Technical science and innovation

Volume 2022 | Issue 3 Article 11

10-10-2022

THE VIBRATION SOURCES OF CAR TRACTOR ATTACHMENTS

Sh Kh Kurbanov
Tashkent State Technical University named after Islam Karimov

U A. Rajapbayev
Tashkent State Technical University named after Islam Karimov

Recommended Citation
Kurbanov, Sh Kh and Rajapbayev, U A. (2022) "THE VIBRATION SOURCES OF CAR TRACTOR ATTACHMENTS," *Technical science and innovation*: Vol. 2022: Iss. 3, Article 11.
DOI: https://doi.org/10.51346/tstu-01.22.3-77-0194
Available at: https://btstu.researchcommons.org/journal/vol2022/iss3/11

THE VIBRATION SOURCES OF CAR TRACTOR ATTACHMENTS

Sh.Kh. Kurbanov, U.A. Rajapbayev
Tashkent State Technical University
Universitet st., 2.100095, Tashkent, Uzbekistan

Abstract: *This article presents measures to protect against the noise of operators during the work of machine-tractor units, and to prevent the occurrence of vibration as a result of tractor movement during work. Methods of acoustic processing of noise and vibration D-144; It has been proven that the noise characteristics of D-240T engines vary depending on the frequency of rotation of the crankshaft.*

Keywords: *machine-tractor, noise and vibration, engine, agricultural machinery, cotton machines, tractor speed, sound level, working body.*

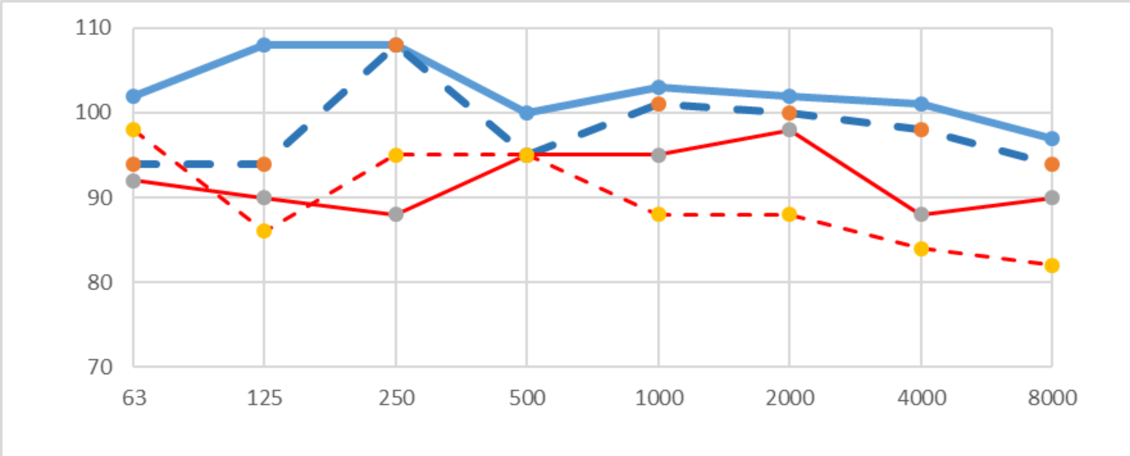
INTRODUCTION. Machine-tractor aggregates (MTA) are divided into tractors and transmission tractors according to the nature of the use of power tools. The peculiarity of the researched cotton MTAs is that the power tool (tractor) of many MTAs does not work in a fixed mode (engine load and speed). This, in turn, is conditioned by the agrotechnical requirements for the technological operation being performed or the limit value of the resistance between the working bodies of the MTA and its composition, agropriyom. All this naturally changes the noise generation process in cotton MTAs and their sources. In order to develop the requirements for the noise protection system, it is important to assess the impact of the technical and operational parameters of the cotton MTAs on the noise characteristics at the initial stage.

Therefore, in the work, the author investigated the noise characteristics of cotton MTAs depending on the change in the operating mode (engine load, speed of movement and technical-operational indicators). Cotton MTA engine load naturally changes their workplace noise load. This situation was proved in the results of noise characteristics of different aggregates on the basis of tractors of the same class operating at different load levels of the engine (Table 1). The dependence of the noise characteristics on the fast operation mode of cotton MTAs is little studied, but their interaction is important.

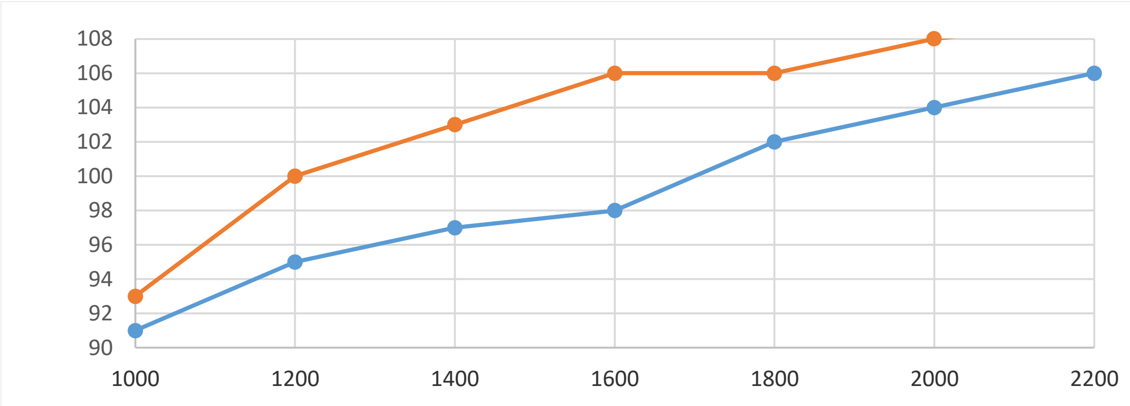
The influence of load-energy, technical-operational indicators and technical condition (term of operation and quality, technical maintenance) on noise characteristics of cotton MTAs and their main sources has also been little analyzed. The significance of the laws of influence of the above indicators of cotton MTA on their noise characteristics is important in solving a number of theoretical and practical problems of forecasting the expected level of noise, reducing it and maintaining the efficiency of the manufactured, implemented technical means, reducing the required noise during the entire life of the MTA allows[1].

The basics of forecasting and calculation analysis of noise characteristics in tractor design are considered in the works of M.A. Razumovsky [2], where he estimates and calculates the average sound level of the main sources based on the elements of similarity, measurements, modeling theories and qualitative analysis of mathematical models of the main sources A number of formulas have been proposed for.

MATERIAL AND METHODS. Our research was mainly aimed at obtaining practical and statistically reliable acoustic characteristics of the main sources (engine and transmission) of cotton tractors in order to evaluate the effect of cotton MTA operating modes on their noise.



a) engine rotation frequency, min $^{-1}$



b) engine rotation frequency, min $^{-1}$

Fig. 1. Noise characteristics of main (base) tractor engines at idle and full load (a) and depending on the crankshaft rotation frequency (b): 1–D-144; 2-D-240T.

The obtained results were used to develop requirements for noise protection systems and their elements. The measurement of noise characteristics is given by the author of this study according to the proprietary methods developed based on the requirements of GOST, where the measurement points and the diagrams of the used technical tools and equipment are also presented[2].

The analysis of the results of the noise characteristics of the engines of the cotton MTA main tractors shows (Fig. 1), that the sound level of the engines increases by 1.5-2 dB (A) at full load . The sound pressure level of engines (D-240T, D-144) usually increases at frequencies of 1000-8000 Hz.

The comprehensive nature of engine noise is explained by the complex polyharmonic nature of various influencing factors. There are no distinct tones in the engine noise spectrum, so engine measurements are given in octave frequency ranges.

The dependence of the engine sound level on the crankshaft rotation frequency is shown in Fig. 1b. As shown in the figure, when the engine rotation frequency changes from the minimum (15 S-1) to the maximum (36 S-1), the sound level value increases by 11-13 dB (A). This increase is approximately equal to the sound insulation efficiency of the TTZ series cabin. The resulting relationship can be used in the preparation of MTA, because often, the permissible technological speed of operation is achieved in two ways: at maximum frequencies of the engine at low gears of the gearbox or at high gears of the gearbox and at the average speed of engine rotation. From the point of view of reducing the noise level, in such cases, it is necessary to give priority to the mode of operation of the MTA in high gears of the gearbox and medium frequencies of the engine rotation, while reducing the fuel consumption of the engine[1,4].

This mode can be set by combining the graph of changes in sound level depending on the speed of the engine with its regular characteristics. As the obtained results show, the correctly installed mode allows to reduce the sound level of the engine by 6 dB (A) and to reduce the specific fuel consumption by 5-10%.

Noise characteristics obtained for different traction and energy characteristics of the main cotton MTA tractor transmission are presented in Figures 2a and 2b. It is known that the traction-energetic properties of cotton MTA are constantly changing during technological operations. The required and reasonable traction force and energy characteristics of the cotton MTA are set by changing the transmission mode of the power unit (tractor), that is, by changing the gears in the box. At the same time, the load and rotational speed of gears and transmission shafts change.

The analysis of the transmission spectrum in the fifth gear at different values of the traction force shows (Fig. 2) that when the traction force is tripled (from 3.4 to 10.2 kN), the sound level increases twice, that is, by 3 dB (A). The nature of the transmission noise spectrum does not change with the increase in traction (Fig. 2a), the transmission sound pressure level increases over the entire width of the normalized octave lanes.

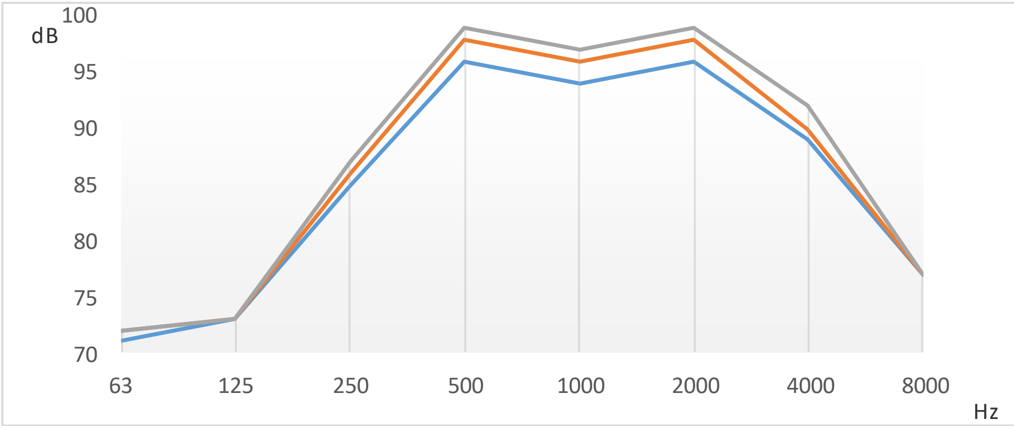
The analysis of the transmission noise spectrum shows that (Fig. 2a), the sound pressure level in the octave bands with geometric mean frequencies of 500, 1000 and 2000 Hz is the gear frequencies of the first (510-630 Hz) and second (1020-1310 Hz) gears and their subsequent harmony is determined by The change of the tractor speed to the noise level of the tractor has the following characteristics: when the value of the movement speed changes from 1.06 m/s (in the second gear) to 2.22 m/s (in the fifth gear), the sound level of the gear by 7.4 dB, that is, they. It increases by about 6 dB (A) per 1 m/s, a further increase in the speed of movement does not cause a significant increase in the sound level of the transmission (Fig. 2). Based on the traction force and energy characteristics of tractor transmission noise characteristics, we took these characteristics into account when developing requirements for noise protection element systems [1, 2, 3, 4].

These noise characteristics are taken at a distance of 1 m from the sources, that is, they describe the direct sources of noise. At the same time, the acoustic safety of work, which is characterized by the possibility of not harming the operator's hearing, is evaluated by the characteristics of noise in the operator's workplace - noise output (emission).

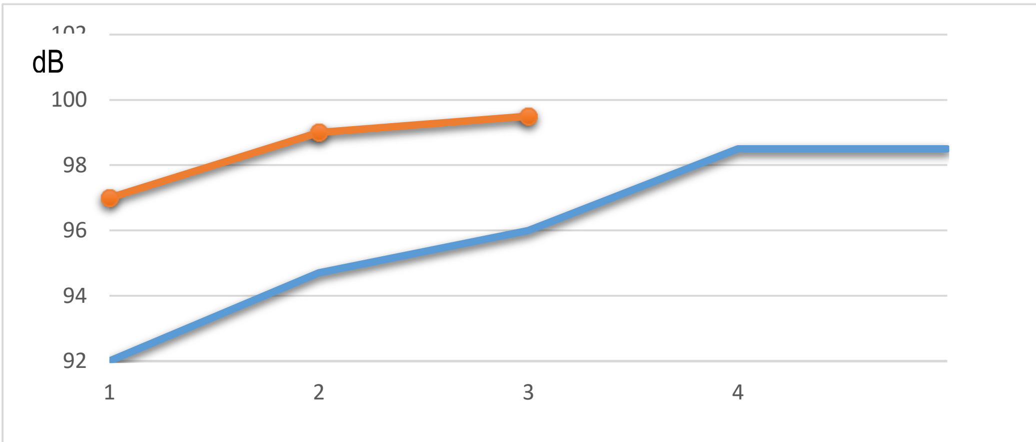
The required efficiency of noise protection systems and elements is determined primarily by the quantitative and qualitative indicators of the part of the acoustic energy of the sources transmitted to the workplace of the cotton MTA operator. Undoubtedly, noise emission is the main cause of emission, but taking into account the presence of reflective and protective elements whose design features and areas correspond to the study surface areas of the sources, we evaluated the noise characteristics of sources in the workplace according to the operational performance of cotton MTA engines and tractors[5] .

The spectrum analysis of the cabins of the investigated cotton MTAs shows that in all cases its lower constituents have relatively high acoustic energy values at frequencies of 63-125 Hz. Assessment of the noise at the workplace of the cotton MTA operator depending on the engine load was carried out on the main cotton MTA tractors (D-140, D-240 engine) [6]. Measurements of the noise characteristics of the tractors at work were carried out at zero and full load of the engines at the parking lot.

Figure 3 shows the changes in the noise spectrum at the workplace of the cotton MTA operator when the engine operates with different loads, which significantly changes the nature of the noise spectrum. In the low and high frequency ranges, the sound pressure level in the cabin increases by an average of 4-5 dB. In tractors with the D-144 engine, the increase in the sound level in the cabin is insignificant and amounts to 1 dB (A), the sound level increases by 2.5 dB (A) when fully loaded in the cabin of a prospective cotton tractor.



a)

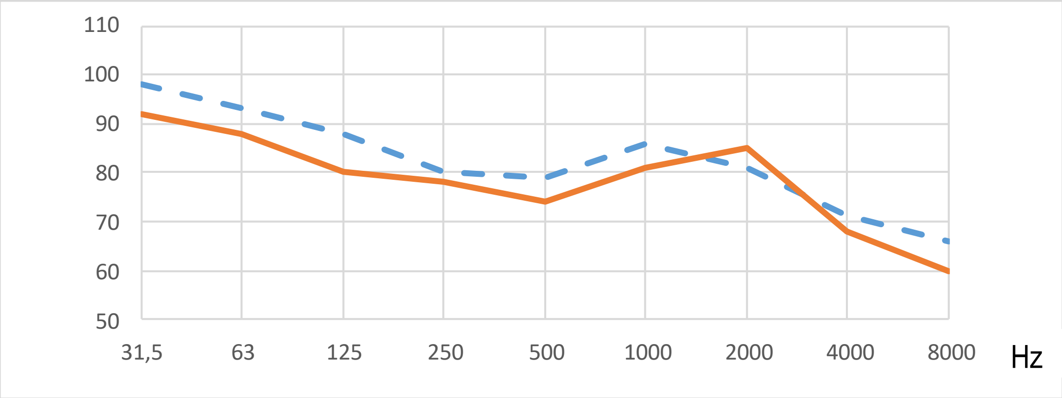


b)

Fig. 2. noise characteristics of the transmission of the main cotton MTA tractor: a - noise spectrum at different values of traction:
1-3.4 kN (25%); 2-6.8 kN (50%); 3-10.2 kN (75%); b - the effect of movement speed (1) and gravity (2) on the sound level of the transmission

The noise characteristics of the transmission in the cab were evaluated by two methods: pulling the evaluated cotton MTA with a flexible steel rope more than 20 m long and using a tractor with gearbox gears connected in series; operation of the cotton MTA in different gears at the nominal value of the motor frequency.

The measurement results showed that the highest values of the sound pressure level in the fourth and fifth transmissions in the octave band with a geometric mean frequency of 500 Hz are the maximum part of the acoustic energy in the frequency range of 63-125 Hz. The sound pressure level in the octave band of 500 Hz is 78 dB and is approximately equal to the sound pressure levels in the same octave band of the engine in the cabin (see Figure 3). Further investigation of the transmission noise characteristics showed that the sound pressure levels in the row crop MTA operator's workplace in the octave range with a geometric mean frequency of 500 Hz are determined by the sound power level of the tractor transmissions.



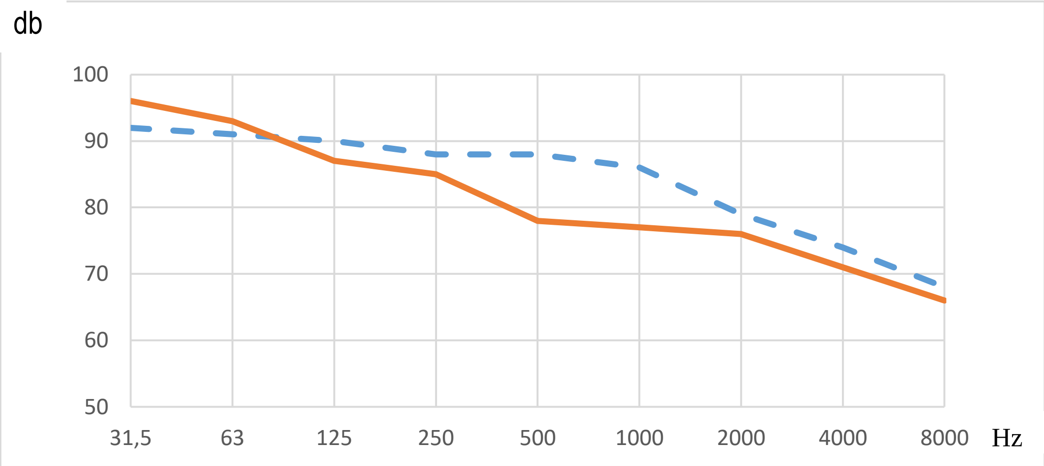


Fig. 3. Noise spectra at the workplace of cotton MTA main tractors D-144 (a) and D-240 (b) in different loading modes of the engines: 1, 2 when the engine is not loaded and at full engine load

It is known from previous experimental data that the sound field at the workplace of the MTA operator in cotton cultivation is formed depending on the location of the sources of noise and vibration. Therefore, it is very interesting to study the influence of various sources and technical factors on the level of noise and vibration in the operator's workplace. First, we will consider the sources of noise in the tractor, which is the most energetic and leading link of all cotton-growing machines. According to the methodology developed under the leadership of Ivanov, three main sources of noise in the tractor are distinguished: engine body, engine output and transmission [8]. Table 1 shows the measurement data of near-acoustic noise of cotton growing MTA sources. The most active source of noise in the tractor is the gas exhaust, its sound level is 108dBA. Exhaust gas noise has high values in the octave range of sound frequencies, and has values of 93-101dB at low frequencies. 99-103 dB A engine and transmission housing noise is high, 103-107 dB at medium frequencies.

RESULTS AND DISCUSSION. The listed sources should also include cabin ventilation and air temperature maintenance systems. These resources are available in all standardized cabin cotton MTAs. According to the geometric theory of acoustics, sound waves propagate along a straight line from the source to the receiver [1]. Therefore, the front wall and the floor of the cabin in the tractor have the greatest acoustic insulation. In turn, first of all, by improving the sound insulation of these elements, it is possible to increase the sound insulation of the entire cabin [7].

Table 1

Sound level and sound pressure level in the octave of the near field of MTA noise sources of cotton growing.

Source of noise	sound level, dBA	Average geometric frequencies of octave lines, Hz							
		63	125	250	500	1000	2000	4000	8000
Tractor D-144									
Body DVS	100	106	97	99	103	107	106	100	96
Gas release	108	103	105	93	99	101	99	100	93
Transmission	103	86	87	100	109	112	111	104	96
Tractor D-240									
Body DVS	99	108	98	100	103	107	104	96	89
Gas release	108	86	78	81	96	104	98	92	76
Transmission	99	99	98	98	104	105	104	98	92

Explanation; indicators are given in accordance with the methodological data [8].

A cotton tractor with an experimental cabin was selected to determine the distribution of noise and vibration. Noise and vibration propagation were studied at the joints of the engine wings, clutch housing and cab frame with the bracket. It was carried out in the connecting elements of the cabin, front, rear, right and left vibration isolators.The obtained results are presented in tables 2, 3.

Table 2

The rate of vibration of the elements of the cotton tractor.

Measurement points	general level, dB	Sound pressure levels at geometric mean frequencies (Hz) in octave lines,						
		63	125	250	500	1000	2000	4000
Left wing engine	112	102	101	101	101.5	103	103.5	107
On the right paw	113	104	101	101	101.5	103	106	104
In the coupling housing	112	103	101	100	101	102	107	103
Connection of the cabin frame with the bracket	97	91	91	91	91	91	96	91

When studying the propagation of noise and vibration from the engine to the connection point of the operator's cabin, it was found that the noise does not pass through the density of holes and holes, and as a result of the transmission of vibration through structural elements, it penetrates into the interior and surfaces of the cabin. The results of the study show that the level of vibration speed on the left and right legs of the engine is 112-113 dB. The level of vibration speed of the coupling body is 112dB, which means that the vibration spreads through the frames and along the elements of its structural connections [9].

Table 3

Level of sound vibration speed of cotton tractor elements.

Measurement points	Total level, dB	Sound pressure levels in octave lines with geometric mean frequency (Hz) in dB.						
		63	125	250	500	1000	2000	4000
Connecting elements of the cabin. From the front left point of the support: - to the vibration isolator -after the vibration isolator	105 98	101 92	101 91	101 96	101 94	102 91	102 91	103.5 91
Front right point of base: - up to the vibration isolator -after the vibration isolator	104 96	100 91	100.5 92	101 92	101 95	101 92	102 91	102 90
the rear left point of the support: -to the vibration isolator - after the vibration isolator	97 85.5	91 82	91 81	91 81	91 83	91 82	95 83	94 80
From the rear right point of the support: - to the vibration isolator -after the vibration isolator	95 85	91 81	91 82	91 82	90 81.5	90 82	93.5 83.5	93 80

It was found that the engine noise in the octave frequencies of 250-1000 Hz is transmitted through the air, and the vibration is transmitted to the operator's cabin through the structural coupling elements in the octave frequencies of 2000-8000 Hz.

CONCLUSION. According to the research results, it was found that the total level of vibration speed in the right and left legs of the engine was 112-113 dB, and the vibration level in the clutch body was 112 dB, which showed that the vibration energy does not decrease and spreads through the elements of the tractor frame. Structural noise spread by engine legs from 250 to 4000 Hz belongs to the frequency spectrum of these noise emitters. At the same frequencies, diffuse or structural noise is not reduced and propagates through solid materials. Therefore, the difference between the vibration speed level of the clutch housing and the vibration speed level of the engine legs is not large. The difference between the level of vibration at the joints of the cabin and at the engine legs is 15 dB. This means that the vibration transmitted through the engine legs penetrates into the cab frame bracket through various joints and vibration isolators. The frame of the bracket cab is connected to the axle of the rear wheel of the tractor. Before connecting the frame of the cabin with the bracket, a rubber vibration isolator (pad) is placed between them, which is fixed with bolts.

When measuring the front fulcrum of the cabin before and after the vibration isolator, the total vibration level has a difference of 9-11 dB in terms of the vibration levels of the rear right and left vibration isolator. According to the data in Table 3, the level of vibration speed at octave frequencies of 125 - 4000 Hz from the right and left front of the vibration isolator is equal to 101 - 103.5 dB. To evaluate the effectiveness of vibration isolators before and after the vibration isolator, the vibration speed levels of the geometric mean frequency of the octave bands were taken as 63 - 4000 Hz.

References:

1. Orderlies norms of acceptable noise levels in the workplace. **2016**. 13.
2. V.I. Nazarenko. Features of the physiological response in persons with increased individual sensitivity to noise when exposed to general low-frequency vibration. *“Occupational health and occupational diseases”,* **1988**. 22.
3. S. Sulaimanov. Ways to create low-noise cotton-harvesting machines. “*Tractors and agricultural machines”,* **1999**. 25.
4. N.I. Ivanov., G.M. Kurtsev., N.A. Nilov., N.S. Popov. Noise reduction in the cab of the K-70IM tractor. “*Tractory and agricultural machinery”,* **1990**. 40.
5. V.A. Arefev., A.N. Gersimov., V.K. Mikalutsky. Improving the soundproofing properties of the cabins of transport senichnykh machines. “*Tractory and agricultural machines”,* **1990**. 18.
6. S. Sulaymanov., Sh. Kurbonov. On the evaluation of the effectiveness of means of vibration and sound insulation energy saturated machine-tractor unit. “*Technical science and innovation”,* **2022**. 260.
7. G.M. Gulomova., Sh.Kh. Kurbonov. Studying the work of mechanizers, ways to increase comfort by reducing noise in the tractor cabin. “*National Guard Military-Technical Institute of the Republic of Uzbekistan Young scientist’s newsletter”,* **2019**. 188.
8. M. Jelnina. Landscape with decibells. Keep man away from noise. *“Nature and man”,* **1989**. 39.
9. G.M. Kukharenok., A.N. Petruchenko., V.I. Berezun. Reduced emissions of harmful substances from diesel engines. *“New knowledge”,* **2014**
10. A.S. Orlina., M.G. Kruglova. Engines of the internal structure. *“Mechanical engineering”,* **1981**.
11. G.M. Kukharenok., A.N. Petruchenko., V.I. Berezun. Reduced emissions of harmful substances from diesel engines. *“New knowledge”,* **2014**
12. S. Sulaymanov., Sh. Kurbonov. Study of the work of mechanizers, ways to increase comfort by reducing noise in the tractor cabin. “*National Guard Military-Technical Institute of the Republic of Uzbekistan Young scientist’s newsletter”,* **2019**. 188.