DYNAMICS OF NOISE CAUSED BY WOODWORKING MACHINERY

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Abstract. Around one third of workers in Europe are exposed to potentially dangerous levels of noise. Increase of noise level was researched in production circumstances, in wood processing at the inter-sharpening period of cutting tools. Attention was paid also to influence of other physical factors to the noise dynamics in the production. The noise levels are measured at saws, milling machines and grinders processing bulky timber preparations. The measuring was performed by digital noise meter "Uniset" that is supplied by data registering module HOBO HO8-004-02. BOX CAR computer programme is used for activating of the module. It was cleared out during the measures that noise level at all the groups of woodworking machines exceeds admissible equivalent noise level 87 dB(A) the line of not necessity for protection against noise impact on the workers and reaches 106 dB(A). Wearing out of the cutting instruments and their generated level of noise was referred to and cleared out in study of quality of processed surface or depth of kinematical waves. It was stated during the research that, as the result of wearing out of woodworking cutting instruments, the level of noise increases by 2 dB(A). Controlling planed pine preparations, it was stated that, with increase of noise and energy due to wearing out of the cutting instruments, quality of the processing surface or depth of kinematical waves grows by 23 % and is between 25 and 37 microns.

Key words: noise, measuring, woodworking machines

Introduction

Noise as physical value is met at any branch of economics and their technological processes. Prolonged exposure to loud noise can lead to hearing difficulties. To protect workers, the 2003 EU directive on noise that comes into force in all Member States in 2006 sets a daily (8 hr) exposure limit value of 87 dB(A). [2]

In the states of EU, every year millions of people suffer from the noise exceeding norms at work. About one third of employees (60 milj. people) are surrendered to high level noise more than one fourth of their work time [7]. Noise impact on people has to be considered both from the view of work environment and production means that has to be formed by employer, and from the view of motivation of employee to make the decision to work in this environment. The employee, working in the environment with megascopic noise, can be characterized that he/ she is uninformed about the harm of the noise, the person has low level of education and professional knowledge, he/ she needs job for any price in the conditions of unemployment, he/she has low demands to work circumstances, low culture of work, he/ she ignores initiatives by the employer to protect him/her not only from the noise impact. Disbalanced work environment usually is the reason for noise caused by construction of the premises and building materials, physically and morally deteriorated benches, poorly organized maintenance and repair of the benches, dissatisfactory prepared cutting tools, their quality, geometric parameters and adjustment to concrete production process, length of intersharpening period, quality of sharpening etc. The fact has to be appreciated that EU directive on equal daily amount of equivalent noise at 87 dB(A) in all the states of EU has come into force. Woodworking processes are usually performed in the presence of humans, in the work environment with large noise. Some benches, even marked by CE, can exceed 103-106 dB(A). It is allowed to work limited time in such noise without individual preventive means at high usage coefficient of woodworking benches. Hypothesis of the research is issue if woodworking cutting tools have dynamic changes of noise level during the inter-sharpening period because it can influence health and safety of the worker.

Does the quality of the material change with increase of the noise level? When the noise measures as a work environment parameter, for further environmental risk research should be done.

Topicality

Employers of Latvia do a lot to improve work environment conditions by obtaining new certified benches, original technologies, building new factories both in Latvia and abroad. There are also factories with physically and morally deteriorated benches and worsening work environment

parameters. Every modern wood processing bench has real work environment risks with harmful parameters for health.

As the object of the research, was chosen work environment of timber preparations processing with different woodworking benches circular saws, cross-cut saws, one-side and four-sides plaining and calibrating of glued timber shields with grinders.

Work subject of the research was pine preparations (1453x49x23 mm) with humidity W=8%, density 510 kg/m^3, shavings 2 mm. Medium quality dry saw timber is cut into required length, planed, sawn into laths, glued in shields that are calibrated afterwards. Measurements are performed long time period in series. Noise is measured at all the stages without interfering in production process at work places of operators of the benches. The results have common features and character.

Topicality of the issue is connected with growing demands to work environment in Latvia. It is necessary to measure work environment parameters at enterprises including noise. Laboratories performing the measurements are not always supplied with people with technical knowledge in wood processing. Therefore it is important to elaborate concrete suggestions to make the measurements maximum objective to enable the employers to organize purposeful work protection. There is not information about similar researches. The existing studies are connected with geometric forms of cutting tools but not exactly with time set of noise measurement. Increase of equivalent noise level at inter sharpening period of cutting tools is serious announcement of measurements activities at any branch of economics where cutting tools are used as the working instrument. Cutting tools wear out during working process; roughness of the surface worsens resulting in increased noise at the work environment. Therefore it is important to determine the time period when to start noise measuring in such cases, what mistakes are done if they are performed by free choice.

Noise influences negatively nerve system, heart and heart vessel system, hearing and other systems. Weakening of hearing because of noise at work environment is included in list of occupational diseases [7]. Hearing trauma is damage of nerve cells of ear that do not renew.

Influence of noise to health of employee expresses as more frequent breathing, loss of concentration and too high blood pressure. Consequences can result in damaged heart and vessel system, alimentary canal, optic and nerve systems. Noise can promote also other diseases and related work missing. Noise can cause accidents and increased production mistakes. Practice shows that the noise from the wood processing benches exceeds the maximum permissible level by 15-20 dB(A).

Rules in Latvia determine work protection demands for employees' safety at the noise risk circumstances, especially if worsening of hearing is possible. It is stressed in the rules that nobody at enterprise must be submitted to noise with equivalent level above 87dB(A) during shift [2]. If the level of the noise exceeds permissible 87dB(A) equivalent level of noise and no individual protection means are use, the rules envisage limited (shorter) working hours.

Research object and methods

The noise measuring is performed according to noise measuring procedure [2] that is based on norms and technical documentation of producers of noise measuring equipment.

Before the noise measuring, preparatory activities were done: organizatory questions were set up (time of measurements, preparatory activities for the measurements).

Noise measurement points were set by following demands:

- The measurements are performed in places where the noise can cause risk for human safety and health, especially hearing;
- The measurements are performed at 1m distance from walls or other reflecting surfaces, 1.2 – 1.5 m above the floor and about 1.5 m from windows;
- Two measurement points are chosen;
- Measurements are taken at presence of people at 0.1 m from ear of the operator receiving the biggest equivalent noise level;
- Measurement circumstances are characterized by 1m distance between the benches and the walls;
- Measurements are applied by verified acoustic measure equipment;
- The obtained results of the noise level are indicative.

Measurements of depth of kinematical waves are made with digital indicator "Millitast 1082". The measurements are performed according to GOST 15612- 85 methodic. Slowly moving the foot of the measuring tool along plained surface of a timber preparation, the needle of the tool is copying rugs. The deepest rug with sign "-" is read on the screen and fixed in the report.

Measurements are done at wood processing enterprise, at production circumstances with digital noise level meter (Department of Work Environment, Latvia University of Agriculture) " Unitest Sound level meter 93411" for determining of level of acoustic pressure, that is equipped with module " Hobo HD - 004- 02" for keeping of information of noise pressure level. Box Car computer program is used for the module activating. The data registering period and time of registration is entered in the module from the computer. Previous information is deleted from the memory and entered into the data registering program. After the data registering, the module has to be connected to the computer again to load the information from the module in the Box Car program file of the computer. The loaded data are tables and graphs [6]. You can see, copy, print and export them to other programs, for instance, to Microsoft Excel, and to process in necessary way.

"Hygiene Rules for Noise Measurements at Work Places" are used for the noise data processing [4]. Correlation analysis is done to the data of the measures on correlation between surface roughness and level of equivalent noise. The aim of the correlation analysis is to determine closeness between the factorial and resultative indices. The factorial indices is responsible for variety of resulting indices. Variability of numeral value of the resultative indices is studied depending on values of other indices.

For calculation of the correlation coefficient, the function CORREL at the programme Microsoft Excel is used. If connection between the indices is linear, e. i. changes of proportionally equal resultative indices correspond to changes of factorial indices, then closeness of this connection is determined by linear correlation. Diagrams of correlations are used to visualize kind of connection and closeness between the factorial and resultative indices. Dissemination of the points characterizes the closeness of the linear correlation. The calculated correlation coefficient has to be compared to critical value of the correlation coefficient and it has to be bigger or equal. The critical value of the correlation coefficient is determined by credibility 95 %.

Results and discussion

Measurements of noise are performed at eleven work places of operators of wood processing benches. Three measurements were done at inter- sharpening period of cutting tools: after sharpening, in the middle of the inter-sharpening period and before their change. Length of the measurements is per 20 minutes each time. As the result, graphoanalytic record of the noise level is got at each time period. For the analysis of the noise level, the most stable interval from the record was chosen. It is taken as a basis for determining of equivalent noise at the concrete wood processing bench (Fig. 1).

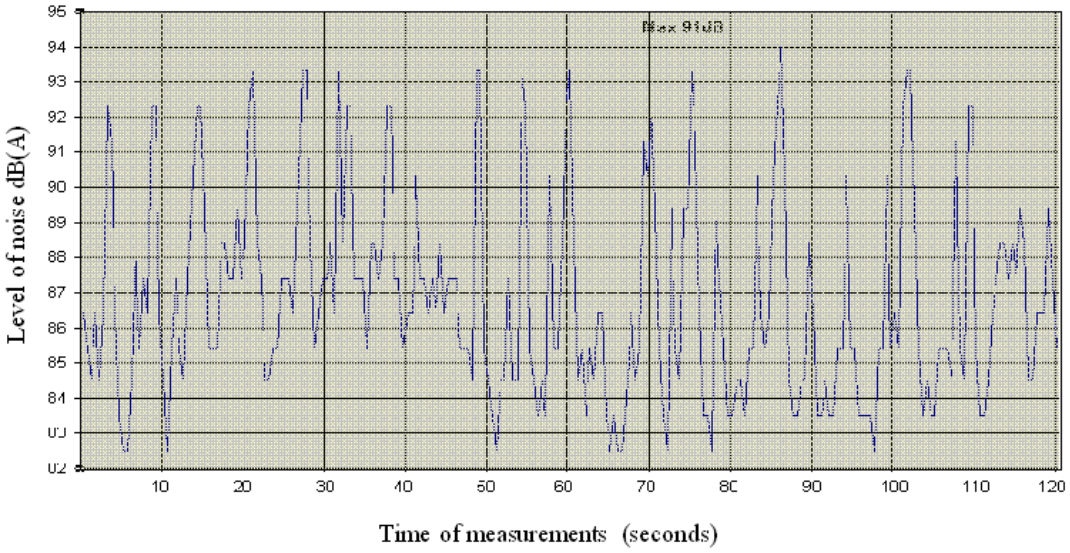

Fig. 1. **The characteristic noise level used for determining of equivalent noise level at the optimizing line "Grecon Dimiter Opti- Cut 304"**

Table 1

Determining of equivalent noise level at the optimizing line "Grecon Dimiter Opti- cut 304"

Level of noise, dB(A)	Length of noise level during the measure-ments (sec)	Time that an employee spends at the noise (% of measure-ment time)	Calculated time that an employee spends at the noise min. / shift, (420 min. / shift)	Amount per which the noise level has to be changed, dB(A)	Level of noise after changes, dB(A)	Correction of the noise level, dB(A)	Correction of the noise level and the greatest sum of neighboring level, dB(A)
82	5.0	4.2	17.50	-14	68	-	68.00
83	14.0	11.7	49.00	-10	73	1.2	74.20
84	16.5	13.8	57.75	-9	75	2.5	77.50
85	21.0	17.5	73.50	-9	76	2.25	79.75
86	13.0	10.8	45.50	-11	75	1.2	80.95
87	12.5	10.4	43.75	-10	77	1.5	82.45
88	9.5	7.9	33.25	-12	76	0.9	83.35
89	5.5	4.6	19.25	-14	75	0.6	83.95
90	4.5	3.8	15.75	-15	75	0.5	84.45
91	4.0	3.3	14.00	-15	76	0.55	85.00
92	8.5	7.1	29.75	-12	80	1.2	86.20
93	5.5	4.6	19.25	-14	79	0.75	86.95
94	0.5	0.4	1.75	-23	71	0.2	**87.20***

*Calculated equivalent noise is 87.2 dB(A).

Using the methodic [4], the equivalent noise level at the optimizing line of wood preparations "Crecon Dimiter Opti- cut 304" is calculated (Table 1). Irrespective of noise level changes between 87.0 dB(A) and 94 dB(A) during the time of measurements, the equivalent noise level at the operator's work place during the shift was 87.2 dB(A). It exceeds the permissible value 87.0 dB(A) just a little bit. Such noise level is not dangerous for health but it must not progress. Similarly noise level is analyzed also at other operators' work places. The research shows that at 6 work places out of 11, equivalent noise level largely exceeds permissible margin (Table 2). Therefore activities for the workers' health and safety maintenance are necessary. Research of noise dynamics is performed at the same time with study of surface asperities of processed timber preparations.

Table 2

Equivalent noise level at the work places

Work places	Amplitude of noise level measurements, dB(A)	Equivalent noise level, dB(A)
Grecon Dimter Opti-Cut 304	82-94	87.2
Opti-Kap 2002	78-101	87.9
Grama UK 92 SP	94-97	94.6
Gubisch	95-101	96.0
AT Innova OY	82-91	85.2
DMC-Polisand (loading)	87-93	88.9
DMC-Polisand (unloading)	87-93	87.8
Holzma	86-96	88.0
Mita MM	84-88	85.2
Sorting place	79-93	84.2
Unloading of glued blocks	84-88	85.1

Cutting tools are wearing out in the work process. As the result, the surface becomes rugged, kinematical waves become deeper. Wherewith, the equivalent noise at work environment is growing (Fig. 2). After three series of measurements (see Fig. 2), we can see how the level of noise and depth of kinematical waves is changing in time. Noise dynamic changes in time are fortified by equations but their credibility is proved by determination coefficient R^2 [5].

In all the series of measurements, graphic character of equations is similar. At each measurement series, the absolute value of noise depends on many other factors that are not studied here, for instance, cutting power, speed of material supply, size of crosscut of the preparation etc.

It is characteristic at the third measurement series (Fig. 2) with rugs between 32 - 37 microns. Preparation with crosscut 45x19 mm is processed. To escape vibration during the processing process, sliver is thinned. Therefore the noise level is between 99 and 99.8 dB(A), but the roughness of the processed surface is greatest of all the series.

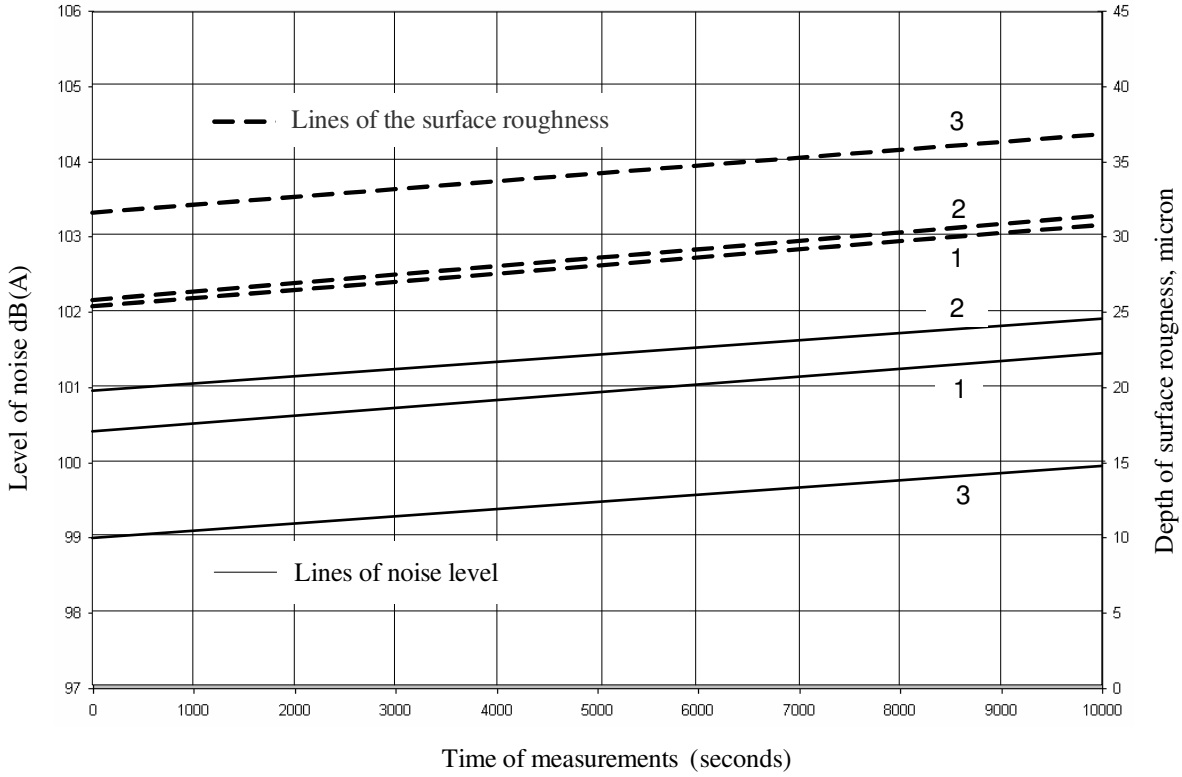

Fig. 2. **Dynamics of the noise and surface roughness:**
1, 2 and 3 – numbers of experiment

The research shows that, processing the preparations with grinder "Gubisch", level of noise grows approximately by 2 dB(A) during the inter- sharpening period (5- 6 working hours) after sharpening of the cutting tools. Wearing out of cutting tools is confirmed by increase of depth of the rugs from 25 till 37 microns.

The research proves that the noise level at wood processing benches has to be measured shortly before change of the cutting tools, not at just sharpened cutting tools because they have dynamic increasing changes.

The research shows that if the employed does not use hearing protection means at the work place, permissible exposition time of the noise at the level between 99 dB(A) and 102 dB(A) at boundary value 87 dB(A) decreases from 30 minutes to 15 minutes [2].

To choose hearing protection means for safety and health protection of the workers, noise dynamic changes during working time have to be taken into account.

Conclusions

1. Evaluating work environment risks, equivalent work environment noise, not maximum values of the noise have to be taken into account.
2. During the measurements and wood processing, noise level was between 78.0 and 101.0 dB (A), but the equivalent noise at the work environment is between 87.2 and 96.0 dB (A) and it remarkably exceeds the permissible 87 dB(A) noise level.
3. Dynamics of noise level at wood processing has probability 0.95. We can conclude that it has linear character. It is characterized by equations and their correlation coefficients. The correlation coefficients are tested with critical value; they are credible because, in all the cases, inequality is valid that the coefficient of correlation is larger than its critical value at concrete number of measurements.
4. Inter- sharpening period of cutting tools and depth of kinematical waves with approximate exactness (necessary for practice) can be determined by increase of the noise level.
5. Noise level increases by 2 dB(A) at inter- sharpening period (5-6 hours) of the cutting tools.
6. Graphoanalytic record of the noise level with data registering module HOBO H08-004-02 gives opportunity to get, keep and make analysis repeatedly with the same data- output.
7. Calculating of correct equivalent noise level is guarantee for the protection of the workers from the noise caused harm: obligatory medical care in time, corresponding selection of individual protection means, purposeful spending of money, it is caution for health and safety of the workers.

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