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Diagnostic usefulness of granulometric analyses of chips distribution while sawing of wood

R. WASIELEWSKI[1], K. ORŁOWSKI[1], L. DZURENDA[2]
[1]Department of Manufacturing Engineering and Automation, Mechanical Engineering Faculty, Gdansk University of Technology, Poland
[2]Department of Woodworking, Faculty of Wood Sciences and Technology, Technical University in Zvolen, Slovakia

Abstract: *Diagnostic usefulness of granulometric analyses of chips distribution while sawing of wood.* In this paper ways of chips transportation and those ways' effect on chips' size reduction in wood sawing process are described. The granulometric distributions of chips obtained during sawing with circular saw blades of the regular design with the circular saw blade in which gullets are semi-closed have been presented.

Keywords: sawdust, chips, granulometric analysis, wood cutting, circular sawing machine

INTRODUCTION

Chips (sawdust) formed in machining bring out a lot of information about the realised process. Their analyses may be a source of messages about phenomena which accompany the machining. In wood cutting shape and size of chips, their chemical and physical properties depend on many factors as follows: raw material (species, moisture content, wood temperature [1 Sandak et al.]), a circular saw (geometry, cutting speed, feed per tooth, position in relation to a workpiece, workpiece height, type of sawing: climb or up-sawing) and a machine tool (accuracy of workpiece movement in relation to a saw blade). The presented factors only decide about chips' shape formed in the cutting zone. Those chips could have different forms. Furthermore, in specific cutting conditions their dimensions result from cutting parameters (cut thickness, a overall set and a contact length with the workpiece). Thus, those chips have the unique character of continuous chips(fig. 1a). Nonetheless, in a large majority of cases formed chips are rather in character of small measure particles (fig. 1b) [2 Dzurenda et al.].

The path of chip transportation from the cutting zone (a place of its formation) to the workpiece outside is an additional factor which affects formed chips. It is just a result of the cutting conditions in the narrow slot in which the circular saw blade relocates. This causes some difficulties with removal of chips outside of the workpiece, which are accompanied by a lot of disadvantageous phenomena. They could cause a decrease in quality and accuracy of sawn surfaces, an increase of the circular saw blade wear, and also in particular cases tools' destruction, a workpiece damage or even in case of the machine tool its serious break-down. Hence, the proper transportation of chips from the cutting zone to the workpiece outside is part and parcel of the cutting process with circular saw blades.

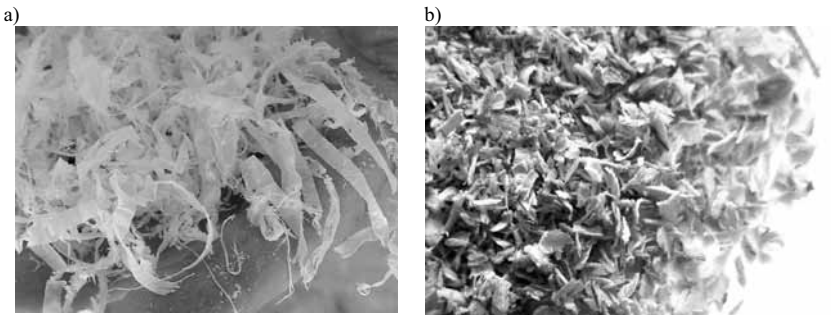

Fig. 1. Examples of chip forms formed during wood sawing: a) continuous chips, b) fine chips and sawdust

If chips and sawdust are collected outside of the workpiece it is feasible, on the basis of their granulometric analysis, to obtain information not only about the sawing process but also about the way of chips and sawdust transportation from the cutting zone (the place of chips formation) to the place their collection.

WAYS OF CHIPS' TRANSPORTATION IN THE CUTTIG PROCESS WITH CIRCULAR SAW BLADES

In circular saw blades of the regular design, commonly used in the sawmill industry (fig. 2a), only a part of chips formed in the cutting process is directly conveyed in gullets and then thrown out the workpiece [3 Wasielewski]. The chips' residuum remains longer in the kerf slot being transported on both sides of the saw blade and also between successive teeth. For that reason only some chips are conveyed outside the workpiece by the saw blade. Furthermore, a part of chips, which are still present in the slot between the saw blade and the kerf wall, are eventually thrown out by passive teeth on the top surface of the workpiece. With the purpose of the chip transport intensification in many circular saw blade designs additional slots (grooves) of different shape, sometimes equipped with cleaning carbide knives, are applied.

Another type of the chips' transportation characterizes circular saw blades in which gullets are semi-closed (fig. 2b) [4 Wasielewski et al., 5 Wasielewski et al., 6 Wasielewski]. The gullet design in those circular saw blades allows chips to stay in it and reduce simultaneously the chips' flow between teeth and on the saw blade. The design of gullets is characterized by the connection of the tooth with the properly formed carbide cleaning knife. As a result chips are kept in the gullet and move together in it (fig. 2b). While circular saw blade teeth leave the slot (kerf) the chips are removed beyond the workpiece. Semi-closed gullets in circular saw blades have improved cutting conditions of saws.

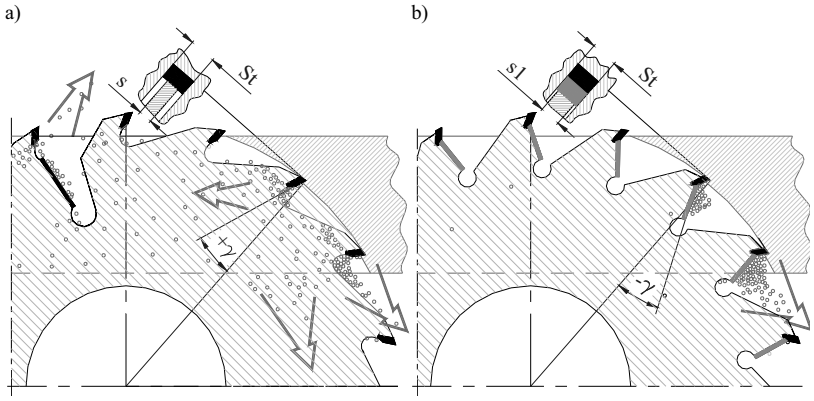

Fig. 2. Ways of chips transportation during sawing of wood with circular saw blades of the regular design (commonly used) (a) and circular saw blades with semi-closed gullets (b)

THE EFFECT OF THE SAWDUST TRANSPORTATION WAY ON CHIPS' DIMENSIONS

Thanks to the modification in chip transportation ways there is, among other things, a visible change in dimensions of examined sawdust particles and chips. Not only the cutting process affects chips dimensions but also a way of their transportation whereas in the meantime the chips might be additionally disintegrated. The examples of granulometric sawdust distributions are presented in fig. 3 for the case of sawing with the circular saw blade of the regular design (fig. 2a), and for the modified circular saw blade with semi-closed gullets (fig. 2b). Other cutting conditions such as a kind of sawed species (pine), a workpiece height and moisture content (MC ~25%) were the same in those experiments.

In figure 3 there is visible that after sawing process with the circular saw blade in which gullets are semi-closed a number of obtained bigger chips (2mm and 1 mm mesh size in sieving) is fairly larger. On the other side, in the cutting with the circular saw blade of the regular design we obtained a lower number of larger chips and also a larger volume of small chips of dimension equal to ~0.5 mm (mesh size during sieving). The latter follows from the phenomenon of disintegration process of the larger chips' portion during their movement between the saw blade and a formed kerf wall. They are comminuted to the dimension which is roughly equal to the side slot dimension. In the case of sawing with the circular saw blade shown in fig. 2a the side slot dimension was equal just ~0.5 mm ($(S_t–s)/2 \approx 0.5$ mm, where S_t is a theoretical kerf value (overall set) and s is a saw blade thickness).

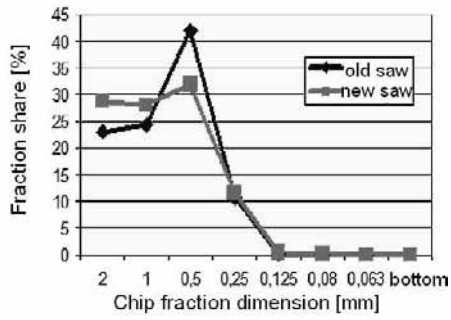

Fig. 3. Granulometric distribution of chips and sawdust obtained during sawing of pine with circular saw blades of the common design of gullets (old saw) and circular saw blades with semi-closed gullets (new saw)

SUMMARY

Size of chips in wood sawing process undergoes a change because of the long way of their transportation from the place of forming to the workpiece outside (disintegration phenomenon). The comparison of granulometric chips' distributions allows us to analyse ways of sawdust transportations from the cutting zone to the workpiece outside.

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Streszczenie: *Przydatność diagnostyczna rozkładu segregacji wiórów na przykładzie przecinania drewna.* W niniejszym artykule opisano drogi transportu wiórów w procesie przecinania drewna i ich wpływ na rozdrobnienie wiórów. Przedstawiono również wyniki badań rozkładu segregacji wiórów powstających w procesie przecinania piłą o powszechnie stosowanej konstrukcji i piłą z domkniętymi rowkami wiórowymi.

Corresponding author:
Department of Manufacturing Engineering and Automation, Mechanical Engineering Faculty, Gdansk University of Technology, Narutowicza 11/12, 80-952 Gdańsk, Poland
E-mail address: rwasiele@pg.gda.pl (Roman Wasielewski)