its viability. The plasticity of the bimaterial will allow you to easily attach and place the finished panels in the process of creating the structure.

REFERENCES

1. Батутіна Т., Бондарь Д. Огляд результатів експериментальних досліджень зниження шуму при старті ракет-носіїв шляхом прискання води. *Системне проектування та аналіз характеристик аерокосмічної техніки.* 2019. Т. XXVII. С. 3-6.