DUST CREATION IN CNC WOODWORKING
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Key words
Wood dust, CNC machine, Furniture production, Occupational disease

Abstract
Exposure to airborne particles in furniture industry is connected with dust creation in woodworking operations. CNC machining is a significant source of dust which involves the risk of occupational diseases of furniture makers. Conditions of dust creation in CNC machines during working wood and wood composites were described. Characterization of physical properties and particle-size distributions of dusts created in these conditions and were presented in this paper.

1. INTRODUCTION

Production of furniture requires conducting machining of wood and wood based materials in manufacturing plants. These operations are diverse which is very characteristic for the production of furniture products complicated in terms of design. Operations performed using versatile CNC machines are becoming increasingly important among woodworking operations. Unfortunately, secondary wood processing and machining of wood based materials, which are made of wood that has previously been fragmented in varying degrees is the source of the creation of large amounts of fine waste particles. A significant part of this waste is often dust, which when dispersed in the air can pose a threat to the health of workers employed in furniture factories (Chung et al. 2000, Dolny et al. 2005, Dolny and Rogoziński, 2010, Fujimoto et al. 2011, Očkajová et al. 2014). There are numerous reports indicating an increased risk of respiratory diseases such as: lung cancer, sinus and nasal cancer, asthma and cough symptoms and other respiratory problems, such as allergic alveolitis and chronic bronchitis as well as the skin and eye irritation in woodworking industry workers (Kauppinen et al. 2006, Jacobsen et al. 2010, Dutkiewicz and Prażmo 2008, Baran and Teul 2007).

The use of CNC machines is very unfavorable regarding dust control problems in the furniture industry (Varga et al. 2006, Rautio et al. 2007). Usually the working zone of these machines is quite large and difficult to cover with effective action of a suction head of dust extraction devices. In addition, efficient removal of generated particles is difficult because the tool moves during operation to the considerable distances. Air movement caused by the rotation of the tool rarely corresponds to the direction of air flow sucked by the exhausting system. These factors significantly reduce the effectiveness of dust extraction. Attempts to increase the effectiveness by increasing the air velocity in the exhaust hood and connecting pipe and thereby increase its volume often does not give the desired effect and is a cause of the cost increase by the increase of energy consumption related to the operation of the fan. Difficulties in reaching the required removal efficiency of airborne dust particles from woodworking stations are the cause of increased occupational risks associated with exposure...
to dust. The risk of occupational diseases is strongly related to the content of the finest particles in dust created in woodworking (Beljo-Lušić et al. 2011, Čavlović et al. 2013). There is also the additional problem resulting from the necessity of cleaning the surface of working position from settled dust, resulting in lower productivity by increasing the consumption of time (Rogoziński et al. 2010). The aim of the study was to determine the content of fine particles in the dust generated on CNC machines in processing of different wood materials by various methods to ensure the subsequent occupational risk assessment.

2. MATERIAL AND METHODS

Studies on particle-size distribution and bulk density of the waste dust generated during machining MDF, particleboard, HDF and pine wood using different CNC machines were carried out. Determination of particle size distribution was carried out by sieve analysis and for the finest fraction using a laser particle counter by laser diffraction method. Details of the methodology of the analysis have been described by Rogoziński et al. (2014). The tests in this work were performed in the same way taking into account other dimensional ranges of the laser analysis. Determination of bulk density was conducted according to the Polish standard PN-Z-04002-02:1974 Air purity protection-Tests of dust physical properties-Determination of apparent densities and static porosities of dusts shell.

3. RESULTS

Results of the determination of particle-size distribution by sieve analysis were shown in Fig. 1,2,3 and 4 and in Table 1. They demonstrate a significantly greater proportion of fine particles in the dust from the machining MDF and HDF. Working of solid pine wood on CNC machines is a source of a smaller amount of fine dust in comparison with wood composites.

Fractions of the smallest particles calculated on the basis of laser diffraction analysis were shown in Table 2.

Figure 1. Particle size distribution of dust created during drilling HDF

Rogoziński (2015). “Dust creation in CNC woodworking”
Figure 2. Particle size distribution of dust created during milling pine wood

Figure 3. Particle size distribution of dust created during milling MDF

Figure 4. Particle size distribution of dust created during drilling particle board
Table 1. Content of particles with size <0.032 mm

<table>
<thead>
<tr>
<th>Material and machining type</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>drilling HDF</td>
<td>3.17</td>
</tr>
<tr>
<td>milling pine wood</td>
<td>0.03</td>
</tr>
<tr>
<td>milling MDF</td>
<td>0.40</td>
</tr>
<tr>
<td>drilling particle board</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Table 2. Content of finest fractions in dust created in CNC machining

<table>
<thead>
<tr>
<th>Upper limit (µm)</th>
<th>Mass rate in the total dust (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>drilling HDF</td>
</tr>
<tr>
<td>2.5</td>
<td>0.064571</td>
</tr>
<tr>
<td>4</td>
<td>0.007552</td>
</tr>
<tr>
<td>10</td>
<td>0.265685</td>
</tr>
<tr>
<td>20</td>
<td>0.798772</td>
</tr>
<tr>
<td>30</td>
<td>0.695967</td>
</tr>
<tr>
<td>40</td>
<td>0.499949</td>
</tr>
<tr>
<td>50</td>
<td>0.330060</td>
</tr>
<tr>
<td>60</td>
<td>0.209126</td>
</tr>
<tr>
<td>70</td>
<td>0.130630</td>
</tr>
<tr>
<td>80</td>
<td>0.075746</td>
</tr>
<tr>
<td>90</td>
<td>0.044879</td>
</tr>
<tr>
<td>100</td>
<td>0.024490</td>
</tr>
</tbody>
</table>

It seems that a very small amount of these fractions of dust is created in CNC woodworking. Generally, this is true only for solid wood and in comparison with the dust creation in sawing operations of modified wood (Hlaskova et al. 2015). But compared with the results of study on the same fractions of dust in milling self-locking longitudinal joints in pine wood there is created much more fine dust, especially for wood composites (Wieruszewski and Rogoziński 2013). The content of fine dust is very variable and depends on the type of material used for machining (Rogoziński et al. 2014).
Figure 5 shows the results of measurements of the bulk density of the dust. It should be noted that there is a certain relationship between this parameter and the density of the wood material. This is related to the size and mass of the particles created during machining, which certainly has an impact on the efficiency of dust extraction devices.

4. CONCLUSIONS

On the basis of performance tests of characteristic od dust created in CNC machining it can be concluded that this type of woodworking is a source of some amount of very fine dust particles. These dust fractions may be hard to remove by extraction devices and can remain in the surroundings of a machine. Then, the dust can disperse in the air and cause the occupational exposure of wood workers.

References


Hlásková, L., Rogoziński, T., Dolny, S., Kopecký Z. and Jedinák M., (2015): Content of respirable and inhalable fractions in dust created while sawing beech wood and its modifications Drewno 58 (194), 135-146. DOI: 10.12841/wood.1644-3985.096.11


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