Creation of Wood Dust during Wood Processing: Size Analysis, Dust Separation, and Occupational Health

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Mechanical separators and fabric filters are being used to remove airborne fine particles generated during the processing and handling of wood. Such particles might have a harmful effect on employee health, not only in small- but also in large-scale wood processing facilities. The amount of wood dust and its dispersion conditions vary according to geometric boundary conditions. Thus, the dispersion conditions could be changed by changing the linear size of the particles. Moreover, the smaller the particles are, the more harmful they can be. It is necessary to become familiar with properties, from a health point of view, of wood dust generated from processing. Wood dust has to be sucked away from the processing area. The fractional separation efficiency of wood dust can be improved using exhaust and filtering devices. Filtration efficiency depends on moisture content, particle size, and device performance. Because of the carcinogenicity of wood dust, the concentration of wood dust in air has to be monitored regularly. Based on the results hereof, a conclusion can be made that both mechanical separators of types SEA and SEB as well as the fabric filters with FINET PES 1 textile are suitable for the separation of wet saw dust from all types of wooden waste produced within the process.

Keywords: Wood dust; Job performance; Employee health; Wood dust carcinogenicity; Fractions of wood dust

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INTRODUCTION

Wood dust represents one of the dangers of processing wood mass both in small enterprises as well as in large wood processing plants. It is generally understood that the operation and handling of wood generates fine particles that are more hazardous the smaller they become (*i.e.*, when the surface area of the particles is greater relative to volume).

Given that the biological properties, in addition to their physical and chemical properties of substances, have essential characteristics, it is necessary to deal with them especially in terms of their possible adverse impacts on health. Within wood mass processing, when abrading *via* sanding or other processing technologies, it is necessary to have knowledge of the properties of harmful chemical agents generated from wood waste, *i.e.*, the wood dust. In particular, toxicology bases show how to study and handle them to eliminate the properties that are dangerous for employees (Andersen *et al.* 1999; Kauppinen 2000; Lioy 2002; Douwes *et al.* 2003; Acheson *et al.* 1968; Pukkala 2009; Kanagesan *et al.* 2013; Gašparík and Gaff 2013a,b) while not decreasing their working performance, which can be defined as the quantity of work associated with a given period of time (working shift, week, month, year). The more complicated the work is, the longer will be the period connected with the working performance. At the same time, the determination of a suitable measurement unit applicable to working performance is a key factor affecting the results. Each level of working performance depends on two basic parameters, *i.e*., the employee's personal preconditions and on the technical and organizational conditions in which the working activity takes place. The employee's personal preconditions are determined mainly by his/her qualifications, abilities, health conditions, and motivation. The technical and organizational conditions of work represent the sum of the parameters determining the course of the working process. These include, in particular, workplace equipment (production, organization, and IT equipment), working procedure, type and quality of processed material, type and extent of processed information, quality product or work requirements, organization of the workplace, working regime, and last but not least working environment and safety conditions.

Wood dust, whether generated from hand-made wood processing or at large-scale wood processing plants, should be purged from the working area and disposed of. Since oak-wood and beech-wood dusts were included on the list of health-endangering substances, producers as well as users have made great efforts to minimize it. The result has been the maintenance of wood-dust exhausting regimens conducted by stationary wood-processing devices with the aim of reaching the prescribed permissible maximum total dust concentration of 2 mg/m^3 (Očkajová *et al.* 2014). However, within hand-made production lines, this threshold value is often highly exceeded.

Since 1982, wood dust has belonged to the catalogue of dangerous substances of whose carcinogenic potential there is reasonable suspicion. This substantiation is based on a manifold of epidemiologic studies describing adenocarcinogenicity of the nose and sinuses of employees working in the wood processing industry as a typical occupational carcinogenic disease (Hernberg *et al.* 1983; Brinton *et al.* 1984; Hubbard *et al.* 1996; Andersen *et al.* 1999; Yu and Yuan 2002). Further publications have confirmed that one cannot doubt the risk of cancer from working in close association with certain types of hardwoods. Oak-wood and beech-wood dusts have been unambiguously confirmed to be carcinogenic substances in workplaces (Hadfield 1970; Varsha and David 2006). The following reasons could be considered probable origins of cancer risk:

- chemical content of wood substances;
- pyrolysis products;
- auxiliary substances and protective substances used in wood processing; and
- mechanical irritation of nasal mucous membrane surface.

Grain surfaces can be smooth, rough, soft, hard, or flexible. The inhalation of wood dust may cause allergic symptoms in the respiratory tract mucous membrane. In large amounts, dust acts as an irritant to the eyes, nose, and throat. Significant accumulations of fine particles can result in damage of lung functioning, cause asthma, and be carcinogenic (Nylander and Dement 1993; Ameille 2003). For safety and health protection at work, there are prescribed threshold values for wood dust. The EU Directive (the Council Directive 1999/38/EC on the protection of workers from the risks related to exposure to carcinogens at work and extending it to mutagens) prescribed the limit of 5 mg/m3 for the inhalation hardwood fractions.

The time-weighted average (TWA) is widely applied in dust analysis. There exist two reference periods for which the limit is valid: the 8-h TWA and the 15-mi short-term exposure limit (STEL). A substance can be assigned to the occupational exposure limit (OEL) in one or in both reference periods.

In order to demonstrate certain adverse health effects using the 8-hour timely measured average (TWA), longer or accumulated exposure is necessary. The 8-h TWA checks these effects by restricting the total breathing over one or more working shifts.

For the 15-min STEL, certain adverse health effects can occur after a short exposure period. The 15-min STEL can be used to control these effects. Exposure to a substance that has been assigned the maximum exposure limit (MEL) in the 15-min STEL should not exceed that limit. The TWA value is measured or calculated in terms of the reference period of eight hours of the Time Weighted Average on Permissible Exposition Limits (PEL). The standard is prescribed by the Occupational Safety and Health Act-OSHA 3371-08: 2009 Management of Safety and Health Protection at Work in the USA:

- TWA 15 mg/m3 for each wood dust (both softwood and hardwood); and
- TWA 5 mg/m3 for respired wood dust (both softwood and hardwood).

EXPERIMENTAL

Materials

Generally, the dust is crushed and pulverized from the solid substance of any shape, structure, and density. The wood dusts, from physical and chemical standpoints, belongs to the range of colloidal and dispersed systems for which the linear dimension of the particle is the essential characteristic. Dust is understood to consist of particles of a solid substance that have at least two dimensions smaller than 0.5 mm (Bartknecht 1987). Small linear dimensions lead to a significant increase in the surface area relative to the given mass of the entire system. From physical and chemical standpoints, a dust is a dispersed system that arises by means of the continual dispersion of particles within a dispersing environment. If the solid substance is dispersed within the air, then it is defined as an aero-dispersed mixture according to the size of the dispersed particles. The degree of dispersion is determined by the ratio of the surface of all particles, *S*, to their total volume per the mass unit,

$$d_0 = \frac{S}{V} \tag{1}$$

where d_0 is the degree of dispersion (m^{-1}); *S* is the surface area of particles (m^2); and *V* is the volume of particles (m^3).

The value of the dispersion index depends on the geometrical shape of dust particles. The value of the index grows as the linear size of particles decreases. The growing dispersion index leads to higher occurrence of surface phenomena. The forces from the neighbouring particles affecting the atoms or molecules in the depth of solid or liquid phases are balanced. However, the forces occurring on the surface interface are not balanced (Brázda and Zegzulka 2011). This is related to the surface tension and surface energy needed to enlarge the surface. The surface energy in the system grows with higher dispersion index. More atoms and molecules come into contact with another phase.

Particle size and shape belong among the most important quantities that characterize the particles and determine their degree of separation from the gaseous environment. They affect motion characteristics, which in mechanical and electrical separating precipitators determine the separation velocities and thus the final degree of separation. The particle size affects the size of the electrical charge that can be transferred by the particle, and thus the separation possibilities are determined at the electrical separating precipitators. At the same time, the diffusion of particles, which plays a significant role during the filtration process, is strongly dependent on the particle size. Also depending on particle size are the optical characteristics that are used for the concentration as well as the particle graininess measurements.

Three essential types of particles can be distinguished:

- isometric particles, in which all three dimensions are mutually comparable;
- laminar (plane) particles, in which two dimensions exceed the third one (lamellas, shavings, chippings);
- fibrillar particles (fibres), in which one dimension is significantly larger than the other two (fibres, needles).

The classification of particle shapes and their marking for the characterization of graininess of loose materials:

I sharp corners with three similar dimensions (*e.g*., cube);
II sharp corners with one dimension significantly greater than the remaining two (*e.g*., prism, rod);
III sharp corners with one dimension significantly smaller than the remaining two (*e.g*., board, blade);
IV rounded corners with three similar dimensions (*e.g*., sphere);
V rounded corners with one dimension significantly greater than the remaining two (*e.g*., cylinder, rod);
VI filamentous, curling, segmental.

Methods

Saw Dust Isokinetic Sampling

The sampling took place by means of a gravimetric apparatus of type MU 5 - OT manufactured by ORGREZ Brno, Czech Republic (Fig. 1)

The sampling point is selected in a manner such as to keep an upstream straight section with constant cross section and length equal to 10 times of the piping diameter. Should this condition not be met, lesser accuracy of the result must be expected. The gas flow speed in the piping is measured in the sampling point. The isokinetic probe head diameter is determined in function of this value (v_{max}).

The sampling of the required amount of saw dust is carried out after the isokinetic probe installation in the air-conditioning piping and after the isokinetics setup.

As the exhaust piping diameters (d) from the frame saws are ranging from 160 to 250 mm, and those from log saws and circular saws from 125 to 280 mm and the circular cross-section area of the exhaust piping from these saws is $S \leq 0.09$ m^2, the saw dust sampling is carried out in accordance with STN ISO 9096: by means of a single sampling point located in its plane center.

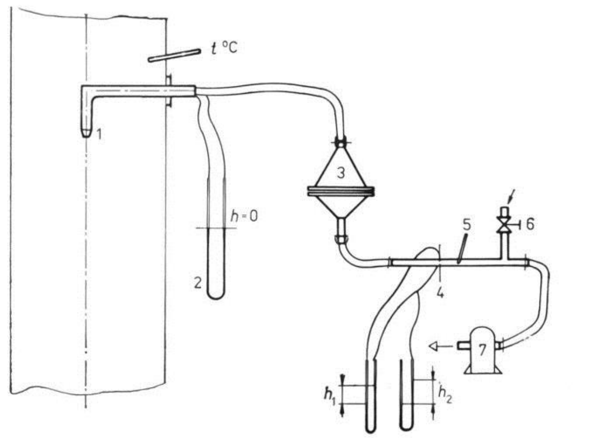

Fig. 1. Gravimetric apparatus for saw dust isokinetic sampling: 1 – input suction nozzle, 2 - differential pressure gauge for the isokinetics setup measurements, 3 – filter, 4 – orifice pressures senzor, 5 – thermometer, 6 – control valve for air supply, 7 – suction source

Determination of saw dust moisture

Gravimetry is the most usual method to determine the wood moisture. This method is based on finding the mass of both as-received and dried wood by means of weighing with an accuracy of 0.01 g. The sample drying time inside the hot-air lab dryer at 103 ± 2 °C depends on the sample amount and grain size. Therefore, the measurement of the loose wooden mass moisture is carried out on a sample of approximately 10 g, spread across the entire scale pan. The test sample reaches its constant mass when the mass change between two weighings carried out through the interval of 2 h, shall not exceed 0.01 g. Once the saw dust reaches the constant mass, it is cooled down in a dessicator with hygroscopic substance to room air temperature. After the cooling, the saw dust is removed from the dessicator and weighed with an accuracy of 0.01 g (Kačík – Solár 1999).

The absolute moisture content is computed from the body mass before and after the drying using Eq. 2,

$$Wa = \frac{m_w - m_0}{m_0} * 100\ [\%] \tag{2}$$

where m_W is the wet sample mass [g], and m_0 is the sample mass after the drying [g].

Determination of saw dust grain size by sieving

Sieving of the saw dust on a set of sieves with the following mesh sizes was carried out for the basic granulometric analysis: 2 mm, 1 mm, 0.50 mm, 0.250 mm, 0.125 mm, 0.080 mm, 0.063 mm, and 0.032 mm above a bottom tray, on a Retsch automatic vibration engine model AS 200. The sieving engine AS 200 is suitable for sieving of loose dispersed products, with max. size of 25 mm, both wet and dry.

The procedure for the determination of powder fraction content in the saw dust (Methodologic procedure IM-AS 200) is as follows.

1. Each sieve and the bottom tray for the analysis are cleaned and weighed on lab scales with weighing accuracy of 0.01 g; the masses are recorded in a table.
2. The set of sieves ordered from the biggest mesh size to the smallest one, followed by the bottom tray, are placed on the sieving vibration machine AS 200.

3. A sample (50 g approx.) is weighed on the lab scales with weighing accuracy of 0.01 g. This sample is put on the uppermost sieve of the sieving machine.
4. The set of sieves is enclosed inside a glass lid. After the lid is screwed by the mean of tightening bolts, the sample is sieved during τ = 15 min.
5. When the sieving is over, the individual sieves with the saw dust fractions thereon are weighed, and the results are recorded in the table.
6. The difference between sieve mass after sieving and sieve mass before the sieving is equal to the saw dust fraction mass.
7. The sieve analysis can be deemed correct if the fractions total mass *vs.* sample mass is ranging between 0.98 and 1.00.

Optical analysis of powder fraction with size under 125 μm

In order to quantify the shape and dimensions of the smallest particles of the fine fraction, microscopic analysis of the saw dust grains smaller than 125 μm was carried out. An optical method was used for this analysis, investigating the image obtained on a Nikon Optiphot – 2 microscope with Nikon 4x objective lens. The saw dust grains were recorded with a 3-chip Hitachi HV-C20 (RGB 752 x 582 pixels) CCD TV camera and with horizontal resolution 700 TV lines. This was evaluated by the mean of LUCIA-G 4.0 (Laboratory Universal Computer Image Analysis) software program installed on a PC.

The image analysis application LUCIA-G allows the identification of the individual particles of loose wooden mass and the quantification, among others, of such basic information for the individual particles within the analyzed image as follows: particles length, width, and circularity. The circularity expresses the degree of deviation of the projection of the grain shape from the circular shape according to the following formula,

$$\psi \; \psi = \frac{4 * \pi * S}{O^2} \; [-] \tag{3}$$

where S is the particle area [m^2], and O is the particle perimeter [m].

The procedure for observation of fraction with sizes under 125 μm was as follows:

1. A sample was taken from the saw dust to be analyzed.
2. The sample was placed on a watch glass and, together with black paper in order to obtain dark background, then placed under a Mitsubishi CCD 100 E camera.
3. Using the PC and LUCIA application, saw dust images with 30-fold magnification were created.

RESULTS AND DISCUSSION

Wood sawing and sand abrading operations, besides forming the main products also generate sawdust and wood dust; the shape, dimension, and amount dust produced is dependent on both the physical and chemical characteristics of the sawed and abraded wood as well as on shape, dimension, sharpness of cutting tools, and the technological conditions of sawing and sand abrading operations (Heisel and Weiss 1995; Očkajová and Banski 2013; Očkajová *et al*. 2014;). These by-products (sawdust and wood dust) can have adverse effects on human health when they are not sufficiently trapped by exhausting and filtration equipment.

The next part of the article deals with the results of measurements of the amount of fractioned loose wood substances generated during the wood sawing and the sand abrading processes. The authors first dealt with the sawing operation of soaked wood, which is considered a type of first-step processing for this raw material. The second phase was focused on the analysis of the sawing and sand abrading processes of dried wood, which is considered a type of second-step wood processing. The subjects of the studies were the sizes of the particles of sawdust and wood dust, their concentrations, and the efficiency of the exhausting equipment in trapping the dust.

Measurements of the Amount of Fractioned Loose Wood Substances from Wood Sawing and Sanding Abrading Processes

In the wood processing industry, the standard way to transport sawdust from sawing equipment is by using air-ducts, *i.e.*, exhausting. The separation of the exhausted sawdust from the air in which it is transported is carried out using one-chamber separators (sawdust collectors), group separators, and fabric filters. These separating technologies differ one from one another by installation construction, separation principles, as well as by the ratio of exhausted, separated sawdust to the transporting air (Zhao *et al*. 1999; Dolny and Rogoziński 2014).

One of the ways that the optimal separating technology was determined was according to Separation Limit (SL) of the separation apparatus, *i.e*., the size of the smallest particle $a_{\min}$ of the sawdust that can be separated in the separating apparatus. The range below $a_{\min}$ is then defined as being below the separation limit.

Figure 3 shows the curves of the residues of the wet sawdust of the species of spruce (*Picea abies*), pine (*Pinus montana*), beech (*Fagus sylvatica*), and oak (*Quercus robur*) when transported through the air ducts from frame saws (FS), log band saws (LBS), and log circular saws (LCS), and their comparison with the Separation Limit in the curves of fractional separation by mechanical wood dust collectors of the SEA type with T3/1000 segments, collectors of the SEB type with T4/630 segments, and fabric filters with filtration textile FINET PES 1 that are commonly used in wood processing.

In Diagram No. 3, the exhaust efficiency is 100%, since the residual curves are not crossing each other. Thus no particles, which could not be exhausted by the given filtration equipment, are generated in the case of wet saw dust. Everything should be correct for the wet saw dust and nothing should escape to the air and increase the dust level.

Based on the results displayed in Fig. 4, it could be stated that the mechanical dust collectors of the SEA and SEB types, as well as fabric filters with the filtration textile FINET PES 1, are all suitable for the separation of wet sawdust. The mechanical dust collectors SEB with T4/630 segments with the Separation Limit SL = 12 µm and mechanical dust collectors SEA with T3/1000 segments with the Separation Limit SL = 40 µm, that is, the lower limit of sawdust graininess generated by the sawing of wet wood using rip circular saws (RCS), were found to best comply with the BAT (Best Available Techniques) criteria.

The fabric filters with the filtration textile FINET PES 1 captured sawdust with 100% efficiency, but they are too expensive in terms of the purchasing and operational costs (textile exchange after 12000 operational hours approximately) for air duct transporting systems.

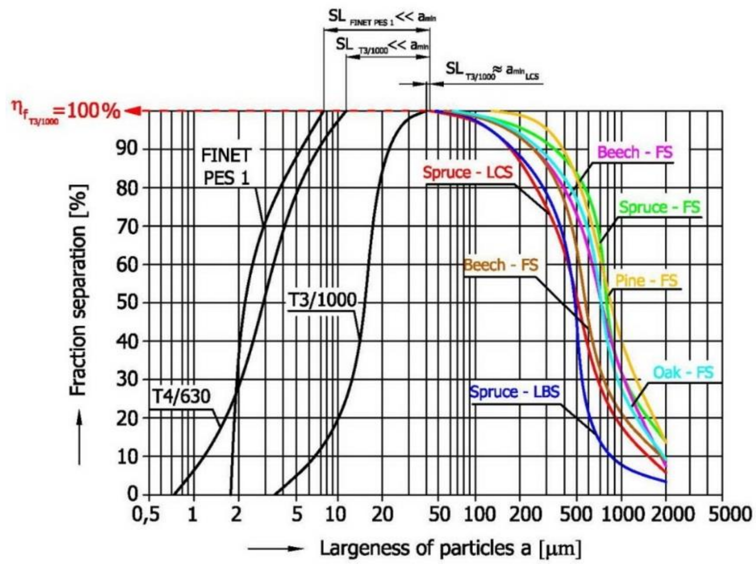

Fig. 2. Comparison of curves of wet sawdust residue from several sawing operations with curves of fractional separation

Similar graphical analyses were carried out to examine the curves of dry sawdust residue transported through air ducts from sawing operations employing the SL, the curves of fractional separation by mechanical wood dust collectors of the SEA type with T3/1000 segments, by mechanical wood dust collectors of the SEB type with T4/630 segments, and by fabric filters with filtration textile FINET PES 1, as shown in Fig. 3. Based on the results, it could be stated that as far as the transportation of dry sawdust from dimension timber workplaces through closed air-duct exhausting systems, the fabric filter that employed the filtration textile FINET PES 1 best complied with the BAT criteria.

The mechanical dust collectors of the SEA type only displayed 97% efficiency when separating the dry spruce sawdust. The efficiency of the SEB-type Mechanical dust collectors approached 100%, but as the grinding machines (sanders) producing the wood dust were usually connected to the air duct system, the concentration of dust fractions of loose wood substances in the recirculation air was higher than the permissible dust content in the recirculation to TZL ≤ 1 mg.m^{-3}.

From the environmental assessment of dry sawdust exhausting during sawing operations at several facilities in the wood processing industry, it was established that air duct systems of subatmospheric pressure and which contain collectors with a Separation Limit MO ≤ 20 μm were suitable for open air duct exhausting systems, and in fact represented the optimal technical solution as far as fulfilling BAT criteria. The mechanical dust collectors with T4/630 segments and fabric filters with the filtration textile FINET PES1 met this mentioned criterion.

As shown in Fig. 4, if the residual curve crosses the curve of the given filtering equipment, for example, at 97%, as in this case, then 3% of the particles will escape to the atmosphere; this is the dust that the present article is mainly concerned about. Mostly, these particles escape to the atmosphere during the grinding of dry wood. The difference between the two diagrams is the following: nothing escapes in case of Diagram 3, *i.e.*, the given filtering equipment is able to exhaust even the smallest partices, while in case of Diagram 4 for dry saw dust, the 3% escape to the atmosphere.

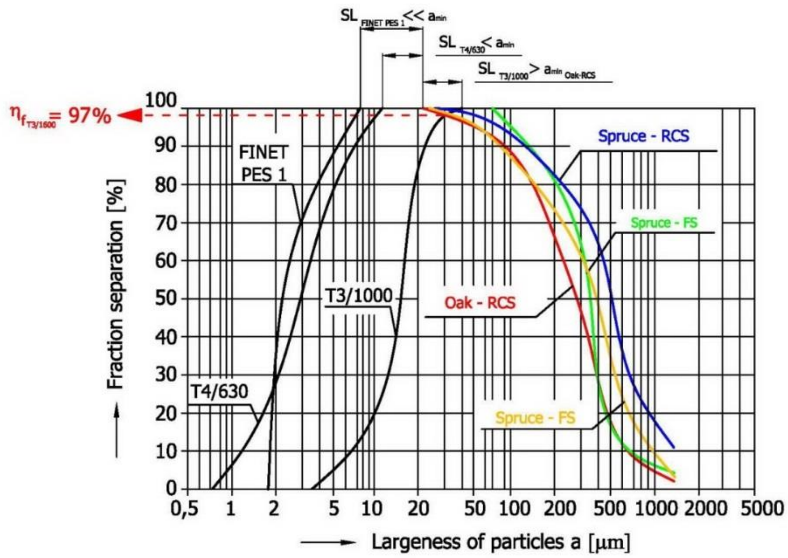

Fig. 3. Comparison of curves of dry sawdust residue from several sawing operations with curves of fractional separation

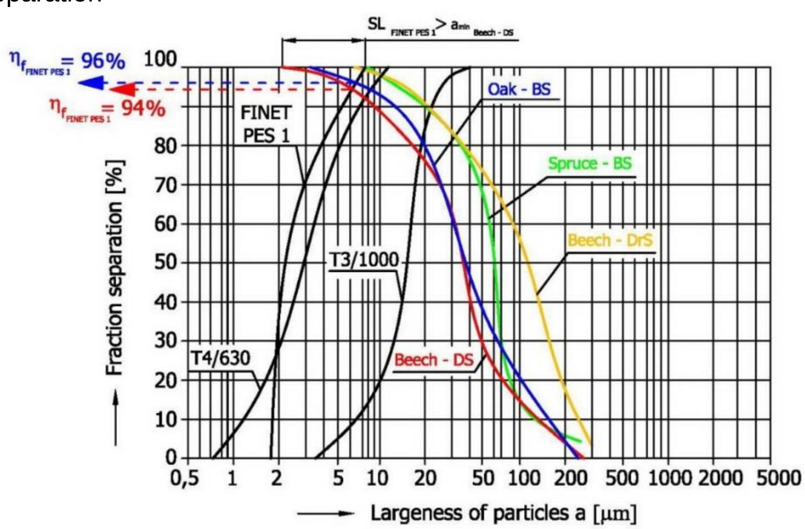

Fig. 4. Comparison of curves of wood grinding dust residues from several grinding operations with curves of fractional separation

Sanders are usually connected to the air duct systems that exhaust dust from workspaces handling dry wood material. Upon grinding the wood, waste in the form of wood dust is generated, where 98% of the volume of this waste represents particles smaller than 0.5 mm. When removal of dust is insufficient, the dust spreads freely through its environment. High dust concentrations in ambient air can cause serious health problems.

Figure 4 shows the curves corresponding to the wood grinding dust residue generated during the grinding of selected tree species (spruce, oak, and beech) by belt sanders (BS), drum sanders (DrS), and disc sanders (DS) and provides a comparison thereof with curves describing fractional separation by mechanical dust collectors of the SEA type with T3/1000 segments, dust collectors of the SEB type with T4/630 segments, and fabric filters with the filtration textile FINET PES 1.

Based on Fig. 4, it was possible to state that neither mechanical dust collectors of the SEA and SEB types nor fabric filters with filtration textile FINET PES 1 were able to separate the finest particles from grinding operations with 100% efficiency. Of the tested mechanical collectors of the SEA and SEB types and the fabric filters with filtration textile FINET PES 1, the most effective equipment was the fabric filters with filtration textile FINET PES 1, which were able to filtrate oak wood dust at 96% efficiency and beech wood dust at 94% efficiency. In the case of the mechanical dust collectors of the SEA and SEB types, the separation values for the grinding operations were even lower.

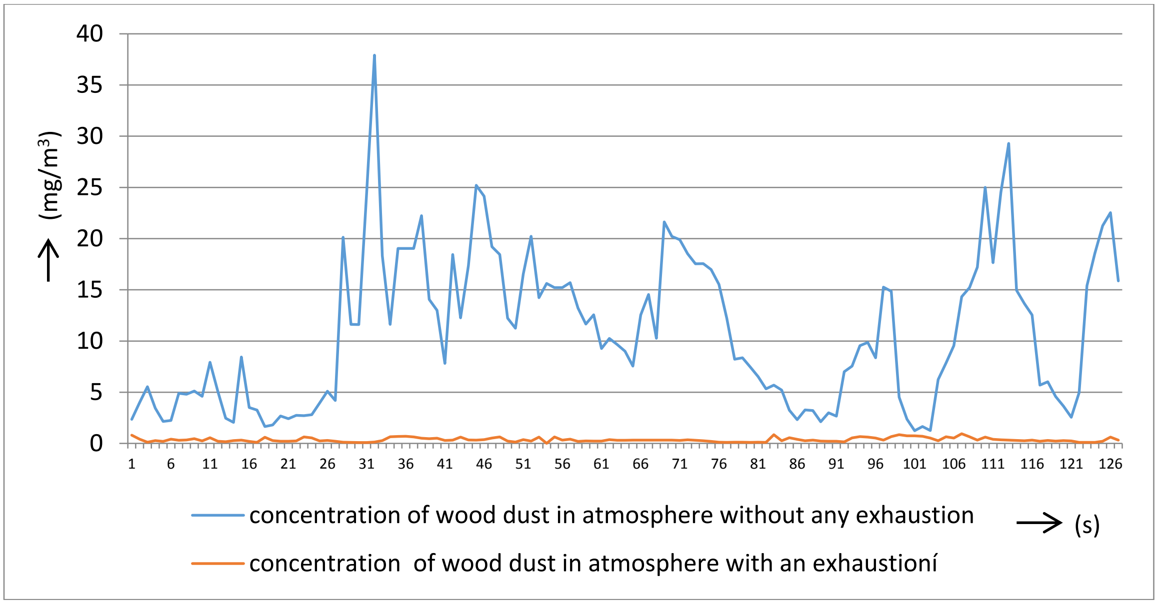

Fig. 5. Comparison of concentration levels of wood dust in atmosphere with exhaust and without exhaust (mg/m^3)

Figure 5 shows the measured concentrations of wood dust particles in an ambient atmosphere without exhausting compared to those with exhausting; both were measured using the MicrodustPro, which is a portable device with a monitor designed to evaluate dust aerosol concentrations.

Based on the measured values, the concentration of wood dust particles in the atmosphere of workplace areas without exhaust reached 38 mg/m^3, while those with exhaust decreased to 1 mg/m^3. The Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 was implemented by the Regulation of the Government of the Slovak republic No. 393/2006 Coll. on minimal requirements for securing safety and health protection at work in explosive atmospheres. This regulation required that wood processing machines be equipped with individual exhaust devices. Despite the nationwide Slovak trend of the general and sustained increase in oncologic diseases, as Fig. 6 shows, Slovakia has experienced a rapid decrease in the occurrence of nasopharynx carcinomas among men and women employed at work in processing factories (100,000 workers altogether). Because of the mentioned governmental regulation and its application in practice, principal changes, in terms of the occurrence of nasopharynx carcinoma, to the health status of employees of the wood processing industry in Slovakia have taken place.

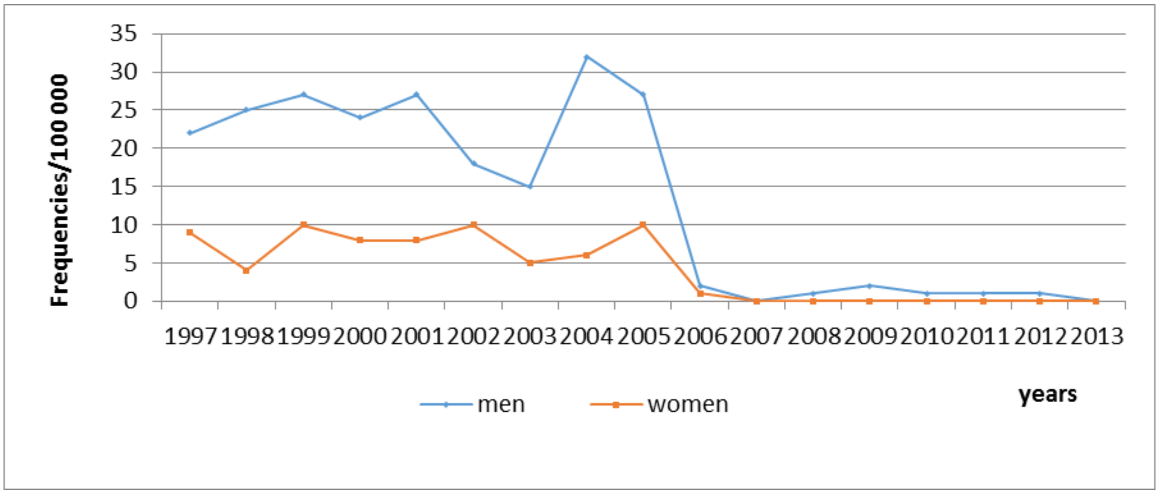

Fig. 6. Frequencies of occurrence of nasopharynx carcinomas among men and women in Slovakia

CONCLUSIONS

1. Wood processing, in the present case specifically the processing of the wood mass of spruce (*Picea abies*), pine (*Pinus montana*), beech (*Fagus sylvatica*), and oak (*Quercus robur*), was the subject of this work. These mentioned materials were subjected to sawing using the frame saw, the log band saw, and the log circular saw in technological operations, while waste in the form of wood sawdust as well was generated by means of abrasion by sanding at belt sanders, at drum sanders, and at disc sanders.
2. From the results of the study, it could be said that both mechanical wood dust collectors of the SEA and SEB types as well as fabric filters with the filtration textile FINET PES 1 were suitable to perform the separation of wet sawdust from other types of wood-waste generated during processing. Among the closed air-duct exhausting systems intended to expel dry sawdust from dimension timber production, the fabric filters with the filtration textile FINET PES 1 complied best with the BAT criteria. As far as dealing with the residues of wood grinding dust, the fabric filter with the filtration textile FINET PES 1 seems to have been the most effective, as it was able to filtrate oak wood dust with 96% efficiency and beech wood dust with 94% efficiency. As for the mechanical wood dust collectors of the SEA and SEB types, the separation values for the abrading operations were even lower. There are other types of filtrating equipment (*e.g.*, electrical filters) available on the market that are able to absorb wood dust with higher efficiency than the tested fabric filters, but their costs are significantly higher, and thus these filters are used only rarely. Based on previous results, it could be stated that increased wood dust concentration in the air can be generated, especially during wood abrading, where the separation efficiency is not 100%. While wood dust concentration in the workplace atmosphere without exhausting reached 38 mg/m^3, that for the atmosphere with exhausting was 1 mg/m^3. This verified the exhausting efficiency of fractional separation technology and its effect on decreasing the wood dust concentration in the workplace atmosphere for employees in the wood processing industry.

3. The European Union Directive for safety and health protection stipulates a marginal value for wood dust at 5 mg/m^3, and the OSHA Regulation (OSHA 3371-08:2009). Management of safety and health protection at work in the USA also stipulates 5 mg/m^3 for aspirated wood dust (hard as well as the soft dust). From the results referred to in the paper, these values were regulated using wood dust exhausting. At correct fractional separation of wood dust, the health damage due to the fact that employees do not inhale substances with mutagenic effects.
4. To maintain long-term working performance of employees, it is necessary to fulfil several criteria. From an organizational standpoint, this constitutes the maintenance of the supply of sufficient working material, quality technology, and machinery operation without malfunction. From the management standpoint, it is necessary to secure equitable evaluation of work and sufficient motivation aimed at maintaining performance. However, last but not least, it is necessary to promote the well-being of workers in the workplace, which depends on factors besides the quality of the working environment. The future health status of employees depends on the quality of care devoted to the working environment (in this case, an investigation into fractional dust collection). Based on the conclusions herein, it could be expected that a rapid decrease in the concentration of wood dust in the workplace air would take place, thus minimalizing the inhalation of carcinogens and decreasing the occurrence of nasopharynx tumors. If the regulations concerning safety and health protection at work are consistently met, by means of the use of quality and high-performance exhausting equipment and prescribed work breaks for rest, it should be possible to maximally eliminate the risk of unwanted carcinogenicity in the air which wood dust introduces.

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