Article

Evaluation of Marblewood Dust's (*Marmaroxylon racemosum*) Effect on Ignition Risk

Miroslava Vandlíčková ^{1,*}, Iveta Marková ^{1,*} , Katarina Holla ² and Stanislava Gašpercová ¹

¹ Department of Fire Engineering, Faculty of Security Engineering, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia; miroslava.vandlickova@fbi.uniza.sk (M.V.); stanislava.gaspercova@fbi.uniza.sk (S.G.)

² Department of Crisis Management, Faculty of Security Engineering, University of Žilina, Univerzitná 8215/1, 010 26 Žilina, Slovakia; katarina.holla@fbi.uniza.sk

* Correspondence: iveta.markova@fbi.uniza.sk; Tel.: +421-41-513-6799

Abstract: The paper deals with the selected characteristics, such as moisture, average bulk density, and fraction size, of tropical marblewood dust (*Marmaroxylon racemosum*) that influence its ignition risk. Research was focused on sieve analysis, granulometric analysis, measurement of moisture level in the dust, and determination of the minimum ignition temperatures of airborne tropical dust and dust layers. Samples were prepared using a Makita 9556CR 1400W grinder and K36 sandpaper for the purpose of selecting the percentages of the various fractions (<63, 63, 71, 100, 200, 315, 500 μm). The samples were sized on an automatic vibratory sieve machine Retsch AS 200. More than 65% of the particles were determined to be under 100 μm . The focus was on microfractions of tropical wood dust (particles with a diameter of $\leq 100 \mu\text{m}$) and on the impact assessment of particle size (particle size < 100 μm) on the minimum ignition temperatures of airborne tropical dust and dust layers. The minimum ignition temperature of airborne marblewood dust decreased with the particle size to the level of 400 °C (particle size 63 μm).

Keywords: marblewood dust; granulometry; sieve analysis; shape of particles; ignition temperature

Citation: Vandlíčková, M.; Marková, I.; Holla, K.; Gašpercová, S. Evaluation of Marblewood Dust's (*Marmaroxylon racemosum*) Effect on Ignition Risk. *Appl. Sci.* **2021**, *11*, 6874.

<https://doi.org/10.3390/app11156874>

Academic Editor: Réh Roman

Received: 18 June 2021

Accepted: 24 July 2021

Published: 26 July 2021

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Copyright: © 2021 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

The timber industry is involved in the processing of ecologically safe raw materials with excellent utility properties. Flammability is a controversial feature, where on the one hand we want the product, e.g., wooden beam or door, to be nonflammable [1–3], and on the other hand wood as a fuel is required to have the highest possible calorific value. The wood composite materials industry is an important part of the wood processing industry. Its products provide very useful large-area materials with a wide range of uses and significantly contribute to the higher recovery of wood raw material [4,5]. Both aspects play a decisive role in the unprecedented dynamism of the sector on a global scale.

The wood materials industry is also strong and promising in Slovakia. It maintains a standard position, retaining on average a 17.5% share in the total number of companies according to [6] and is also one of the dominant producers of waste [7]. The character of the wood dust generated during production is influenced by its preparation and the type of wood processed. Significant attention in woodworking practice is given to the issue [8–11] as well as to the system of their extraction [11]. Lesser attention (but not an insignificant amount) is paid to the issue of their existence and the resulting negative impact on the work environment and on the human body. Microclimatic conditions contribute to the stabilization of the generated proportions of wood dust, which forms a dust–air mixture when agitated [12,13] or gets deposited on the surface of technical equipment [14]. The number of formed fractions of wood dust particles depends on the type of technological equipment used in the preparation of the wood [15]. The type of wood also has a significant effect on the composition of wood dust. Here, several problems come to the fore, which interact with each other and ultimately have a significant impact on both the health of

employees and the occurrence of a fire or explosion [16,17]. The first problem is the work environment. As part of climate change, the ambient temperature rises regularly, and summer and tropical days increase in the middle of the year. There is a decrease in ambient air humidity and an increase in working temperature [18]. All the listed parameters support the existence of dust particles. The second problem is the creation of very fine dust particles, thanks to the use of “eco-friendly” wood processing technologies, i.e., the processing of dry native wood without the addition of chemicals. Emphasis is placed on the quality of the obtained surfaces, for example by grinding and smoothing (leading to the formation of ultra-fine dust particles). Thirdly, also in the context of globalization, tropical woods are being introduced into our market, about which little scientific knowledge is available, especially in terms of their behavior in the event of the creation of undesirable dust–air mixtures during their mechanical processing. Studies [19–21] have shown an increase of interest in tropical woody plants for their excellent performance in exteriors and high stability. The preference for their use, especially in interior design, is growing, because the use of domestic wood is focused on industrial processing (such as paper production).

Marblewood (MW) originates from Northeastern South America. This heartwood (1005 kgm^{-3}) is yellow to golden brown, with irregular brown, purple, or black streaks [22]. Its common uses include flooring, sliced veneer, turned objects, cabinetry, and fine furniture as well as historical artifacts [23,24]. There exist works about MW as a resonance material [25]. Vivek et al. [26] introduced the possibility of using marblewood dust as a partial replacement for cement and sand in concrete. Marblewood (MW) is one of the most used tropical wood materials in various applications such as timber [27,28] or art objects [23]. More studies about marblewood are focused on the structure of marblewood and the quality its surface for its attractive design [29,30]. There is a lack of knowledge about the parameters assessing the ignition risk of marblewood and its dust.

The aims of the article are to show the granulometric structure of wood sanding dust from marblewood (*Marmaroxylon racemosum*), to show that its shape determines its physical properties, and to assess the impact of particle size (particle size $< 100 \text{ }\mu\text{m}$) on the minimum ignition temperature of airborne marblewood dusts.

2. Materials and Methods

MW dust samples were prepared from raw material, marblewood (*Marmaroxylon racemosum*) with a density of $1000.08 \pm 9.98 \text{ kgm}^{-3}$. The basic samples with dimensions of $120 \times 35 \times 35 \text{ mm}^3$ and a moisture content of approximately 8–10% were made in a private company that manufactures interior elements based in Žilina (Slovakia) using a wood cutting saw (CNC Panel Saw Machine, Shandong, China) (Figure 1).

Figure 1. Experimental dust samples.

The dust samples (Figure 1) were sanded using a Makita 9556CR 1400W disc sander (Makita Numazu Corp., Branesti Ilfov, Romania) and K36 sandpaper (Topex, Kinekus, Žilina, Slovakia). A detailed description of the procedure is given in [31].

The moisture value of the tropical wood samples was determined using granulometric analysis according to [32]. The bulk density of wood dusts was determined according to [33]. Sieve analysis was conducted on a Retsch AS 200 sieve shaker vibration machine (Retsch AS 200 control, Retsch GmbH, Haan, Germany) in line with [34].

The microscopic analysis was realized using a Nikon Eclipse Ni (Nikon Corp., Tokyo, Japan) with a Nikon DS-Fi2 camera (Nikon Instruments Inc., Melville, NY, USA) for the determination of the shape and the size of marblewood dust particles. The microscopic analysis (for 500, 315, 200, and 100 μm fractions) was completed at the Institute of Research in Banská Bystrica, Slovakia. The determination of the particle size was limited by the technical specifications of the cameras. The scans of fraction sizes <63, 63, and 71 μm were unreadable. A detailed description is given in [35].

The measures of the minimum ignition temperature of airborne dusts (Figure 2a) were conducted in a test equipment (VVUÚ, a.s., Ostrava, Czech Republic) with the help of the following accessories: automatic weighing machines (Steinberg Systems, Łódź, Poland), HL 100 ZU EINHELL air compressor (Einhell Corp., Landau an der Isar, Germany) and ALMEMO equipment (Ahlborn, Berlin, Germany) (Figure 2a). The procedure was conducted in line with [36] and details are described in [35]. The minimum temperature of airborne dusts was tested in 10 experiments with constant volumes of marblewood dust and different air flows.

The minimum ignition temperature of a dust layer (thickness 5 mm) was determined on an electrically heated plate, 185 mm in diameter, according to [36] (Figure 2b). This standard defines the minimum temperature for ignition of a dust layer as the minimum temperature of a hot surface at which ignition can occur of a dust layer with a set thickness located on that hot surface [37]. The experiments were performed on a laboratory hot plate apparatus with temperature controller, type CLARE 4.0, with measurement errors of $\pm 0.3^\circ\text{C}$ (Clasic, Czech Republic) in the experimental laboratory at the Faculty of Safety Engineering in Žilina (Slovakia). Detailed information about the behavior test is available in [38,39].

(a)

(b)

Figure 2. (a) The test equipment for the measurement of the minimum ignition temperature of airborne dusts; (b) experimental equipment “hot-plate” from [39].

3. Results and Discussion

Marblewood (*Marmaroxylon racemosum*) is ranked among the hardwoods. Everything about working with it revolves around its incredible hardness and density [40]. The density is measured based on the mixed particles' size before sieve analysis.

Different types of dry woods, dried to a constant weight (105 °C), have practically the same elementary chemical composition and the same density of wood substance [9].

Disintegration of wood into dust does not change the elemental chemical composition but changes the ratio of surface size to volume of disintegrated particles (example Figure 3) and changes the density (Table 1). Density and humidity are standard values to be considered when evaluating the examined dust samples. The marblewood dust experiments were performed in agreement with other experiments.

Table 1. Comparison of density and moisture of selected wood dusts with experimental sample.

Dust	Parameters			Sources
	Density of Raw Wood (kg·m ⁻³)	Average Bulk Density (kg·m ⁻³)	Dust Moisture (%)	
oak	672.86	238.01	6.00	[41]
beech	686.84	189.00	6.10	
spruce	446.35	77.77	7.80	
marblewood	1000.8	187.9	7.34	

Dust is a crushed (dispersed) solid and can be dispersed in air to form a dust–air mixture. The particle size in dust dispersion is determined by sieve analysis (particle size distribution), which determines the percentage of particles of a certain size (Table 2).

Table 2. Experimental result analysis of marblewood dust.

Fraction Size, MW Dust (µm)	Particle (%)	Minimal Ignition Temperature (°C), Airborne Dust	Minimal Ignition Temperature (°C), 5 mm Dust Layer
500	1.26 ± 0.244	420	305 Temperature of ignition source (°C) <300 °C, Experimental time 120 s
315	5.33 ± 0.591	420	
200	27.31 ± 0.462	420	
100	39.61 ± 0.367	410	
71	15.22 ± 0.111	400	
63	5.5 ± 0.383	400	
<63	5.64 ± 0.612	400	

Dust dispersion has a significant effect on its ignition risk. More-dispersed dust has a considerably large surface area, increased chemical activity, and a lower minimum ignition temperature [42,43], as seen in Table 2.

Marblewood has the highest tested minimum ignition temperature (Table 2) as compared with other tropical wood dusts [35].

It was found that more than 65% of particles were sized below 100 µm. This fact determines the possibility of the formation of airborne dust mixtures. The airborne mixtures of wood dust pose a risk of reaching explosive concentrations. The experimental results show a minimum initiation temperature for the airborne dust mixture of 400 °C. As the particle size increases, the ignition temperature value increases, for 500 µm it is 420 °C. The minimum ignition temperature for airborne dust is the lowest furnace temperature at which ignition occurred in this process, reduced by 20 °C for furnace temperatures above 300 °C [36]. This condition for the ignition of marblewood particles was met.

For dust layers, depth is the most important factor affecting the ignition temperature, particle size is not important, and density affected the ignition temperatures only for thin layers [13].

The MIT of a dust layer is the lowest temperature of a surface at which a dust layer resting on the surface can self-ignite. This is usually given for a 5 mm deep layer [44]. Pastier (2013) [45] researched a variety of wood dust layer samples. For determining the minimum ignition temperature of dust layers, all samples (Table 3) were sieved through a 0.5 mm sieve.

Table 3. Results from the testing of the minimum ignition temperature of a 5 mm dust layer.

Dust Samples	MIT _{5 mm} Layer	Sources
Dust formed when cutting particleboard and fiberboard on the saw	350	[45]
Dust from the forming saw where raw slabs from poplar, spruce, alder, and ash trees are processed	330	
Dust consisting of particles that arise when cutting chipboard	340	[13]
Beech dust	320	
<i>Miscanthus</i> dust	415	[46]
Marblewood dust	305	

The question of the description of particle size is clearly addressed in the work of [47]. Irregularity of particle shapes results from the anatomical structure of the wood mass, as their basis is the vessels in the lamellar structure [48,49].

The goal of all particle size determination techniques is to provide a simple number that indicates the particle size. However, particles are three-dimensional objects for which at least three parameters (length, width, and height) are required in order to provide a complete description. The particle size is given by the longest edge “d” of the rectangular parallelogram described around the particle (Figure 3), where length d is the largest dimension, thickness is the smallest dimension, and width is the intermediate dimension [50].

Figure 3. Basic dimensions of disintegrated wood mass particles [50].

An example of the shape of the marblewood dust particles is shown in Figure 4. Three dimensional scans were performed for fractions of 500, 315, 200, and <100 µm with a magnification of 0.63 zoom (27× magnification of the subject), 1 zoom (44× magnification of the subject), 2 zoom (88× magnification of the subject), and 3 zoom (132× magnification of the subject). Scans determine the shape for selected fractions.

Figure 4. MW dust particles and their shape measured by Nikon Eclipse Ni with Nikon DS-Fi2 camera.

The purpose of microscopic analysis is to show the diversity of the shape of the individual fractions. Figure 4 shows a selected series of pictures for each fraction. The first four are of a monolayer of dust, magnified at 0.63, 1, 2, and 3 zoom. The second series of pictures (foursome) show the same fraction (for example 500 μm) as a 1 mm continuous layer of dust under the microscope, again magnified at 0.63, 1, 2, and 3 zooms. Of course, the smaller the fraction, the greater the problem of preparing the monolayer.

The monolayer of the fraction below 100 μm is no longer pure (Figure 4). The particle shape varies with the size of the fraction. Fractions of 500, 315, and 200 μm were fibrous, curled, and articulated. The fraction below 100 μm formed clumps, and the shape was difficult to identify.

The visualization shows the difference in shape and area of the fractions. This fact is also observed on the change of the value of the minimum ignition temperature of airborne dust, also called of the ignition temperature of an explosive mixture according to [44].

4. Conclusions

Research on marblewood dust is part of the solution of a grant task dealing with the evaluation of fire parameters of domestic and tropical woody plants. The selection of experimental samples was based on the requirements of practice. Tropical woody plants have entered the Slovak market in all forms (decorative elements, furniture, building elements) and have been domesticated. Research into their properties will make it possible to gain a greater overview of the behavior of dust in our environment and will enable the creation of predictive models of its behavior. The fire risk of wood dust increases with the decrease in the size of the dust particles. The result is a decrease in the minimum ignition temperature.

Based on the obtained results of MW dust, it is possible to summarize the following:

- MW dust has more than 65% of particles with a size below 100 μm ;
- at the same time, the most numerous group (39.61%) are particles with a size of 100 μm ;
- MW dust forms an airborne dust mixture with a minimum initiation temperature of 400 $^{\circ}\text{C}$ at the smallest particle size
- an MW dust layer (5 mm) has a minimum initiation temperature of the ignition source of ($^{\circ}\text{C}$) <300 $^{\circ}\text{C}$ after 120 s.

Tropical marblewood has comparable parameters to domestic woods. Due to the expansion of the use of this wood in our country, it is possible to assume that it will have a similar behavior in its processing in our wood industry.

Author Contributions: Conceptualization, M.V. and I.M.; methodology, investigation, and resources, M.V.; writing—original draft preparation, I.M.; writing—review and editing, M.V., S.G., I.M. and K.H.; project administrator K.H. All authors have read and agreed to the published version of the manuscript.

Funding: This article was supported by Project KEGA 033ŽU-4/2019, integrating practical learning in a study program with rescue services.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: This article was supported by Project KEGA 033ŽU-4/2019, integrating practical learning in a study program with rescue services.

Conflicts of Interest: The sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; and in the decision to publish the results.

References

1. Gašpercova, S.; Makovicka, O.L. Influence of surface treatment of wood to the flame length and weight loss under load single-flame source. *Key Eng. Mater.* **2017**, *755*, 353–359. [\[CrossRef\]](#)
2. Makovicka Osvaldová, L.; Osvald, A. Flame Retardation of Wood. *Adv. Mat. Res.* **2013**, *690–693*, 1331–1334.
3. Čekovská, H.; Gaff, M.; Osvaldová, L.; Kačík, F.; Kaplan, L.; Kubš, J. Tectona grandis Linn. and its Fire Characteristics Affected by the Thermal Modification of Wood. *BioResources* **2017**, *12*, 2805–2817. [\[CrossRef\]](#)
4. Očkajová, A.; Kučerka, M.; Krišťák, L.; Ružiak, I.; Gaff, M. Efficiency of Sanding Belts for Beech and Oak Sanding. *Bioresources* **2016**, *11*, 5242–5254. [\[CrossRef\]](#)
5. Kadlicová, P.; Gašpercová, S.; Osvaldová, L.M. Monitoring of Weight Loss of Fibreboard during Influence of Flame. *Procedia Eng.* **2017**, *192*, 393–398. [\[CrossRef\]](#)
6. Sujová, A.; Hlaváčková, A.; Šafařík, D. Analysis of the performance of the wood processing industry through ratios. *Acta Fac. Xylol. Zvolen* **2015**, *57*, 165–178. (In Slovak)
7. SAE. Waste Generation in Industry. Available online: <https://www.enviroportal.sk/indicator/detail?id=987&print=yes> (accessed on 12 December 2019). (In Slovak)
8. Očkajová, A.; Kučerka, M.; Krišťák, L.; Igaz, R. Granulometric Analysis of Sanding Dust from Selected Wood Species. *Bioresources* **2018**, *13*, 7481–7495. [\[CrossRef\]](#)
9. Dzurenda, L.; Orlowski, K.A. The effect of thermal modification of ash wood on granularity and homogeneity of sawdust in the sawing process on a sash gang saw prw 15-M in view of its technological usefulness. *Drewno* **2011**, *54*, 27–37.
10. Orlowski, K.A.; Chuchala, D.; Muzinski, T.; Barański, J. The effect of wood drying method on the granularity of sawdust obtained during the sawing using the frame sawing machine. *Acta Fac. Xylol. Zvolen* **2019**, *1*, 83–92.
11. Mračková, E.; Krišťák, L.; Kučerka, M.; Gaff, M.; Gajtanská, M. Creation of Wood Dust during Wood Processing: Size Analysis, Dust Separation, and Occupational Health. *Bioresources* **2016**, *11*, 209–222. [\[CrossRef\]](#)
12. Kuracina, R.; Szabova, Z.; Balog, K. *Study of Selected Fire Characteristics of Beech Wood Depending on Particle Size*; Wood & Fire Safety, Technical University in Žilina: Žilina, Slovakia, 2020.
13. Polka, M.; Salamonowicz, Z.; Wolinski, M.; Kukfisz, B. Experimental Analysis of Minimal Ignition Temperatures of a Dust Layer and Clouds on a Heated Surface of Selected Flammable Dusts. *Procedia Eng.* **2012**, *45*, 414–423. [\[CrossRef\]](#)
14. Pedzik, M.; Rogoziński, T.; Majka, J.; Stuper-Szablewska, K.; Antov, P.; Kristak, L.; Kminiak, R.; Kučerka, M. Fine Dust Creation during Hardwood Machine Sanding. *Appl. Sci.* **2021**, *11*, 6602. [\[CrossRef\]](#)
15. Osvaldova, L.M.; Gasparik, M.; Castellanos, J.R.S.; Kadlicova, P.; Cekovska, H. Effect of thermal treatment on selected fire safety features of tropical wood. *Commun. Sci. Lett. Univ. Zilina* **2018**, *20*, 3–7.
16. Mvondo, R.R.N.; Meukam, P.; Jeong, J.; De Sousa Meneses, D.; Nkeng, E.G. Influence of water content on the mechanical and chemical properties of tropical wood species. *Results Phys.* **2017**, *7*, 2096–2210. [\[CrossRef\]](#)
17. Krentowski, J. Disaster of an industrial hall caused by an explosion of wood dust and fire. *Eng. Fail. Anal.* **2015**, *56*, 403–411. [\[CrossRef\]](#)
18. Marková, I.; Monoši, M. Expressions of climatic change in Slovak Republic. *Ann. Univ. Paedagog. Crac. Studia Nat.* **2020**, *5*, 145–156.
19. Mamonova, M.; Reinprecht, L. The impact of natural and artificial weathering on the anatomy of selected tropical hardwoods. *IAWA J.* **2020**, *41*, 333–355. [\[CrossRef\]](#)
20. Vandlíčková, M.; Marková, I. Ignition of Wood Dust of African Padauk (*Pterocarpus soyauxii*). In *International Scientific Conference on Woods & Fire Safety*; Springer: Cham, Switzerland, 2020; pp. 58–65.
21. Osvaldova, L.M.; Kadlicova, P.; Rychly, J. Fire characteristics of selected tropical woods without and with fire retardant. *Coatings* **2020**, *10*, 527. [\[CrossRef\]](#)
22. Marblewood. The Wood Database. Available online: <https://www.wood-database.com/marblewood/> (accessed on 21 March 2020).
23. Georgopoulos, J.; Ioannidis, C.; Valanis, A. Assessing the performance of a structured light scanner. In *Proceedings of the International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences 2010, XXXVIII, Part 5 Commission V Symposium, Newcastle upon Tyne, UK, 21–24 June 2010*; pp. 250–255.
24. De La Torre-López, M.J.; Dominguez-Vidal, A.; Campos-Suñol, M.J.; Rubio-Domene, R.; Schade, U.; Ayora-Cañada, M.J. Gold in the Alhambra: Study of materials, technologies, and decay processes on decorative gilded plasterwork. *J. Raman Spectrosc.* **2014**, *45*, 1052–1058. [\[CrossRef\]](#)
25. Kim, J.; Noh, B.; Park, J.W. Giving Material Properties to Interactive Objects: A Case Study of Tangible Cube Representing Digital Data. *Arch. Des. Res.* **2020**, *33*, 3, 55–72. [\[CrossRef\]](#)
26. Vivek, V.; Vinod, K.; Sonthwal, K. Effect of Marble Dust Powder & Wood Sawdust Ash on UCS and CBR Values of Soil. *Int. J. Innov. Res. Sci. Eng. Technol.* **2017**, *6*, 8.
27. Longwood, F.R. *Present and Potential Commercial Timbers of the Caribbean with Special Reference to the West Indies, The Guianas and British Honduras*. Agriculture Handbook No. 207, March 1962; U.S. Department of Agriculture, Forest Service: Washington, DC, USA, 1962.
28. Binding, C.; Tudhope, D. Integrating faceted structure into the search process. *Adv. Knowl. Organ.* **2004**, *9*, 67–72.

29. Møller, B. Marble, Tortoiseshell, Wood and Other Materials Created in Paint and Lacquer during the Baroque Period in Denmark. 13th International Symposium on Wood and Furniture Conservation. 2017, pp. 19–32. Available online: http://www.ebenist.org/wp-content/uploads/2017/11/Moller_LR.pdf (accessed on 1 November 2017).
30. Cardell, C.; Rodriguez-Simon, L.; Guerra, I.; Sanchez-Navas, A. Analysis of Nasrid polychrome carpentry at the Hall of the Mexuar Palace, Alhambra complex (Granada, Spain), combining microscopic, chromatographic and spectroscopic methods. *Archaeometry* **2009**, *5*, 637–657. [\[CrossRef\]](#)
31. Vandlíčková, M.; Marková, I.; Makovická Osvaldová, L.; Gašpercová, S. Tropical Wood Dusts—Granulometry, Morphology and Ignition Temperature. *Appl. Sci.* **2020**, *10*, 7608. [\[CrossRef\]](#)
32. STN 49 0103: 1979. *Wood. Determination of Moisture Content at Physical and Mechanical Testing*; Slovak Technical Normalisation: Bratislava, Slovakia, 1979. (In Slovak)
33. ISO 23145-1:2007. *Determination of Bulk Density of Ceramic Powders—Part 1: Tap Density*; International Organization for Standardization: Geneva, Switzerland, 2007.
34. ISO 3310-1:2016. *Test Sieves—Technical Requirements and Testing—Part 1: Test Sieves of Metal Wire Cloth*; International Organization for Standardization: Geneva, Switzerland, 2016.
35. Vandlíčková, M.; Marková, I.; Osvaldová, L.M.; Gašpercová, S.; Svetlík, J. Evaluation of African padauk (*Pterocarpus soyauxii*) explosion dust. *BioRes* **2020**, *15*, 401–414.
36. EN 50281-2-1: 2002. *Electrical Apparatus for Use in the Presence of Combustible Dust. Part 2-1: Test Methods. Methods for Determining the Minimum Ignition Temperatures of Dust*; European Committee for Standardization: Brussels, Belgium, 2002.
37. Dastidar, A.G. Chapter Four—Dust explosions: Test methods. *Methods Chem. Process Saf.* **2019**, *3*, 71–122.
38. Turekova, I.; Markova, I. Ignition of Deposited Wood Dust Layer by Selected Sources. *Appl. Sci.* **2020**, *10*, 5779. [\[CrossRef\]](#)
39. Danzi, E.; Marmo, L.; Riccio, D. Minimum Ignition Temperature of layer and cloud dust mixtures. *J. Loss Prev. Process Ind.* **2015**, *36*, 326–334.
40. Marblewood, Wood Turning Pens. Available online: <https://www.woodturningpens.com/marblewood/> (accessed on 21 April 2020).
41. Marková, I.; Očkajová, A. *Assessing the Risk of Wood Dust in the Work and Environment*, 1st ed.; Monograph Belainum: Banská Bystrica, Slovakia, 2018. (In Slovak)
42. Turekova, I.; Turnova, Z.; Harangozo, J.; Kasalova, I.; Chrebet, T. Determination of Ignition Temperature of Organic Dust Layers. *Adv. Mater. Res.* **2013**, *690–693*, 1469. [\[CrossRef\]](#)
43. Lowden, L.A.; Hull, T.R. Flammability behaviour of wood and a review of the methods for its reduction. *Fire Sci. Rev.* **2013**, *2*, 4.
44. Macangus, G.G. *Chapter 4—Hazardous Area Installation*; Geoff, M.-G., Ed.; Offshore Electrical Engineering Manual, Gulf Professional Publishing: Oxford, UK, 2018; pp. 303–324.
45. Pastier, M.; Tureková, I.; Turňová, Z.; Harangózo, J. Minimum ignition temperature of wood dust layers. *Res. Pap. Fac. Mater. Sci. Technol. Trnava Slovak Univ. Technol. Bratisl.* **2013**, *21*, 127. [\[CrossRef\]](#)
46. Malmgren, A.; Riley, G. Biomass Power Generation. *Compr. Renew. Energy* **2012**, *5*, 27–53.
47. Mazzoli, A.; Favoni, O. Particle size, size distribution and morphological evaluation of airborne dust particles of diverse woods by Scanning Electron Microscopy and image processing program. *Powder Technol.* **2012**, *225*, 65–71. [\[CrossRef\]](#)
48. Bekhta, P.; Mamoňová, M.; Sedláčik, J.; Novák, I. Anatomical study of short-term thermo-mechanically densified alder wood veneer with low moisture content. *Eur. J. Wood Prod.* **2016**, *74*, 643–652. [\[CrossRef\]](#)
49. Mamoňová, M. *Wood Anatomy*; Monography; Technical University in Zvolen: Zvolen, Slovakia, 2013.
50. Longauer, J.; Sujová, E. *Selected Properties of Solid Parts*, 1st ed.; Monography 9/2000/A; Technical University: Zvolen, Slovakia, 2001. (In Slovak)