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INVESTIGATION OF NOISE PARAMETERS AT HEAD THRESHER OPERATION AND NOISE MAP DEVELOPMENT IN FREE SOUND FIELD

Sergey Rodimtsev, Yury Kuznetsov*, Vladimir Goncharenko, Evgeny Patrin, Larisa Kalashnikova

Orel State Agrarian University, Orel, the Russian Federation

Abstract: The article demonstrates the need to solve the problems connected with adverse acoustic impact on small tools and equipment operators of selective and seed-production process in plant breeding. Assessment method of the overall area of hazardous values of equipment noise characteristics in similar conditions and specialized device for carrying out acoustic research are described. The method to do research and to compile two-dimensional noise map by the example of head batch thresher is developed.

Key words*: noise characteristics, safety, head thresher, means of individual protection, professional diseases, small tools and equipment, noise audiometer-analyzer, measuring face, noise map*

INTRODUCTION

It is known that, excessive noise at long-term effect can result in workers' professional diseases, for example, occupational deafness. Excessive noise level effect during the working process is the cause of hearing loss in 16% of all cases. Besides, excessive noise level can increase workers' injury risk at the sake of decreasing the possibility of acoustic hazard assessment [1-3].

Under current conditions, the problem of noise impact on workers is considered by many leading experts and scientists. One of the activity spheres that are under investigations is agriculture where noise produces considerable impacts on personal.

* Corresponding author. E-mail: kentury@rambler.ru

But if for “big” mechanization of the production processes in plant breeding and cattle breeding the noise influence on workers is studied sufficiently detailed when utilizing small tools and equipment this influence requires further investigation. Thus, in selective and seed-production process (SSP) at relatively small quantities of the obtained samples and strict requirements to the quality of the performed operations small-sized and specialized machinery and equipment that can do sufficient noise impact on operators are used.

It is known that, different threshing devices belong to the machine types with the excessive noise level at operation. This is explained with their constructive peculiarities (the presence of belt driving, pulleys, rotating threshing drums, separator fans) and the method of influence on the processed material (shock action, friction processes between working elements and vegetal mass, separation of grain and non-grain part), and their utilization conditions.

For example, if at the Ist stage of SSP for separate plants threshing tabletop threshers with manual or mechanical drive (their noise impact level on operator varies from 40 to 65 dB) are used or plants are threshed manually, then at the II nd stage plant threshing is done in portable small-sized threshers with noise achieving 80 dB and more. At the III rd and the IV th stages of SSP bunch and sheaf threshers are used (70…120 dB, that is more than maximum acceptable level (MAL) 80 dB), and also grain combine harvesters of selective and selective and seed-production purpose are used. The noise impact level in their cabins can exceed 90 dB.

It is important to emphasize that low batch sizes of the tested material are processed in the closed laboratory conditions. At that, the noise spreading process indoors has its peculiarities being characterized with multiple reflections of acoustic waves from walls and different objects that are located in the working range and wave overlapping and increasing noise impact correspondingly. Except noise impact on machine operators using standard protective means, the influence is produced on other workers who are in the same room and are occupied with other job types.

To solve these problems the task to investigate free acoustic wave distribution and their frequency characteristics generated by one of the small tools and equipment means heavily used in SSP was formulated. As the result of this work we plan to reason methodology and develop guide lines to compile noise maps for the industrial noise sources. The last ones allow modeling acoustic waves spreading in laboratory closed space and starting to realize the complex of organizational measures and engineering and technical solutions directed to decrease the level of negative impact of industrial noise on workers.

MATERIAL AND METHODS

Researches were carried out on specially allotted territory of Federal State Budgetary Educational Establishment of Higher Education Orel State Agrarian University, using well-known and authentic testing equipment and methods.

The research object was noise level impact on workers. The research subject was head thresher MKS-1M (MKC-1M) utilized in SSP for threshing of separate spikes and grain crop bunches distinguishing light impurities. The basic technical thresher characteristics are presented in Tab. 1.

The recommendations on determining noise characteristics of noise sources in free sound field above sound-reflecting surface listed in GOST 12.1.026-80 are used as the main method [5]. To study noise level dependence from distance in the open space the individual method was developed.

Table 1. Technical characteristics of thresher MKS-1M (MKC-1M) [4]

Efficiency per hour, plants	*320*
Total capacity of electromotor [kW]	*0,25*
Rotational frequency [min^{-1}]: *- drum* *- fan*	 *1000;1300;1600* *3400*
Drum diameter [mm]	*194*
Changeable concave number	*3*
Mesh size of concaves [mm]	*6×32; 4×25; 3×20*
Overall dimensions [mm]	*570×330×485*
Mass [kg]	*21,3*

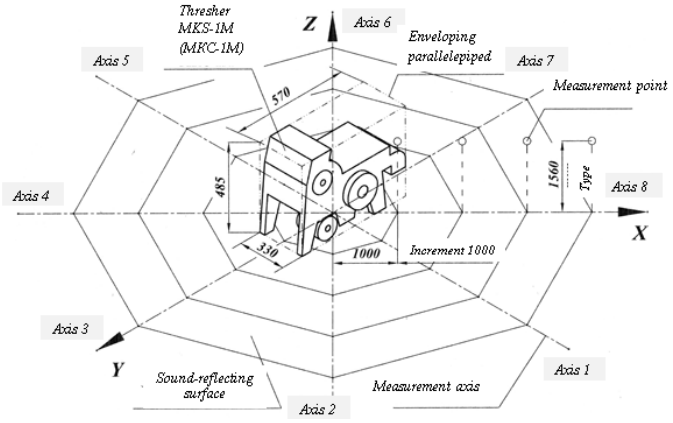

Figure 1. Scheme of measurements procedure

Thresher noise impact study was carried out in an exposed position excluding any obstacles and acoustic wave reflection. Eight axes were determined relatively noise source (Fig. 1), measurements were done in their direction. Each axis was divided into ten points in increments of one meter. Height from floor level in each point was chosen 1560 mm, which approximately corresponds to ordinate of adult acoustic analyzer position, according to anthropometric measurements in ergonomics [6].

Measurements were carried out at the thresher steady operating mode not less than in triplicate. The prepared bunches of winter wheat "Moskovskaya 39" were used for threshing. Drum rotational frequency was 1300 min^{-1}. Method of cluster analysis was used to compile a noise map, to arrange the empirical data in comparatively uniform groups [7].

Color scheme of the noise map is suggested by analogy with traditional one in similar investigations [8]. Color range corresponded to the obtained groups of noise levels in the coded units (Tab. 2).

Study of influence of distancing from noise source on its level in frequency ranges was carried out by means of correlation analysis method. Noise index measurements were done by spectra noise audiometer-analyzer "Oktava - 101 AM".

The device is intended to measure mean-root-square, equivalent and peak sound levels, acoustic pressure levels (SPL) in octave and one-third octave, to provide evaluation of noise influence on a person in industries, in dwelling and public buildings, to determine acoustic characteristics of mechanisms and machine and also scientific researches. Accuracy class: 1, according to GOST 17187 (IEC 61672-1) [9].

Measurement range: 16...146 dBA, mean-root-square levels of acoustic pressure in octave frequency band 31,5…16000 Hz. Measurement error of noise audiometer in standard environment does not exceed ± 0,7 dBA.

Table 2. Color codes of noise levels groups

№ of group	*Intervals of numerical series*	*Color code*	
		Linguistic meaning	*Color designation*
1	*70…71,12*	*green*	
2	*71,12…72,24*	*bright green*	
3	*72,24…73,36*	*yellow*	
4	*73,36…74,48*	*orange*	
5	*74,48…75,6*	*red*	
6	*75,6…77,1*	*brown*	

RESULTS AND DISCUSSION

On the carried out research ground, two dimensional noise map of head thresher MKS-1M (MKC-1M) is obtained in free sound field (Fig. 2). Apparently, the used color range and accepted intervals of measurement point spacing give full visualization of distributional pattern of acoustic waves and acoustic pressure values in different operating space zones, nearby operated equipment.

It is obvious from the noise map that acoustic wave distribution along axes of measurements is not uniform. Acoustic pressure level shifting in the area of axes 1, 2, is explained by the location of electromotor with basic mechanism drive and thresher separator fan in these areas. On the contrary, screening effect of housings of threshing and centrifuged device and machine side panels decreases considerably noise level in the direction of axes 3…8.

Thus, it is obvious that noise maps of separate units of mechanized equipment allow optimizing their arrangement in laboratory, considering decrease of adverse impact on personnel. Sound field modeling of the entire equipment complex indoors will provide an obvious picture of areas of direct and reflected sound, their combined action; provide the opportunity of predictive estimate of noise dose, obtained by personnel, analytical justification of acoustic pressure level decrease by means of utilization in laboratories the acoustic absorption means and individual protection means.

Finally, it will allow creating the most comfortable labor conditions at the workplaces, increasing labor productivity of workers, involved in selective and seed-production process, in the manufacturing process and testing new varieties of agricultural crops.

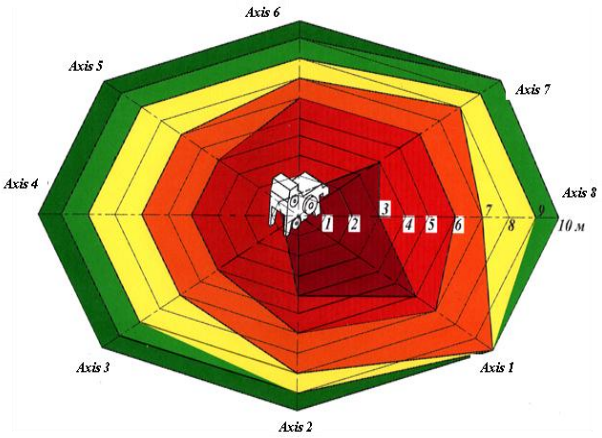

Figure 2. Two dimensional noise map of head thresher MKS-1M (MKC-1M)

CONCLUSIONS

1. Concerning labor conditions selective and seed-production process is one of the most underexplored branches of agriculture. Workplace noise connected with utilization of small tools and equipment is a real threat to workers' health;

2. Sound field mapping of the entire laboratory equipment complex is suggested to be used for effective solution of problems on decreasing of noise impact on scientific laboratory workers;

3. The method of investigation and compilation of two dimensional noise map, by the example of head thresher MKS-1M (MKC-1M) is developed;

4. The results of methodical experiment has allowed to establish that acoustic wave distribution along the axes of measurements is not uniform, which is explained by noise source arrangement and screening effect of thresher separate constructive components. The maximum value of equivalent level of thresher sound in operating mode is 81,2 dBA, the minimum value – 70,0 dBA. The intensity of acoustic pressure level decrease in frequency band on an average is 0,3…0,4 dBA, per 1 m of the length of distancing from noise source. At rather high equivalent sound level for low frequencies, its intensity at distancing from noise source, in the given band, is less than for high and medium frequencies;

5. Being carried out on the ground of noise map complex utilization, optimization of mechanized laboratory equipment arrangement will allow creating the most comfortable labor conditions, decreasing adverse noise impact on workers, increasing labor productivity, accelerating development of new progressive national varieties of agricultural crops.

BIBLIOGRAPHY

[1] Cvetanovic, B., Cvetkovic, M., Cvetkovic, D. 2014. Health risk assessment of vi bration generated by tractor exploitation to the drivers. *Poljoprivredna tehnika*, Vol. XXXIX, No. 3, p.p. 21-29.

[2] Radonjic, R., Jankovic, A., Aleksandrovic, B. 2012. Effect of terrain characteristics on the tractor vibration. *Poljoprivredna tehnika*, vol. XXXVII, No. 3, p.p. 11-23

[3] World Health Organization [Electronic resource] / *Deafness and hearing loss*; Information bulletin №300, March 2015. http://www.who.int.

[4] *Machines for mechanization of selective and seed-production works in plant-breeding*: catalogue / Ministry of Agriculture of the RF, Federal State Research Institution "Rosinformagrotech". - M.: Federal State Research Institution, 2002. – 69p.

[5] GOST R 12.1.026-80. Noise. *Determination of noise characteristics of noise sources in free sound field above sound-reflecting surface*. Technical method. – introd. 1981-07-01. – M.: - 12 p. - (Occupational Safety Standards System).

[6] Panero, D. 2008. *Fundamentals of ergonomics*. A man, space, interior: work book / D. Panero, M. Zelnik. - AST. : 2008. - 320 p.

[7] Dyuran, B. *Cluster analysis: work book* / B. Dyuran, P. Odell Per. from English. E. Z. Demidenko. Under the editorship of A. Ya. Boyarsky. Foreword of A. Ya. Boyarsky. - M.: «Statistika», 1977. - 128 p.

[8] Bocharov, A.A. 2012. *Acoustic noises of urbanized territories by the example of Tomsk* / A.A Bocharov, A.G. Kolesnik, A.V. Solovyev // News of Tomsk Polytechnic University. - 2012. - №1, Volume 321. - P. 191-196.

[9] GOST 17187-2010 (IEC 61672-1: 2002) Noise audiometer. Part 1. Technical requirements. – Instead of GOST 17187-81; introd. 2012-11-01. - M.: Standartinform, 2012. 36 p.

ISPITIVANJE PARAMETARA BUKE PRI RADU VRŠALICE I RAZVOJ MAPE BUKE U POLJU SLOBODNOG ZVUKA

Sergey Rodimtsev, Yury Kuznetsov, Vladimir Goncharenko, Evgeny Patrin, Larisa Kalashnikova

Državni poljoprivredni univerzitet, Orel, Ruska Federacija

Sažetak: U radu je predstavljena potreba rešavanja problema povezanih sa štetnim uticajem buke na rukovaoce malih alata i opreme za proizvodnju semena. Opisani su metod procene opšte oblasti opasnih vrednosti karakteristika buke ispitivane opreme u sličnim uslovima i specijalizovani uređaji za izvođenje akustičnih ispitivanja. Razvijen je metod ispitivanja i sastavljanja dvo-dimenzionalne mape buke kroz primer vršalice.

Ključne reči*: karakteristike buke, sigurnost, vršalica, sredstva za ličnu zaštitu, profesionalne bolesti, mali alati i oprema, merač-analizator buke, merna površina, mapa buke*

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