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# The effect of operational parameters on the size of chips in the finishing wood-based materials by milling

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**Abstract:** *The effect of operational parameters on the creation of chip particles in the CNC finishing processing of wood-based materials*. The object of this study was a comparison of created chips from the process of milling two wood-based materials: medium-density fiberboard, and particleboard, using a modern CNC 5-axis milling center. The materials in the form of blocks were milled at constant revolutions of the cutting tool (18,000 rev/min), with changeable variables of feed rates (8, 10, and 12 m/min), and width of cut (1, 2, and 3 mm). The size of created chips was measured by gravimetric weighing from sieving analysis of the retained volume of chips on sieves with pre-defined mesh sizes. The main emphasis was aimed at studying particles of chips obtained in the finishing process of the milling below <0.125mm. However, the others are mentioned and discussed. Gravimetric differences of the retained volume of chip mass show that created MDF chips are mostly in the size range of <0.250 to 0.125 mm, and particleboard in the size range of <0.500 to 0.250 mm. Distribution of average values in dependence on different conditions shows a decreasing effect with increasing feed rate on the amount of very small chip particles in the volume of both materials. Increasing the feed rate can decrease the amount of very particles in the range below <0.125 mm in the volume of chip mass.

*Keywords*: CNC milling, Medium-density Fiberboard (MDF), Particleboard, Wood Dust, Feed Rate, Width of Cut

## INTRODUCTION

The furniture market is today more dependent on the use of wood-based materials, due to their alternative viability to natural wood materials. The wood processing industry faces many challenges such as rising prices and limited sources of wood availability. This is putting pressure on looking for alternative sources of materials used in the furniture market (Wieruszewski *et al.* 2023). The furniture manufacturing industry is significant not only from economic and social standpoints but also from the perspective of environmental compatibility (Azizi *et al.* 2016). Using materials made of various wooden parts is more relevant because, wood composites are made of various wood shavings, flakes, wafers, chips, sawdust, strands, slivers, wood wool, fibers, and other parts which can be complicated to use elsewhere. In general, everything primarily composed of various forms of wood substances is considered today technically as renewable.

The change of shape, size, and volume of material is a result of the mechanical process and interaction between the cutting tool and the workpiece. Nowadays, the manufacturing of modern furniture parts is with the use of modern CNC milling centers. The European furniture industry consists mainly of small and medium-sized enterprises, and around 1 million workers in 127,000 entities are currently involved in furniture production. This production value is almost worth one-quarter of the global furniture industry (Silvius *et al.* 2021, Renda *et al.* 2014, Forrest *et. al.* 2017, Červený *et. al.* 2022).

Mechanical machining such as wood sawing, milling, sanding, etc. is an essential part of the product manufacturing path. The milling process is one of the most widely used processes in wood and wood-based materials processing (Bendikiene and Keturakis 2017).

Machining by milling is after sawing the second most used machining operation of wood-based materials. However, in the case of CNC machining, milling is the primary used mechanical method (Kowaluk 2012). The newly formed surfaces after mechanical machining are never perfectly smooth, whether they are straight or curved. The quality and the details of finished products depend on several factors, such as the material structure, quality of construction, quality of treatment, achieved surface roughness, and many more. These are the conditions that the market demands from the finalized product (Malkoçoğlu 2007, Bakar *et. al.* 2013). The quality of the process is the most important condition for achieving the required quality of products which includes precision machining and the quality of certain surfaces (Lučić *et. al.* 2007, Dilik and Hiziroglu 2012, Azemović *et. al.* 2014). These quality requirements cannot be achieved so easily in roughing operations such as sawing and rough milling. Thus, additional finishing operations are necessary.

In the production stage, during the wood-based material cutting, there is a presence of increased dustiness in the production environment (Pędzik *et. al.* 2021, Gottlöber 2023). The dust can be defined, based on the size of the particles, as small particles of various sizes in the range from 1 to 400μm (Kumar and Kumar 2018). Typical woodworking activities that are responsible for producing dust-like particles are mostly finishing operations (Holla *et. al.* 2016). Small dust-like particles produced during sharpening, sanding, or polishing surfaces are the most harmful to human health (Tong *et. al.* 2018). However, when cutting the MDF panels, no matter the used mechanical machining, typically obtained chips are in the coiled, granular, and dust-like form (Teng *et al.* 2014). Wood dust presents several issues associated with exposure in the workplace. In general, exposure to excessive amounts of wood dust is considered to have an irritant effect on the eyes, nose, and throat in addition to pulmonary function impairment and is considered as a human carcinogen (Occupational Safety and Health Administration 2022). But, it is also from the point of the workplace associated with increased fire or explosion hazards (Santamaría-Herrera *et al.* 2023, Dudarski *et al.* 2015, Eckhoff 2005, Eckhoff 2016, Yuan *et al.* 2015). Depending on the various sizes of chips, there is a potential hazard to human health. However, not all size ranges of chip particles are hazardous equally. The most hazardous are particles in the respirable range <10 μm (Gottlöber 2023, Brown *et. al.* 2013). In the case of wood dust, it is also required to know how many dust-like particles are in the inhalable range below <100 μm, because workers may inhale those particles if they become airborne. If small chip particles airborne become aerosols, the inhalation of aerosols by workers would be a function of particle size (i.e., the aerodynamic diameter) (Chae *et. al.* 2019, Dorrian and Bailey 1995). If the dust has a particle size of smaller than 100 μm, it can remain suspended in the air, and be inhaled by workers, causing diseases such as pneumoconiosis, asthma, chronic bronchitis, and nasal cancer. Smaller particles are more dangerous than coarse ones, due to the larger total surface area (Dobashi 2009). Also, smaller particles can be lifted into the air more quickly (Očkajová *et. al.* 2020, Pałubicki *et. al.* 2020). Thus, created chip mass must be from the process extracted by exhaust systems.

If exhaust systems are not perfectly designed and optimized, leading to increased dustiness in woodworking places. In reality, the exhaust systems are never perfect. Smaller particles tend to spread in the air quite quickly, making them hard to catch and transport compared to the bigger chips. Newer innovations in mechanical processing from the point of mechanical machining or machining equipment, can also be a potential source of increased dustiness, due to changes in operational parameters. Thus, looking for options on how to reduce the amount of small dust-like chips is required. It is not easy to determine whether the high content of fine particles is due solely to the structure of materials, geometry of the cutting tool, CNC machining conditions, etc. The aim of the article is to determine in what size ranges created chips from particleboard and medium-density fibreboard are, and how much different technological and operational conditions could potentially lead to a decrease in amount of small dust-like presented in the chip mass.

## MATERIALS AND METHODS

### Tested materials

The experiment study focuses on studying the chip sizes created in the finishing process of two wood-based materials. It is thought that increased dustiness can be associated with machining new different wood-based materials now used in modern furniture manufacturing. However, there are many wood-based materials that are suitable for furniture parts, but two materials are very common in small or large manufacturing companies and enterprises. For this study, we used two raw wood-based materials - medium-density fiberboards and particleboards, without any form of surface treatment. Particleboard and medium-density fiberboard of thickness 18 mm were prepared for the experiment in the form of blocks, with the following dimensions of 500×300×18 mm. Specific mechanical properties of the tested materials are shown in **Tab. 1**, which were provided by the manufacturer in the product lists. Tested materials were machined with various combinations of main operational parameters.

**Tab. 1** Table of the tested materials with specific mechanical properties

| Type of material | Density [kg·m$^{-3}$] | Thickness [mm] | Properties based on standards | Recommended use |
|---|---|---|---|---|
| **Medium-density fibreboard** | ≅ 720 | 18 | EN 622-5 | Support plate, E1, furniture and indoor equipment |
| **Particleboard** | ≅ 680 | 18 | EN 312 | P2, furniture and indoor equipment |

### The choice of revolutions of the cutting tool

In this experiment, the machining operation was a peripheral profile (face) outside the down-milling (climb milling) method. It is a method commonly used in the finishing stage of the machining process, used in milling wood-based materials with CNC centers. The purpose of this study was to simulate real conditions of finishing stages, used for milling the outside material edges. The removal of unwanted material layers can vary, because it is dependable on the required accuracy of needed dimensions, required surface quality, the use of the cutting tool and its main design parameters, plus various additional parameters such as the price of work, optimal energy consumption, the final use of the finalized workpiece, etc. Studying all variables would be very complicated and not easily controllable. Thus, to choose variables that are suitable for milling operations, we focused on studying the main operational parameters of the milling process which are directly adjustable and controllable from the point of a CNC machinist. Those variables are revolutions of the cutting tool, feed rate, and width of cut. Recommended revolutions are usually pre-described by the manufacturers of cutting tools, based on machined workpieces. However, this is not mandatory. For this experiment, we choose revolutions of the cutting tool by 18,000 rpm, which remained constant during the total machining process.

### The choice of dependable variables

Setting the proper values of the width of the cut and feed rate compared to revolutions of the cutting tool is more complicated. It can be different for every wood-based material even in the same company in various finishing processes. In this study, three different variables were studied to determine their effect on the amount of chip dust-size particles. In the experimental setup, we varied variables: the **feed speed** ($v_f$ = 8, 10, and 12 m·min$^{-1}$), the **width of the cut** ($a_e$ = 1, 2, and 3 mm), and two wood-based **materials** (MDF and PB). Other variables such as the temperature of the environment, the **revolutions** of the cutting tool at $n$ = 18,000 rpm ($v_c$ = 1130.9734 m·min$^{-1}$), the moisture content, temperature of the room in the machining workplace, and laboratory conditions, remained constant as much as possible.

The cutting tool

In the finishing process of milling medium-density fiberboard and particleboard, the global market offers a large variety of tool designs and materials for cutting edges used for milling cutters. For our experiment, we use a standardized spiral shank milling cutter with three flutes, without removable bit leaves. For such purpose, we think that the distance between the bits of cutting edges would be affecting the amount of dust-size particles in this study. By this decision of choosing a different design of the cutting tool, we remove the possible effect of distance between those leaves on the amount of wood dust-like particles. The tool used during the milling process was a new solid carbide spiral shank milling cutter provided by ITA Tools. The diameter of the cutting tool is d = 20 mm, and the cutting length of the tool (effective length) is l = 120 mm.

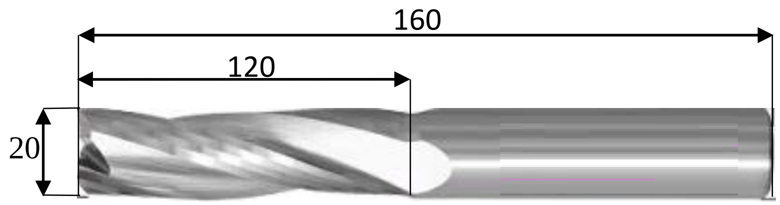


**Fig. 1** ITA Solid Carbide Cutter Z3 - D20x160xL120xS20 Right (Courtesy of ITA Tools)

Particle size analysis

When analysing wood dust, the particle size density distribution or chip granulometry is one of the most important factors (Vandličková *et. al.* 2020). The size of the created chips was analyzed by sieve analysis with the sieves of different pre-defined mesh sizes divided into size ranges. The particle size distribution (PSD) was determined by sieving analysis off-site at the laboratory condition. The sieving method is using an electromagnetic vibration sieve device AS 200 (Retsch, Germany) with a set of sieves. The sieves have mesh sizes of **2 mm**; **1 mm**; **0.5 mm**; **0.250 mm**; **0.125 mm**; **0.063 mm**; **0.032 mm**; and **PAN** (<0.032) mm. The sieves were arranged from top to bottom, where on the top is a 2 mm sieve and on the bottom is a PAN. The particles during vibration are passing thru the mesh sieves. If the particle size is smaller than the defined mesh sieve size, it passes through. If not, the particle is retained on a sieve with a smaller mesh size. The whole set of sieves was subjected to vibration (amplitude 10 sec, total duration 15 min). The masses of fractions isolated on the sieves were weighted by the laboratory scales Radwag (Poland) with a weighing accuracy of 0.001 g. Analysis was performed for a total of 3 measurements for 3 samples of each combination. A total of 54 samples.

Milling machine

In the milling experiment, we used a 5-axis CNC machining center SCM Tech Z5 designed for the timber industry. The manufacturer of CNC is the company SCM, Italy. The

CNC machine is equipped with a vertical spindle attached to an electric motor of 11 [kW] power with adjustable rotational speed control, ranging from **600** to **24,000** [rev·min$^{-1}$]. The workplace of the CNC machine consists of 6 adjustable beam supports, equipped with vacuum clamps used for mounting the machined workpiece. The machining process was carried out with the main central chip extraction installation turned off, due to a decision to exceed the extraction mechanism's effectiveness by using a custom extraction device.

## RESULTS AND DISCUSSION

### Results of sieve analysis

Within this study, the presented analysis was conducted for average values from 54 samples of chip masses, obtained by various conditions of feed rates, and widths of cut. The samples were split into two groups for sieve analysis based on tested material, and compared to each other. The dividing of the samples was based on pre-defined size ranges of mesh sizes, to determine the size content in which are the created chips represented. With the use of statistical analysis of variance, we determine the effect of studied variables on size distribution. The distributions of the average particle size range (X) for measured samples are shown in **Fig. 2** for particleboard and in **Fig. 3** for MDF. The average percentual distribution of chip particle size ranges with respect to the combination of variables width of cut ($a_e$) and feed rate ($v_f$) are listed in **Table 2.1** and **Table 3.1** below.

Based on the gravimetric measurements with pre-defined sieves, we find that chip mass from particleboard samples is a "collection" of smaller chips mostly in the size range of <1.0 to 0.063 mm, where other sizes are present in small amounts. In the MDF case, most of the chips compared to particleboards are mostly in the size range of <0.500 to 0.032 mm. Weighting shows that chips from particleboard samples were mostly retained on the sieve with a mesh size of 0.250 mm (size range of <0.500 to 0.250 mm), and medium-density fibreboard chips were retained on a sieve with a dimension of 0.125 mm (size range of <0.250 to 0.150 mm).

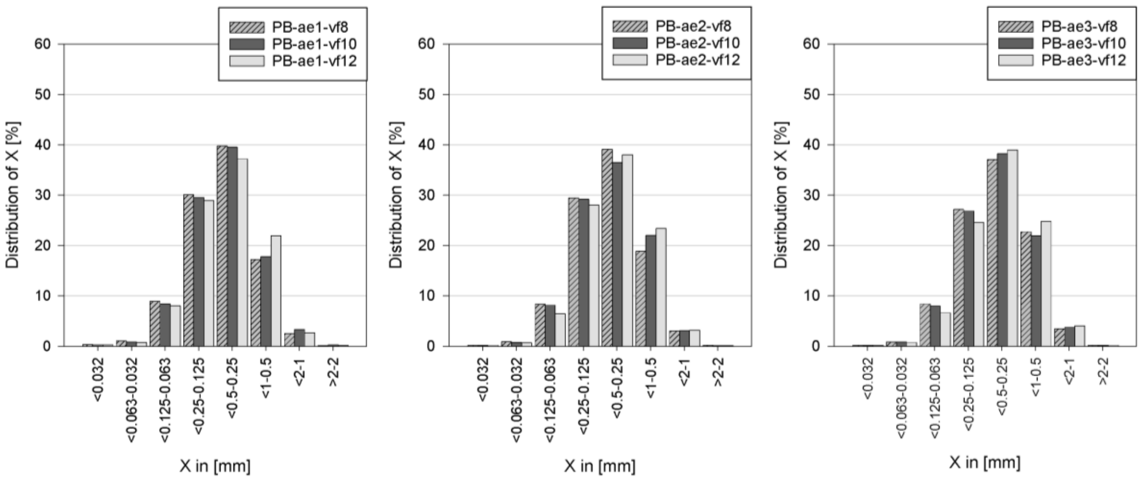


**Fig. 2** Distribution of particle size ranges from sieve analysis for Particleboard

**Table 2.1** Average percentual distribution of particle size ranges (X) for particleboard

| | **<0.032** | **<0.063-0.032** | **<0.125-0.063** | **<0.250-0.125** | **<0.500-0.250** | **<1.0-0.500** | **<2.0-1.0** | **Σ** |
|---|---|---|---|---|---|---|---|---|
| **ae1-vf8** | 0.33 | 1.03 | 8.95 | 30.09 | 39.79 | 17.20 | 2.50 | 100 |
| **ae1-vf10** | 0.30 | 0.87 | 8.41 | 29.54 | 39.54 | 17.79 | 3.30 | 100 |
| **ae1-vf12** | 0.28 | 0.74 | 8.06 | 28.92 | 37.20 | 21.94 | 2.66 | 100 |
| **ae2-vf8** | 0.18 | 0.87 | 8.34 | 29.42 | 39.13 | 18.87 | 3.02 | 100 |
| **ae2-vf10** | 0.16 | 0.75 | 8.16 | 29.20 | 36.50 | 22.02 | 3.07 | 100 |
| **ae2-vf12** | 0.15 | 0.66 | 6.42 | 28.07 | 38.03 | 23.39 | 3.18 | 100 |
| **ae3-vf8** | 0.20 | 0.84 | 8.37 | 27.16 | 37.08 | 22.71 | 3.46 | 100 |
| **ae3-vf10** | 0.19 | 0.81 | 8.01 | 26.84 | 38.23 | 21.93 | 3.78 | 100 |
| **ae3-vf12** | 0.16 | 0.73 | 6.61 | 24.54 | 38.98 | 24.79 | 4.06 | 100 |

Larger chips with a size higher than 1 mm are present in the particleboard case, however in the case of MDF, the presence is not in a significant amount. MDF compared to particleboard have a significantly higher content of chips with a size smaller than <0.032mm. This volume can be approximately 20 times higher, depending on the combination of variables. On average, the content of chips with a size smaller than <0.032mm is in particleboard approximately in the range of 0.33 - 0.15% of the total chip mass volume. However, in the case of MDF, this range is approximately 2.65 - 2.35% of the total chip mass volume.

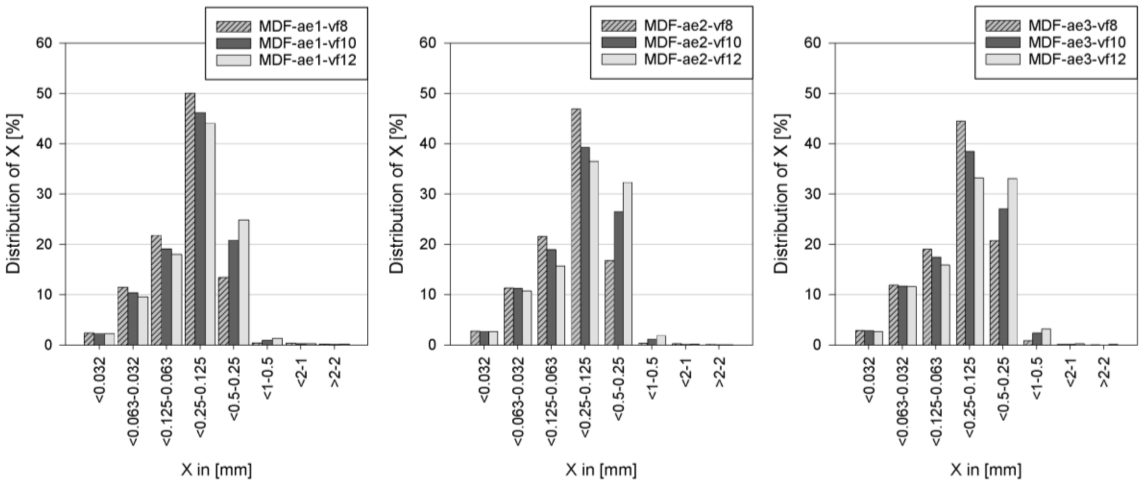


**Fig. 3** Distribution of particle size ranges from sieve analysis for Medium-density fibreboard

**Table 3.1** Average percentual distribution of particle size ranges (X) for MDF

| | **<0.032** | **<0.063-0.032** | **<0.125-0.063** | **<0.250-0.125** | **<0.500-0.250** | **<1.0-0.500** | **<2.0-1.0** | **Σ** |
|---|---|---|---|---|---|---|---|---|
| **ap1-vf8** | 2.35 | 11.47 | 21.77 | 50.06 | 13.42 | 0.42 | 0.31 | 100 |
| **ap1-vf10** | 2.26 | 10.35 | 19.08 | 46.22 | 20.80 | 0.91 | 0.26 | 100 |
| **ap1-vf12** | 2.21 | 9.55 | 18.04 | 44.04 | 24.84 | 1.27 | 0.22 | 100 |
| **ap2-vf8** | 2.72 | 11.31 | 21.58 | 46.89 | 16.79 | 0.34 | 0.23 | 100 |
| **ap2-vf10** | 2.69 | 11.26 | 18.93 | 39.30 | 26.43 | 1.18 | 0.13 | 100 |
| **ap2-vf12** | 2.65 | 10.74 | 15.71 | 36.53 | 32.31 | 1.82 | 0.17 | 100 |
| **ap3-vf8** | 2.85 | 11.91 | 19.00 | 44.49 | 20.71 | 0.84 | 0.12 | 100 |
| **ap3-vf10** | 2.80 | 11.70 | 17.45 | 38.47 | 27.02 | 2.37 | 0.11 | 100 |
| **ap3-vf12** | 2.65 | 11.63 | 15.88 | 33.23 | 33.10 | 3.16 | 0.26 | 100 |

In evaluating the effect of studied variables on the chip size, statistical calculations were made. From the values of retained mass, based on sieve analysis, we calculate the effect of feed rate and width of cut on the amount of chip size range. The results of the graphical interpretation of ANOVA are shown in **Fig. 4** and **Fig. 5**. Obtained results compare the volume of retained chips by the change of feed rate with the change of width of cut. For the purpose of the article, there are present even retained values for chip particles below <0.125 mm, due to lack of sieve with dimensions of <0.100 mm. However, these limitations are easily overcome by the fact that the chosen range contains most of the chip particles in the size range <0.100 mm.

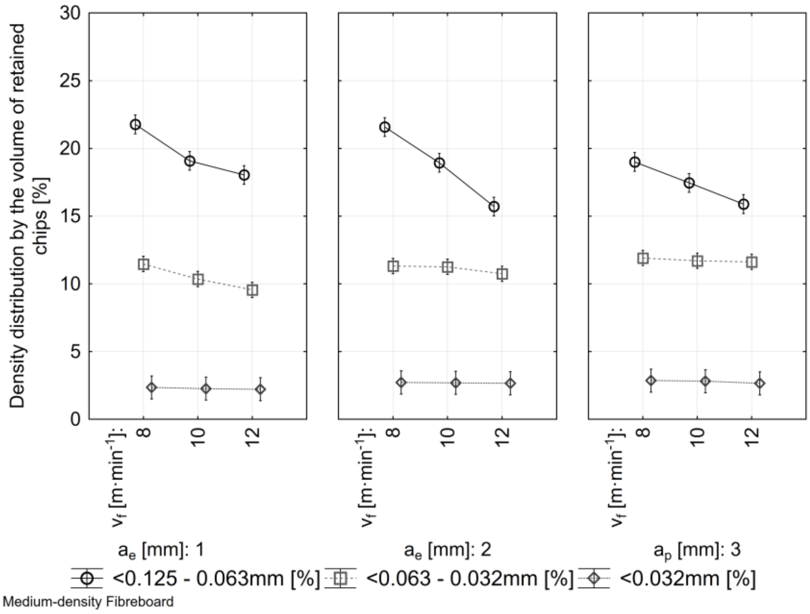


**Fig. 4** Density distribution of chip particle in the volume for medium-density fibreboard, abbreviation $a_e$ – width of cut in mm, $v_f$ – feed rate [m/min]

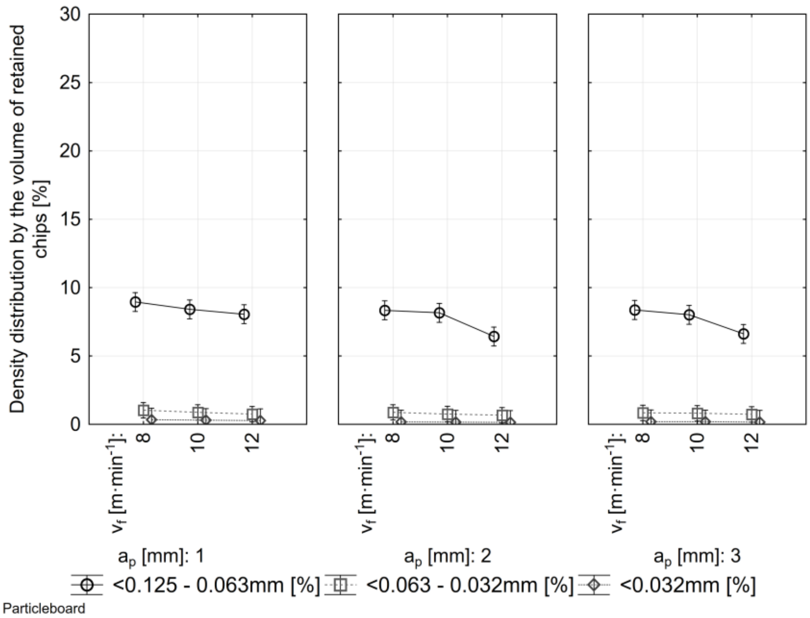


**Fig. 5** Density distribution of chip particle in the volume for particleboard, abbreviation $a_e$ – width of cut in mm, $v_f$ – feed rate in m/min

Plotted results of ANOVA demonstrate a decreasing effect on the amount of fine dust-like particles (size range of <0.125 mm) with increasing feed rate in the case of particleboard as in the medium-density fiberboard. In both materials, with increased feed rates, there is a decrease in the amount of retained chip mass in volume. But in the case of MDF, the decrease is more significant compared to particleboard.

The highest decrease is with the change of feed rate from 10 m/min to 12 m/min and the width of cut by 2 mm. Increasing the width of the cut is not significant in particleboards. This however can't be said about MDF. With the increasing width of cut in MDF, the amount of very fine dust-like particles (<0.032 mm) is increasing. Those statements are based on average values of sieve analysis. In reality, the amount of dust-like particles can vary with the combinations of feed rate and width of cut. Authors (Palmqvist and Gustafsson 1999) stated that average chip thickness is a critical factor in the amount of dust airborne particles in diameter of 1-10μm, no matter how is obtained. However, results obtained by cited authors were with the use of different milling conditions and used cutting tools, where the current trend tends to use a helix (spiral) shape of milling cuter edge over the straight cutting edge, and also feed rates and revolutions are much higher. Getting general information about created average chip thickness with the use of spiral cutting tools, can be compared to straight milling tools more complicated. For proving the statement that reducing average chip thickness leads to a decrease in the volume of dust chip particles with the use of various shapes of milling cutting tools, more tests are needed.

Results of statistical analysis

Recorded results were conducted for statistical analysis. For verifying the effect of studied variables on the amount of chip size particles we subjected the tested variable to the ANOVA muti-way Shapiro-Wilkson test. From the test results, we can see that all variables like material and technological parameters are significant in the amount of chip size particles. Even the combination of material and various technological parameters is very significant ($\rho < 0.05$). However, from our results, the test finds out that the combination of variables significantly affects the chip sizes, but those results are not as significant as the used material or operational parameter width of the cut or feed rate.

**Table 4** Examination of the significance level of 5% for ANOVA test results for Shapiro-Wilks test of individual variables, multivariate tests of significance, sigma-restricted parameterization and effective hypothesis decomposition

| **Variables** | **P - Probability** |
|---|---|
| Material (A) | $\rho < 0.05$ |
| Width of cut (B) | $\rho < 0.05$ |
| Feed rate (C) | $\rho < 0.05$ |
| A × B | $\rho < 0.05$ |
| A × C | $\rho < 0.05$ |
| B × C | $\rho < 0.05$ (0.046653368) |
| A × B × C | $\rho < 0.05$ (0.0409151544) |

To the article, we made statistical calculations for individual size ranges. The calculated univariate tests of significance are shown in Tab. 5. The presented calculations were for individual size ranges in inhalable size range <0.125-0.063 mm, <063-0.032 mm, and <0.032 mm. From calculated statistical test results obtained significance factors were proven only for variable material. But, in the case of size range <0.125-0.032 mm, there were proven factors of feed rate and width of cut. A possible explanation is that on inhalable content only factor material is the key, from the point of sieve analysis. But, on bigger chip sizes above inhalable level >0.100 mm, factors of feed rate and width of cut could have much higher significance importance ($p<0.05$). In calculated test results were also found that in all cases of combination of variables for every size range, those combinations were not proven to have a significance level from the point of obtained size ranges by sieve analysis.

**Table 5** Examination of the significance level of 5% for ANOVA test results for Shapiro-Wilks test of individual variables, univariate tests of significance, sigma-restricted parameterization, and effective hypothesis decomposition

| Particle size range | Effect | SS | df | MS | F-value | P-value |
|---|---|---|---|---|---|---|
| <0.032mm [%] | **Material (a)** | **75.0581** | **1** | **75.0581** | **34.65175** | **0.000001** |
| | Width of cut (b) | 0.3392 | 2 | 0.1696 | 0.07831 | 0.924839 |
| | Feed Rate (c) | 0.0696 | 2 | 0.0348 | 0.01606 | 0.984079 |
| | A × B × C | 0.0087 | 4 | 0.0022 | 0.00100 | 0.999998 |
| <0.063 - 0.032mm [%] | **Material (a)** | **1429.207** | **1** | **1429.207** | **1507.237** | **0.000000** |
| | Width of cut (b) | 3.263 | 2 | 1.631 | 1.720 | 0.193396 |
| | Feed Rate (c) | 2.846 | 2 | 1.423 | 1.500 | 0.236645 |
| | A × B × C | 1.026 | 4 | 0.256 | 0.270 | 0.895069 |
| <0.125 - 0.063mm [%] | **Material (a)** | **1540.296** | **1** | **1540.296** | **1069.699** | **0.000000** |
| | **Width of cut (b)** | **20.325** | **2** | **10.162** | **7.057** | **0.002594** |
| | **Feed Rate (c)** | **74.895** | **2** | **37.447** | **26.006** | **0.000000** |
| | A × B × C | 2.550 | 4 | 0.638 | 0.443 | 0.776865 |

# CONCLUSION

In this article, we studied the effect of main operational parameters on the chip size from the point of retained chip mass on pre-defined sieve meshes. We study the size ranges and the composition of the whole chip mass. We discussed the size range from sieve analysis obtained by weighting. Emphasis was aimed on studying the chip particles lower than <0.125 mm. The results show that depending on the milled material a quite different amount of dust particles would be created in the finishing process of milling, which was statistically proven. Medium-density fibreboards create more of the total fine fractions type (range of <0.250 to 0.125 mm) compared to particleboards (range of 0.500 mm to <0.250 mm). The experiment also shows that it is possible to reduce the content of small dust-like chips in both materials by increasing the feed rate above the inhalable size level. The width of the cut in our experiment demonstrates that could lead to a decrease in the amount of small dust-like chips (<0.125-0.063 mm) in particleboard chip mass. The effect of the width of the cut on the amount of very fine particles in the MDF case is, however, not clear. In general, based on the presented results obtained by sieve analysis, is highly recommended when finishing particleboards of medium-density fibreboards by milling to choose a higher feed rate to the point as the manufacturing process is allowing. The presence of dust particles above the level >0.100 mm would be significantly reduced. From the point of chip mass composition of various size ranges, every factor was proven. Every combination of studied operational variables would affect the created chip, and thus, the total chip mass composition. For verifying the effect of operational parameters on the inhalable chip size ranges, more tests are needed.

The presented test results can be used in the optimization process for CNC milling machines to minimize the amount of dust-size particle content (to an inhalable level) in the created chip mass generated during the finishing of wood-based materials by peripheral milling.

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**Streszczenie**: *Wpływ parametrów frezowania wykończeniowego płyt drewnopochodnych na powstawanie wiórów*. W ramach badań porównano wióry powstające w procesie frezowania dwóch rodzajów płyt drewnopochodnych: MDF oraz płyty wiórowej, przy użyciu nowoczesnego 5-osiowego centrum frezarskiego CNC. Próbki płyt w postaci bloków frezowano przy stałych obrotach narzędzia skrawającego (18 000 obr/min), przy zmiennych posuwach (8, 10 i 12 m/min) oraz zmiennej szerokości skrawania (1, 2, i 3 mm). Wielkość powstałych wiórów mierzono metodą ważenia grawimetrycznego na podstawie analizy przesiewowej zatrzymanej objętości wiórów na sitach o zadanych rozmiarach oczek. Główny nacisk położono na badanie cząstek wiórów otrzymanych w procesie frezowania wykańczającego poniżej <0,125mm. Różnice grawimetryczne objętości zatrzymanej masy wiórów wskazują, że powstałe wióry z MDF występują przeważnie w zakresie wielkości <0,250 do 0,125 mm, a z płyty wiórowej w zakresie wielkości <0,500 do 0,250 mm. Rozkład wartości średnich w zależności od różnych warunków wykazuje malejący wpływ wraz ze wzrostem prędkości posuwu na ilość bardzo małych cząstek wiórów w objętości obu materiałów. Zwiększenie posuwu może spowodować zmniejszenie ilości cząstek w zakresie poniżej <0,125 mm w objętości masy wiórów.

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