IMPACT STUDY OF A DUST REMOVAL SYSTEM ON REDUCTION OF SELECTED HEALTH HAZARDS OF EMPLOYEES IN CARPENTRY

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Abstract: One of the most important aspects related to the proper functioning of prosperous enterprises in the wood industry is to ensure safe and hygienic working conditions. The fulfillment of this condition is obligatory for all workplaces regardless of the field of activity. Due to the specificity of the industry based on wood processing, this industry is inseparably connected with the problem of pollination at workplaces. The chips that are formed during processing make it difficult to work, remain in and around workplaces, creating additional risks and impairing the quality of the manufactured products. It is therefore necessary to apply solutions to eliminate the dust hazard. One of such solutions, belonging to collective protection measures against pollination, are dedusting installations. One of the tools to improve working conditions is mandatory risk assessment. Thanks to its reliable implementation, it is possible to identify hazards occurring at workplaces and take measures to improve working conditions. Proper management of occupational risk is one of the key elements to ensure protection against risks at an appropriate level. The article analyzes the impact of the dedusting installation on the reduction of selected health hazards for employees in the selected carpentry shop.

Keywords: dedusting installations, risk assessment, OHS, health hazard

1. INTRODUCTION – THE CHARACTERISTICS OF THE WORKPLACE IN THE WOODWORKING SHOP REQUIREMENTS

Featured woodworking factory has an area of 360 m^2, it is naturally and mechanically ventilated, lit with natural light (51 m^2 of windows – 1.8 m^2 on 8 m^2 of floor, with 1 m^2 of window required for 8 m^2 of floor (MPiPS, 1997)) and artificial (500 lux). The temperature in the hall varies from 18℃ in winter to 26℃ in the summer. The employee has 12 m^2 of machine–free space (with required 2 m^2 (MPiPS, 1997)), and 40 m^3 of free space from machine tools (with 13 m^3 required (MPiPS, 1997)). The width of transitions between machines is min. 1.1 m (with the required 0.75 (MPiPS, 1997)). A number of personal and collective protection measures are applied.

The following risks were identified in the carpenter's position:

- Fall;
- Damage to the body through moving parts of machine;
- Damage to the body through workpieces;
- Excessive dynamic load;
- Noise;
- Dusting;
- Fire;

- Electric shock;
- Chemical factorsreferences.tables.

2. POLLINATION MEASUREMENT BEFORE INSTALLING THE DUST REMOVAL SYSTEM

To study the level of dustiness (determination of the dust exposure index), one employee was selected, representing the workplace of a carpenter in the examined plant. Air samples taken to determine the concentration of dust at the work of the carpenter were taken in accordance with the guidelines of norm (PKN, 2004). A minimum weight of total dust on the filter at 0.3 mg was assumed. At the time of the measurement, the employee performed typical activities for his station in the following order: transport of items from the warehouse, sawing, planning and milling, grinding of elements, drilling, turning and transport to the warehouse. Samples were taken continuously for six hours. At the time of measurement, five samples were taken (another five filters). The results of the measurements obtained are presented in the table below (Table 1).

Table 1
The result of the sampling measurements before installing the dust removal

Number of filter	Mass of filter before taking a sample of dust [mg]	Mass of filter after taking a sample of dust [mg]	Time of sampling [min]
1	0.20	1.73	45
2	0.20	1.02	125
3	0.20	2.52	40
4	0.20	2.23	35
5	0.20	0.96	115

Based on formula 1, the total dust concentration was determined X_i.

$$X_i = \frac{(m_{2,i} - m_{1,i})}{V_i} * 1000 \left[\frac{mg}{m^3}\right] \quad (1)$$

where:
$m_{1,i}$ – mass of i–filter before taking a sample of dust [mg],
$m_{2,i}$ – mass of i–filter after taking a sample of dust [mg],
V_i – volume of sucked air [dm^3]

The volume of air sucked was calculated based on the formula:

$$V_i = P * t_i \, [dm^3] \quad (2)$$

where:
P – air flow [dm^3/min]
t_i = time of sampling [min]
The results obtained are shown in Table 2.

Table 2
Determination of dust concentration at the workplace before installing the dust removal system

No.	Mass of sample of dust on filter ($m_2 – m_1$) [mg]	Air flow in personal exhauster [dm^3/min]	Time of sampling [min]	Volume of sucked air V_i [dm^3]	Dust concentration X_i [mg/m^3]
1	1.53	2	45	90	1.00
2	0.83	2	125	250	3.32
3	2.32	2	40	80	29.00
4	2.03	2	35	70	29.00
5	0,76	2	115	230	3.30

Then, using the formula 3, the dust exposure indicator C_w was determined:

$$C_w = \frac{\sum_{i=1}^{n} X_i * t_i}{\sum_{i=1}^{n} t_i} * \frac{T_e}{480} \left[\frac{mg}{m^3}\right] \quad (3)$$

where:
X_i – dust concentration in i–sample [mg/m^3]
t_i – time of sampling of i–sample of dust [min]
n – number of samples taken
T_e – exposure time [min]
The results are presented in the table below (Table 3).

Table 3
Determination of the dust exposure indicator before installing the dust removal system

No.	Dust concentration X_i [mg/m^3]	Time of sampling of sample of dust t_i [min]	Dust concentration* Time of sampling of sample of dust	Exposure time T_e [min]	Dust exposure indicator C_w [mg/m^3]
1	17.00	45	765.00		
2	3.22	125	415.00		
3	29,00	40	1160.00		
4	29.00	35	1015.00		
5	3.30	115	379.50		
Sum		360	3734.50	460	9.94

The exposure index for wood dust at the workplace of the carpenter in the plant before the application of the dedusting installation is 9.94 mg/m^3. The highest acceptable concentration in total dust for wood dust (except hardwood dust, ie beech and oak) is 4 mg/m^3 (MPiPS, 2014). The multiplicity of the standard for the result obtained is: k = 9.94 / 4 = 2.49.
The concentration of wood dust on the site in the selected plant exceeds the permissible standard by almost two and a half times.

3. RISK ASSESSMENT BEFORE INSTALLING THE DUST REMOVAL SYSTEM

The ability to satisfy the needs of clients (including internal ones, as well as employees of the company) is necessary not only in activities going outside, but also within all organizations (Sitko, 2015). For carpentry workers, the basic need is safety at the workplace. One of the tools to improve working conditions is a compulsory assessment of occupational risk, i.e. the probability of occurrence of undesirable events related to the work performed, causing losses and the occurrence of adverse health effects in the employee (Komisja Europejska, 2000). Thanks to its reliable implementation, it is possible to identify hazards occurring at workplaces and take measures to improve working conditions. Proper management of occupational risk is one of the key elements to ensure protection against risks at an appropriate level.
Table 4 shows the Occupational Risk Assessment Card before using the de–dusting installation. Due to the volume framework of the article, the selected hazards are included in the card. The following markings have been adopted: C – severity of consequences, P – probability of occurrence, R – risk, M – low severity of consequences/unlikely/low risk, S – average severity of consequences/likely/medium risk, D – high severity of consequences /highly probable/high risk.

Table 4
Risk assessment on the workplace of carpenter before installing the dust

No.	Danger	Source of danger	the potential effects of the threat	Before application of preventive measures			Preventive measures	After application of preventive measures		
				C	P	R		C	P	R
1	Fall	Slippery, uneven surfaces	Bruises, limb fractures, concussion	S	S	S	Non–slip shoes, order at the workplace	Ś	M	M
2	Damage to the body through moving parts of machine	No cover or security, wrong posture or hand positioning	Severe injuries to fingers, hands, face and head	D	D	D	Use of efficient protective covers and mechanisms,	S	S	S
3	Damage to the body through workpieces	Processing of wooden elements	Rubbing, cuts, mainly hand and face	S	D	D	Adheres to the station instructions	M	M	M
4	Excessive dynamic load	Manual handling of components with a weight exceeding the norm	Spinal and joint injuries	D	D	D	Compliance with lifting standards	S	M	M
5	Noise	Non–use of hearing protectors	Hearing loss	D	D	D	Use of hearing protectors	S	S	S
6	Dusting	Mechanical processing of wood	Respiratory diseases	D	D	D	Individual protective equipment (masks). The dedusting installation will be introduced	–	–	–
7	Fire	Placing flammable waste in workstations	Burns, death	D	D	D	Ongoing removal of waste from workstations	S	M	M
8	Electric shock	Damaged anti–shock protection	Death	D	D	D	Applying effective and effective anti–shock protection	M	M	M
9	Chemical factors	Paints, varnishes, solvents	Poisoning, allergies	S	S	S	Follow the guidelines in the substance sheets	S	M	M

On the basis of the occupational risk assessment carried out at the carpenter's workplace in the examined carpentry workshop, it can be concluded that:

1. The source of a significant part of the threats are woodworking machines, whose movable, sharp and protruding parts, when not using appropriate prophylactic measures, can lead to significant bodily injuries. The use of appropriate measures (mainly shields compliant with machine maintenance and technical documentation) limits the probability of an undesirable event and thus the level of risk – from high (unacceptable) to medium (acceptable risk, however, it is still necessary to plan and implement actions that will seek to reduce risk level) or small.
2. An important aspect is the attitude of employees – adherence to job instructions and health and safety regulations is a key element in reducing the level of risk.

3. One of the most important hazards in the carpenter's work is wood waste (chips) that arise during processing – they can lead to damage and damage to the face and eyes.
4. Pollination is an inseparable threat in the carpenter's work. In the woodworking station, the permissible dust concentration is exceeded two and a half times, which can lead to a number of respiratory diseases (pneumoconiosis, allergies, dermatitis, cancer) and eye diseases (including conjunctivitis) (Kordecka, 1999). In addition, this level of dustiness negatively affects the comfort and quality of work.

4. CHARACTERISTIC OF THE DUST REMOVAL SYSTEM

On The basic element of the dust extraction system is a filter that serves to separate dust and chips and sawdust that arise during mechanical woodworking. In the discussed case, a floor filter was installed on the roof of the sawdust tank. The device responsible for transporting dust from filter machines is a fan. The filter capacity was selected for the air demand of all machines working simultaneously. The air demand of machines was calculated based on outlet diameters (openings through which dust and chips are removed during operation) (Juda, 1968).
Due to the machine layout, three extraction lines have been designed. Figure 1 shows the course of these lines.

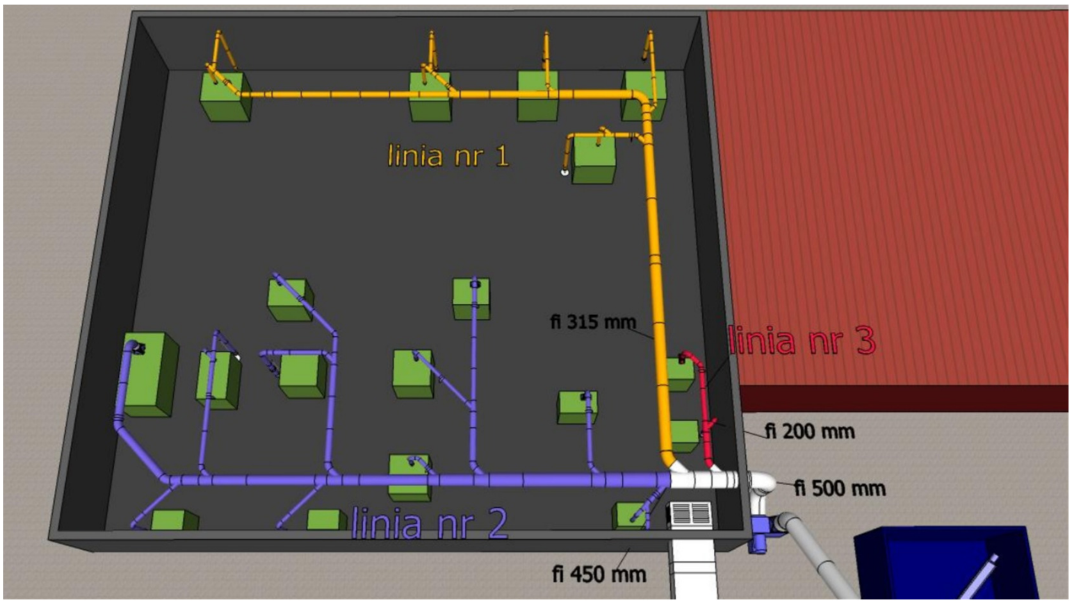

Fig. 1. Route of extraction lines of dust removal system

5. POLLINATION MEASUREMENT AFTER INSTALLING THE DUST REMOVAL SYSTEM

After installing the dust removal system, dust measurements were carried out again. The measurement was carried out continuously for 6 hours, in succession up to two filters. The results of these measurements are shown in Table 5.

Table 5
The result of the sampling measurements after installing the dust removal

Number of filter	Mass of filter before taking a sample of dust [mg]	Mass of filter after taking a sample of dust [mg]	Time of sampling [min]
1	0.20	0.51	215
2	0.20	0.57	145

The dust concentration is shown in Table 6.

Table 6
Determination of dust concentration at the workplace after installing the dust removal system

No.	Mass of sample of dust on filter ($m_2 – m_1$) [mg]	Air flow in personal exhauster [dm^3/min]	Time of sampling [min]	Volume of sucked air V_i [dm^3]	Dust concentration X_i [mg/m^3]
1	0.31	2	215	430	0.72
2	0.37	2	145	290	1.28

The dust exposure indicator was then determined. The results are presented in Table 7.

Table 7
Determination of the dust exposure indicator after installing the dust removal system

No.	Dust concentration X_i [mg/m^3]	Time of sampling of sample of dust t_i [min]	Dust concentration * Time of sampling of sample of dust	Exposure time T_e [min]	Dust exposure indicator C_w [mg/m^3]
1	0.72	215	154.80		
2	1.28	145	185.60		
Sum		360	340.40	460	0.91

The exposure index for wood dust at the workplace in the tested plant after the application of the dedusting installation is 0.91 mg/m^3. The multiplicity of the standard for the result obtained is: k = 0.91/4 = 0.23.

After using the dedusting installation, the concentration of wood dust on the site in the selected plant is almost four and a half times below the permissible standard.

6. RISK ASSESSMENT AFTER INSTALLING THE DUST REMOVAL SYSTEM

After installing the dedusting installation, occupational risk assessment was carried out again based on norm (PKN, 2011). Table 8 summarizes the results of the risk assessment, with only those hazards that were affected by the installation of the dedusting installation.

Table 8
Risk assessment on the workplace of carpenter before installing the dust removal system

No.	Danger	Source of danger	the potential effects of the threat	Before application of preventive measures			preventive measures	After application of preventive measures		
				C	P	R		C	P	R
3	Damage to the body through workpieces	Processing of wooden elements	Rubbing, cuts, mainly hand and face	D	D	D	Dust extraction system Use of safety goggles	M	M	M
6	Dusting	Mechanical processing of wood	Respiratory diseases	D	D	D	The dust removal system	M	M	M
7	Fire	Placing flammable waste	Burns, death	D	D	D	The dust removal system	M	M	M

7. CONCLUSION

The installation has effectively reduced the level of occupational risk associated with hazards such as dust, fire and bodily harm caused by workpieces. The use of the installation caused a nearly eleven–fold reduction in the exposure rate for wood dust. A well–functioning installation reduced the likelihood of a fire. The protective measure applied has contributed to reducing the level of occupational risk associated with the damage to the workpieces and waste generated during this treatment.

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