ACTA SCIENTIARUM POLONORUM
Acta Sci. Pol.
Silv. Colendar. Rat. Ind. Lignar. 10(1) 2011, 11-18

PROPERTIES OF WASTES FROM THE CUTTING OF THERMALLY MODIFIED OAK WOOD

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Abstract. Thermal modification of the oak wood causes changes of the characteristics of wastes resulted from wood processing. The waste particles of thermally modified oak wood are characterised by a higher degree of crumbling and clearly different shape. It influences, first of all increasing of the main bulk characteristics of the wastes – bulk density and tapped bulk density. Slight differences in the scope of the angle of repose, the sliding angle of repose and the entrainment velocity of particles including in the same fractions appeared. The exact knowledge of the range of characteristics changes of the wastes resulted from the thermally modified oak wood in the relation to wastes from natural oak wood makes possible the introduction of suitable corrections by establishing the design data for pneumatic conveyors and dedusting devices of woodworking machines applied in the processing of the thermally modified oak wood.

Key words: oak wood, thermal modification, dedusting, bulk characteristics

INTRODUCTION

The development of technology and techniques of the mechanical processing of wood materials carries along the manifold changes in the basic and side effects of these processes. Introducing of materials with properties different from these which characterise wood in the natural state to the wood industry is also the cause of appearing of such changes. Interference in the structure and the proprieties of wood substance which have been shaped in the growing conditions of the natural environment always finds its reflection, among others, in the way of the waste particles formation during the tooling of worked materials and in varied properties of these wastes. This question is in so-far important, because waste particles, appearing in every case of the mechanical processing of wood materials, cause, in smaller or larger degree, negative influences both in the direct zone of the operation of the cutting tool, and in the whole environment of the running of the working processes.

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Introducing to industrial uses of the thermal modified oak wood with properties clearly different from the natural oak wood caused the new exploitation conditions of the exhaust installations and the dedusting devices applied in wood industry. The particles of the crumbled wood substance marked by the characteristic which is derivative of wood with altered thickness, hardness, hygroscopicity, cleavability etc. flow in the conveying pipelines and are brought to the dust collectors. In order to create the basis to the quantitative description of the properties of wastes from thermally modified oak-wood, the tasks of the exact qualification of their bulk parameters and the basic aerodynamic feature the entrainment velocity were undertaken.

MATERIAL AND METHODS

The tests of the characteristic of wastes were conducted in laboratory conditions with the use of required measuring procedures [Dolny 1999, Dzurenda 2002, McGlinchey 2005]. Air temperature was in the range of 18-20°C and the air relative humidity came to 40%. The kind of the wastes was limited to two processing methods – cross-cut sawing and planing (Table 1). The wastes were taken directly from the working positions in the industrial plant producing furniture panels and flooring materials from the wood of natural oak and thermally modified oak wood. Technological conditions of the creation of both kinds of wastes were always identical. So any differences of their characteristic are exclusively the effect of the oak wood structural features changes appearing in the result of the moisture and temperature influences in the process of wood modification [Dzurenda and Orłowski 2010, Grześkiewicz and Dąbrowski 2004, Grześkiewicz and Nowicki 2004].

Table 1. List of operations conducted on woodworking stations
Tabela 1. Zestawienie operacji prowadzonych na poszczególnych stanowiskach

Operation number Numer operacji	Wood working machine Nazwa obrabiarki	Operation Operacja
1	saw machine Striebig pilarka Streibig	sawing przycinanie na długość
2	four-side planer – Walter strugarka czterostronna Walter	preliminary planing by bottom cutterhead struganie wstępne głowicą dolną
3		preliminary planing by left cutterhead struganie wstępne głowicą lewą
4		preliminary planing by right cutterhead struganie wstępne głowicą prawą
5		prelimniary planing by upper cutterhead struganie wstępne głowicą górną

STUDIED CHARACTERISTICS

The basic characteristics of small particles created during the mechanical processing of wood materials were considered in order to the obtainment of detailed comparative data for the studied wastes. These characteristics were: grain composition, bulk density and tapped bulk density, angle of repose and sliding angle of repose and the entrainment velocity of particles including in various dimension fractions.

A set of such characteristics describes in a complex way any crumbled solid substance under the angle of harmfulness or importunity for the closest surroundings of its creation zone and makes possible the undertaking in all aspects effective efforts to removing, transportation, safe storage and the utilization of these substances. The exact knowledge of these characteristics is particularly required in the projecting and establishing the exploitation parameters of pneumatic transportation devices and dust collectors assembled in such devices [Dolny 1999].

THE RESULTS PRESENTATION

The results of tests of both kinds of wastes were taken down on common graphs in order to show the direct relationships between values obtained during the measurements. The mutual differentiation of every tested characteristic results from it. The results presented in this work enable the possibility to easily take the view of the additional or qualitatively different problems connected with the occurrence of small wastes during the processing of the thermally modified oak wood in comparison with wastes created during the processing of the natural oak wood.

The operation numbers appearing on the graphs presenting the results of the measurements are gathered in Table 1. The darker colour of column, points and lines was applied to values measured or determined regarding the wastes from the processing of thermally modified oak wood.

RESULTS

The grain composition

The grain composition of wastes from the processing of the natural oak wood and thermally modified oak wood obtained by the method of the sieve analysis includes eight dimension fractions. The grain compositions of wastes from the kinds of wood processing taken into consideration were shown on graphs on Figure 1. Differences in the crumbling degree of the waste particles created during processing with the use of the same tools and at the same tooling parameters are displayed there. These differences are especially clear in the reference to the operation of planing, where the small fractions content is decidedly higher for the thermally modified wood. The photos of the samples of wastes from preliminary base planing by the bottom cutterhead on the four-side planer Walter confirm these differences in the obvious way (Fig. 2).

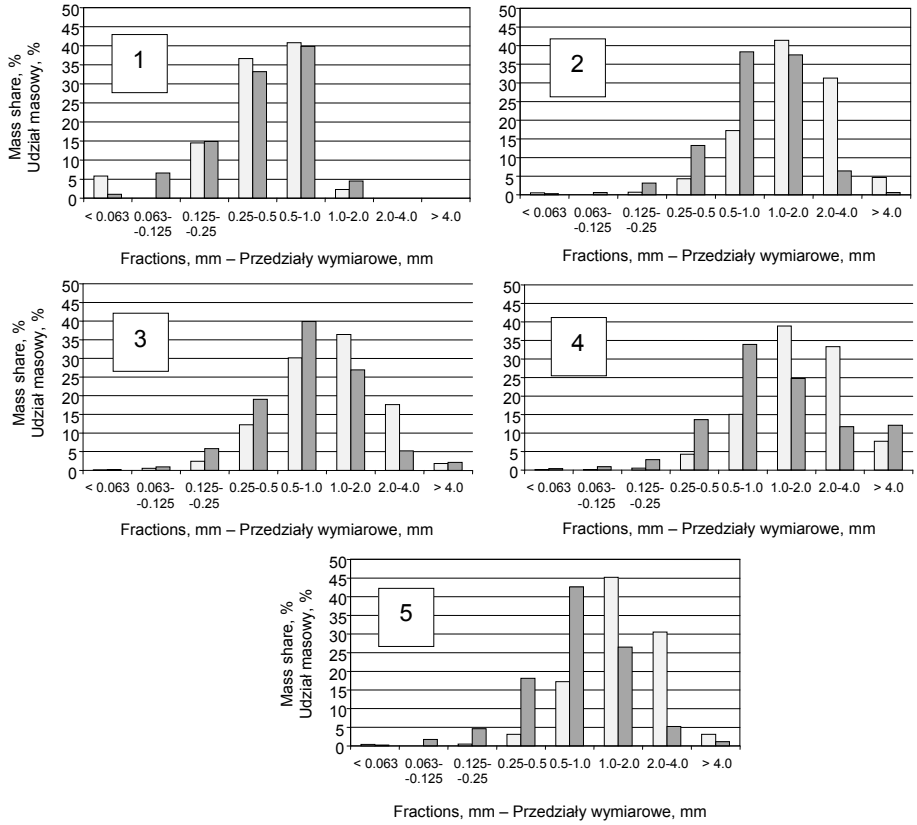

Fig. 1. Grain composition of wastes
Rys. 1. Skład ziarnowy odpadów

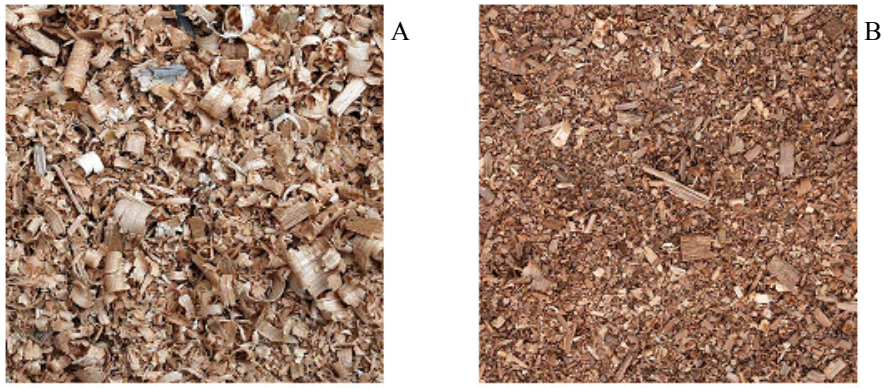

Fig. 2. Waste particles of natural oak wood A and thermally modified oak wood B resulted from operation 2
Rys. 2. Odpady dębu naturalnego A i dębu modyfikowanego termicznie B powstałe w wyniku operacji 2

The differentiation of dimension and shape characteristics of the particles of crumbled wood substance directly affects the value of bulk characteristics of wastes; it resulted from wood processing. It influences the way of the mutual arrangement or bonds in compact layers occupying free or limited spaces.

The bulk density and tapped bulk density

The differentiation of the dimension and shape characteristics of the crumbled wood substance particles affects the value of the bulk characteristics of the wastes from the processing. It influences the way of their mutual arrangement or bonds in compact layers filling in free or limited spaces.

The occurrence of these dependences finds unambiguous confirmation in the results of the tests of the basic bulk parameters of studied wastes (Fig. 3 and Fig. 4). The bulk density of the sawdust created during the processing of the thermally modified oak wood is higher by about 50% than the identical wastes from the tooling of the natural oak wood. Smaller but very clear difference was also affirmed in the reference to the tapped bulk density. Mutual disproportions ampunted here nearly to 25%. The occurrence of both differences has an essential practical meaning. It shows, among others,

Fig. 3. Bulk density
Rys. 3. Gęstość nasypowa

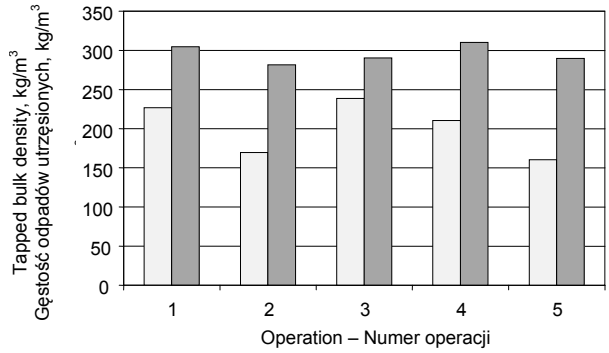

Fig. 4. Tapped bulk density
Rys. 4. Gęstość odpadów utrzęsionych

to the necessity of applying the strengthened constructions of containers for the wastes from the mechanical processing of the thermally modified oak wood and special adapting of the mechanisms or the devices to rake out the wastes from these containers.

The angle of repose and the sliding angle of repose

Within the angle parameters of wastes from the natural oak wood and the thermally modified oak wood no considerable differences (Fig. 5) were affirmed. The values of these angles shape on only somewhat different levels. It has no larger influence on the fulfilment degree of the capacity of containers, especially these which have a large height of the loading space. The same remarks also relate to the position of shoot surfaces and construction of the funnels for gravitational emptying of these containers.

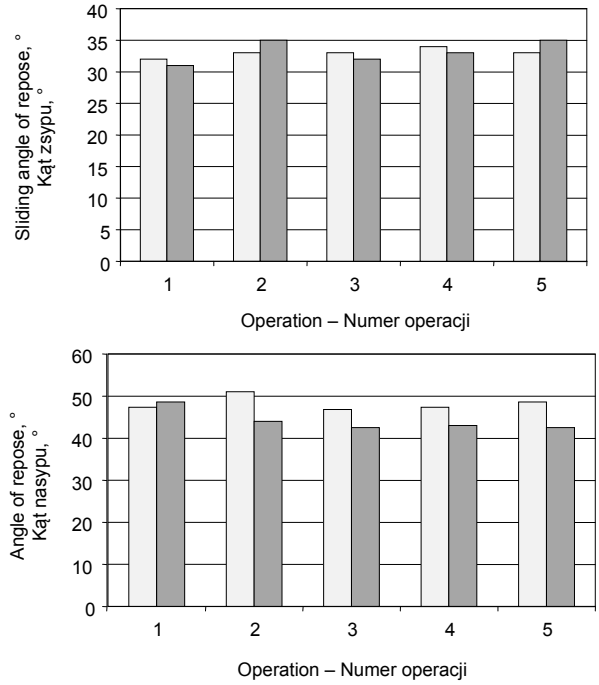

Fig. 5. Angle of repose and sliding angle of repose
Rys. 5. Kąt nasypu i kąt zsypu

The entrainment velocity

Clear differences of the entrainment velocity of particles included in the same fractions were not noted down similarly as for the angle of repose and sliding angle of repose of both kinds of wastes (Fig. 6). These velocities gradually grow along the increase of particle size and it follows almost uniformly for wastes from the natural oak wood and the thermally modified oak wood. Neither the shape differences of both kinds of wastes nor the difference in wood density not crossing 5% have any influence on the entrainment velocity. The particles with the same size can be transported by pneumatic conveyors at the identical flow parameters of the air stream.

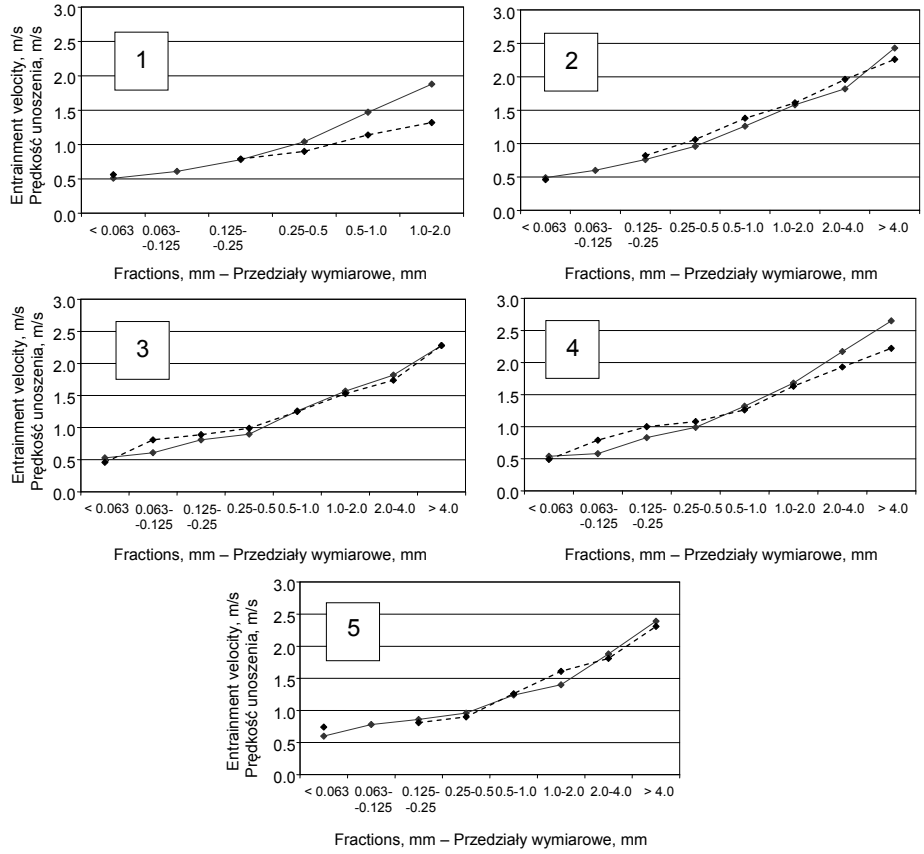

Fig. 6. Average entrainment velocities
Rys. 6. Średnie prędkości unoszenia cząstek

CONCLUSION

The wastes created during such tooling operations of the natural oak wood and thermally modified oak wood show many differences within their characteristics. It is the after-effect of the essential changes which happen in the structure of the wood of this species subjected to the processes of modification.

1. The occurrence of considerable differences within the grain composition of the wastes in dependence on the tooling operation was affirmed.

2. The bulk densities of wastes created during the processing of the natural oak wood and the thermally modified oak wood differ from each other. Both the bulk density and the tapped bulk density of the thermally modified oak wood have higher values. These values also differ from each other within various operations less than the wastes created from the natural oak wood.

3. The angle of repose and the sliding angle of repose of the wastes created from the thermally modified oak wood and the natural oak wood shape was on the comparable

level. They also do not show more considerable hesitations within the tooling operations taken into consideration.

4. The entrainment velocities of the particles created during various tooling operations mainly depend on their size. Wastes from the natural oak wood and the thermally modified oak wood have the comparable values of these velocities for the same operations.

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WŁAŚCIWOŚCI ODPADÓW Z OBRÓBKI SKRAWANIEM DREWNA DĘBU MODYFIKOWANEGO TERMICZNIE

Streszczenie. Modyfikowanie drewna dębowego zabiegami termicznymi wywołuje zmiany właściwości odpadów powstających w wyniku jego obróbki skrawaniem. Drobne cząstki, będące fragmentami drewna dębu-termo, odznaczają się wyższym stopniem rozdrobnienia i wyraźnie odmiennymi cechami kształtowymi. Wpływa to przede wszystkim na zwiększanie się głównych parametrów masowych tych odpadów – gęstości nasypowej i gęstości odpadów utrzęsionych. Niewielkie różnice zarysowują się natomiast w obrębie parametrów kątowych oraz w prędkościach unoszenia cząstek mieszczących się w takich samych przedziałach wymiarowych. Dokładna znajomość zakresu zmian charakterystyk odpadów z drewna dębu poddawanego zabiegom termicznym w stosunku do odpadów z drewna dębu naturalnego umożliwia wprowadzanie odpowiednich korekt w ustalaniu danych do projektowania układów transportu pneumatycznego i odpylania dla zespołów obrabiarek stosowanych w procesach wytwarzania wyrobów z tak zmodyfikowanego surowca dębowego.

Słowa kluczowe: drewno dębu, modyfikacja termiczna, odpylanie, charakterystyka odpadów

Accepted for print – Zaakceptowano do druku: 11.02.2011

For citation – Do cytowania: Dolny S., Grocki W., Rogoziński T., 2011. Properties of wastes from the cutting of thermally modified oak wood. Acta Sci. Pol., Silv. Colendar. Rat. Ind. Lignar. 10(1), 11-18.