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Generalized Model Of The Process Of Forming The Sound Field Of Cotton Machine-Tractor Aggregates

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Abstract: Studies conducted to assess the noise characteristics of cotton machine-tractor aggregates (MTA) and their main sources have shown that the primary noise sources of cotton MTAs are the power unit, transmission of the base tractors, active working bodies, various mechanisms and structural elements of mounted or trailed machines, as well as the technological processes occurring in the machines. The article presents a noise-protection acoustics model for cotton-harvesting machine-tractor aggregates (MTA).

Keywords: Machine-tractor aggregates, noise, acoustic energy of an airborne-noise source, noise protection, noise and vibration.

INTRODUCTION:

It was established that noise sources generate complex sound fields that interact with one another and with various elements and components of the base tractors and the mounted (trailed) MTA.

Experience accumulated in engineering acoustics shows that, under certain assumptions, it is possible to calculate or predict the interior noise inside the cab of a cotton MTA. The sound pressure level at the operator’s workplace in cotton MTAs is determined by the total noise of the sources transmitted through the structural elements or frame of the MTA design (mounting brackets, supports, controls, panels, guards, etc.) and by the total airborne noise of the sources penetrating into the MTA cab or transmitted to the workplace through the air.

The generalized acoustic model for the formation of sound fields is based on the main principles of statistical and geometrical acoustics, as well as on the principle of energy summation of the acoustic energies of sources reaching the calculation point through various channels and paths.

A generalized block acoustic model of the cotton MTA is shown in the figure. The acoustic model of the cotton MTA under consideration is a system consisting of airborne-noise sources and sound vibration sources (simultaneously), secondary noise sources (reflecting and vibrating surfaces), and two channels or transmission paths that convey acoustic energy from the sources to the operator’s workplace. Each channel or path includes a number of noise-and-vibration protection system elements with different parameters and effectiveness. Each element of the generalized acoustic model of the cotton MTA has its own acoustic, technical, or operational characteristics, and its location relative to the workplace (calculation point) is determined by the layout scheme of the cotton MTA.

An airborne-noise source with acoustic energy intensity J1 in a certain frequency band simultaneously participates in forming the sound field of a secondary noise radiator, since the acoustic energy of the airborne-noise source, being repeatedly reflected from the surfaces of secondary radiators, contributes to an increase in their acoustic energy. In cotton MTAs, the airborne-noise sources include aerodynamic-origin noises and noises from MTA sources that have increased vibration-isolation effectiveness at their connection points with the frame of the base tractor.

Secondary noise radiators with acoustic energy intensity J2 are mainly passive sources, and their intensity J2 is closely associated with the sources of airborne noise and sound vibration. The intensity J2 (J1, J3, J4, S, α, V, f, m, k, η, x, y, z) is a complex function determined by the airborne-noise intensities J1 and J3, the sound-vibration intensity J4, the coordinates of the secondary radiator relative to the sources J1, J3, J4 and the workplace x, y, z, the area S, the sound absorption coefficient α, the loss factor η, and the mass m. As experiments on cotton MTAs have shown, secondary radiators participate in forming the sound field at the workplace as reflectors of acoustic energy (toward the calculation point) from airborne-noise sources, as radiators of noise produced by the vibrational energy of the MTA sound-vibration sources, and also simultaneously as both a reflecting and a sound-radiating surface. The transfer functions F1 (J1, S, α, x, y, z) and F2 (J3, J4, V, f, m, k) are interrelated through the dynamic, structural, and geometric parameters of various elements of the MTA acoustic model system. The acoustic energy of airborne-noise sources J1, J2, J3 reaches the workplace by passing through various noise-protection elements that exhibit sound-absorbing and sound-insulating effects. These elements may include the following: hoods of various types [1,2,3,4,5,6,7,8,9], casings, guards, acoustic screens; noise-protective cabs with sound-absorption means; silencers.

The energy of sound vibration J4, which propagates along the frames of the MTA and the tractor, passes through various structural elements and is transmitted to the workplace. In this case, the vibration-isolating effect of the structural elements largely depends on the design features of the sources, the frequency range of the sound vibration, the effectiveness of vibration isolators and vibration-blocking masses, and the methods used to mount the sources to the MTA frame or to the tractor structure, as well as on the effectiveness of vibration-damping means.

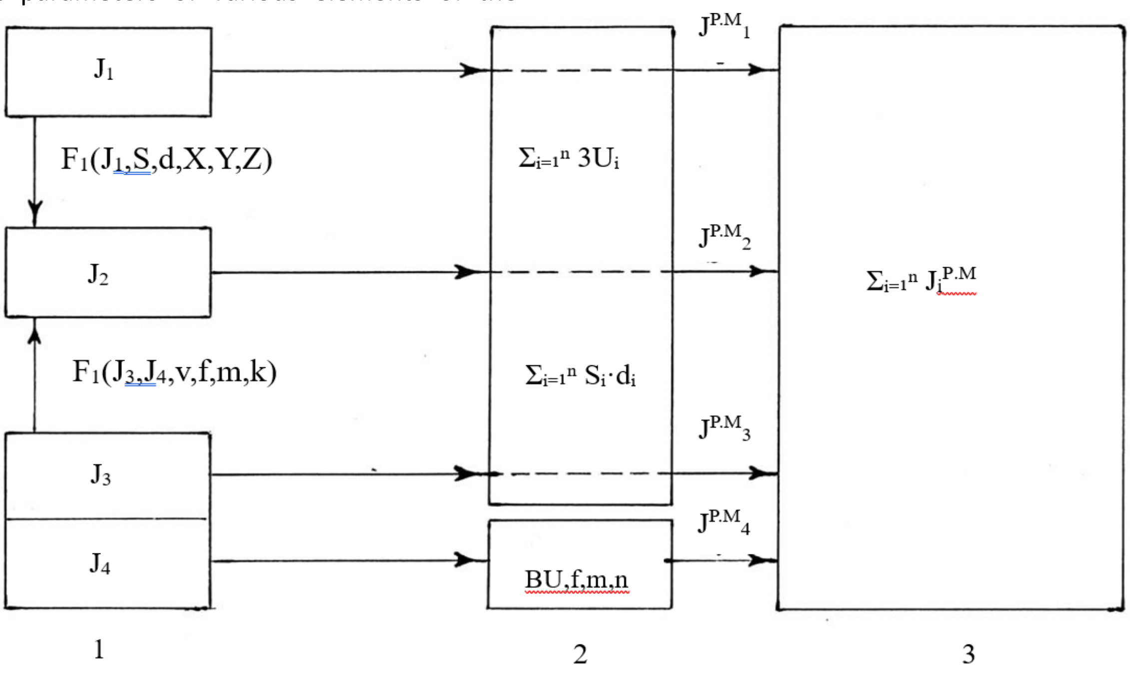

Fig. Generalized block acoustic model of a cotton MTA:
1 – acoustic energy sources (generators);
2 – noise-absorbing and noise-vibration-insulating means;
3 – workstation or cabin design point.

Experimental studies aimed at identifying the channels of sound energy propagation showed that noise transmitted through frame structures—the so-called structural noise—does not play a significant role in the formation of sound fields at the workplace of cotton MTAs. The level of the structural component of noise at the workplace is 10–20 dB lower than the level of the airborne noise component across the entire regulated frequency range. This pattern is especially evident for MTA noise sources, since the latter are mounted, trailed, or integrated into a separate frame and are connected to the tractor structure by numerous hinged and lever-type mounting systems that provide high vibration-isolation efficiency.

In addition, in all types of cotton MTAs, the working bodies and their mounting frames do not have a rigid connection with the frame of the base tractor, while the operator's workplace is located in the tractor cab. Therefore, the formation of the sound field at the workplace of a cotton MTA is mainly determined by the acoustic energies of airborne-noise sources J1 and J3 and of secondary radiators J2. If we consider that the acoustic energy J2 is derived from the energies J1, J3, and J4, then the main role in forming the sound field belongs to the airborne-noise sources J1 and J3. Thus, the entire noise energy is concentrated in the noise sources, and if the cause of noise generation is minimized or completely eliminated, the need to combat it along the propagation paths and at the workplace disappears.

However, in order to solve the problem of reducing noise at the sources, it is necessary to introduce criteria for their vibroacoustic activity in terms of airborne-noise level and to develop dynamic vibroacoustic models of the main noise sources, making it possible to identify the principal causes of increased vibroacoustic activity and the relationships between acoustic and structural parameters. These issues are considered using the example of the main noise sources of cotton MTAs, and a number of technical measures have been developed to reduce noise at its point of origin.

An analysis of the generalized block acoustic model of the cotton MTA showed that the determining factor in forming the sound field is the noise energy concentrated in the source. However, the real designs and layout schemes of all machines, including cotton MTAs, incorporate various hoods, casings, protective and technological guards, and a cab. These elements are integral parts of cotton MTAs and are mainly intended to ensure the normal operation of various working bodies and to protect the frictional parts of the MTA from dust, dirt, and moisture ingress. The cab also not only protects the operator from noise and vibration, but simultaneously provides a microclimate at the workplace, shielding it from dust, wind, rain, cold, thermal radiation, and exposure to pesticides (when performing technological operations and agronomic practices to control diseases and pests and to defoliate cotton).

Therefore, all the above-mentioned elements of the design and layout of cotton MTAs should be used rationally to reduce source noise along the propagation paths, since they are mandatory elements of any machine, regardless of whether noise reduction at the operator's workplace is required or not. To this end, at the design stage of casings, guards, screens of protective and technological purpose, and protective cabs, it is necessary to develop and incorporate into their designs sound-and-vibration insulation and sound-and-vibration absorption means.

From this standpoint, it is very important to evaluate the effectiveness of casings, protective guards, screens, and cabs of cotton MTAs in reducing noise at the operator's workplace, and also to assess the role and significance of the parameters of these elements or structural components of cotton MTAs in forming the sound fields at the workplace. The positive effect of these components of cotton MTAs should be taken into account when determining the required reduction in the noise level of the main sources.

Assessing the effectiveness of hoods, casings, guards, and the noise-and-vibration-protective cab in reducing source noise, and developing highly effective sound-and-vibration insulation and sound-and-vibration absorption means, in turn, is associated with addressing a number of issues: calculating the sound fields of the sources with due regard to their design features and noise characteristics; developing and selecting mathematical models and compiling acoustic calculation schemes; determining and refining the limits of applicability of the developed models and calculation schemes; substantiating the adopted assumptions and experimentally verifying them.

REFERENCES

1. Иванов Н.И. Борьба с шумом и вибрациями на

путевых и строительных машинах. - 2-е изд., перераб. и доп. - М.: Транспорт, 2017. - 223 с.

2. Sunnatulla Sulaymanov. Criterion For Vibroacoustic Activity of The Main Sources of Cotton Machines.// Fifteen International Conference on Thermal Engineering: Theory and Applications, May 28-June 1, 2024 Tashkent, Uzbekistan.
3. Sulaymanov S. Improving conditions and labor protection of operators by improving the vibroacoustic parameters of mobile cotton machines. dissertation of Doctor of Engineering. Sciences-St. Petersburg, 1992.-250 p.
4. Nikiforov A.S. Acoustic design of ship structures: Handbook. - L.: Shipbuilding, 1990. - 220 p.
5. Pobol O.N. Noise in the textile industry and methods to reduce it. U,: Legprombytizdat, 1987. - 144 p.
6. Artobolevsky I.I., Bobrovnitsky Yu.I., Genkin M.D. Introduction to the acoustic dynamics of cars. - M.: Science, 1979-296 s.
7. Anufriev V.I. Handbook of mechanical engineering designer: In 3 volumes - M,: Mechanical Engineering, 1979. - T.2, - P.342.
8. Korn G., Korn T. Handbook of mathematics. - M.: Nauka, 1978. - 831 p.
9. Alekseev I.V. Fundamentals of the theory of piston internal combustion engines with reduced levels of acoustic radiation: Author. dis. ... Doctor of Technical Sciences. - M., 1986. - 38 p.