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Application in circular sawing machines of the experimental results of investigations of the chip removing system operation

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Abstract: *Application in circular sawing machines of the experimental results of investigations of the chip removing system operation*. The experimental results of the chip removing system operation are presented. The main aim of them was to optimize suction system of the panel saw Fx3 and its follower Fx550. The attention was focused on the upper casing, which was the part of removing system. Within the framework of the work a systematic experimental study of pressure distribution in the casing during operation of the selected rotational speed of saw blade with a diameter respectively ∅ 300 mm and ∅ 400 mm was carried out. The analysis of obtained results allowed to predict the areas with insufficient vacuum pressure hindering the organized transport of chips and optimize design of the upper casing to improve chip the extraction system.

Keywords: circular sawing machine,sliding table saw, chip removing system, experimental study

INTRODUCTION

The development of woodworking machines design, the introduction of new technologies, and above of all the machining and feed speed result in the need to provide more effective wood wastes (chips) removing systems. The manufacturers of machines quite freely approach to the problem of chips removing from the workspaces of their machines. Ideas used in some devices for shapes and dimensions of the suction system, linking these suctions to common, interior collectors, separators, moving suctions, etc. do not always work well in practice.In operation manuals there are often presented essential parameters of the extraction installation for the given machine, i.e. the necessary air velocity, its amount and the vacuum pressure value. However, in the area around the tool even higher vacuum pressure is usually required. A modern machine, which operates without connection to a properly designed extraction installation, loses immediately its performance and service life[1-2].

Woodworking machines and cutting parameters as well as wood material properties determine the particle size distribution of chipped wood. In the technological processes of machine wood chipping, a by-product is also formed besides the main product.

Particles of wood substance formed in individual processes of chipping and machining are called “bulk wood substance”[3]. Workers’ exposure to airborne wood dust particles in the surrounding air of the workplace may cause different occupational health problems in wood industry workers[6]. To develop an appropriate suction system, it is important to know the size and shape of bulk substance particles, which are the basic data for characterizing bulk material. The above characteristics affect physical and mechanical properties of bulk substance (bulk density, bulk angle, tilt angle, aerodynamic properties of particles in the piping of the suction system) and conditions of separation or filtration in the separating device[5]. The observed characteristics also affect service life of equipment in the workplace where dust is generated as well as transportation equipment and filtering elements, and last but not least safety of the working environment.

Depending on the type of the machine and the shape and size of its dust creation zone, there may be seriously problematic concerning the effective discharge of dust through an exhaust installation during certain sanding positions. The machine type and method of

processing influence increases in the dust concentration in the air[7]. Removal of dust is difficult when working zone is large and when the tool moves during processing at relatively high velocities. When the movement direction of the chips created during machining does not coincide with that of the air suction created by an extraction system, many of the chips are still not removed and can become dispersed in the air surrounding the machine. This takes places during sawing when the whole tool goes into the work piece. For this reason, there are problems with the direct removal of chips from working zone and working tools.

Many authors investigated the possibility of reducing the particles (airborne) by the control of machining parameters and by varying the cutting speed, feed speed, tool type and tool size, cutting angles, number of blades and processed material[4-5].

In this paper experimental investigations of the wood chip removingsystem for panel saw Fx3 and its follower Fx550 were performed. The aim of the study was to optimize chip extracting system in existing machine, commercially available on the market. The special attention was focused on its upper casing without influence on parameters of the fan.

MATERIALS

Experimental tests consisted of measuring of relative pressure distribution zero-referenced against ambient air pressure at several points on the wide and narrow cover of suction-chip removing system (points "A"-"I" on the upper part and "a"-"i" on the side part of the wide cover and points "b*"-"h*" on the side of narrow cover). Locations of all measuring points are shown in Figure1 and Figure 2.

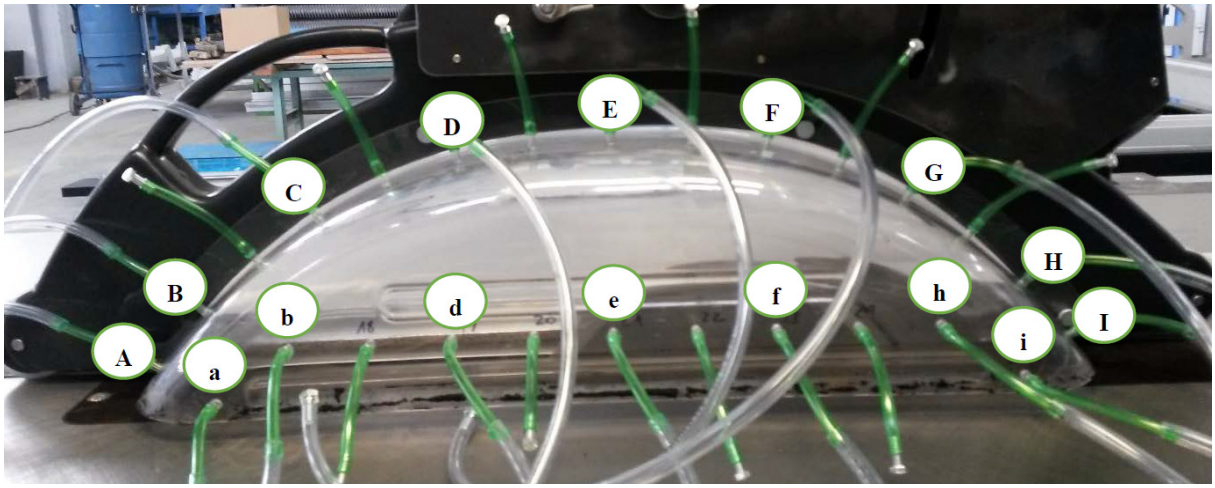

Figure 1. Location of measurement points on a wide cover

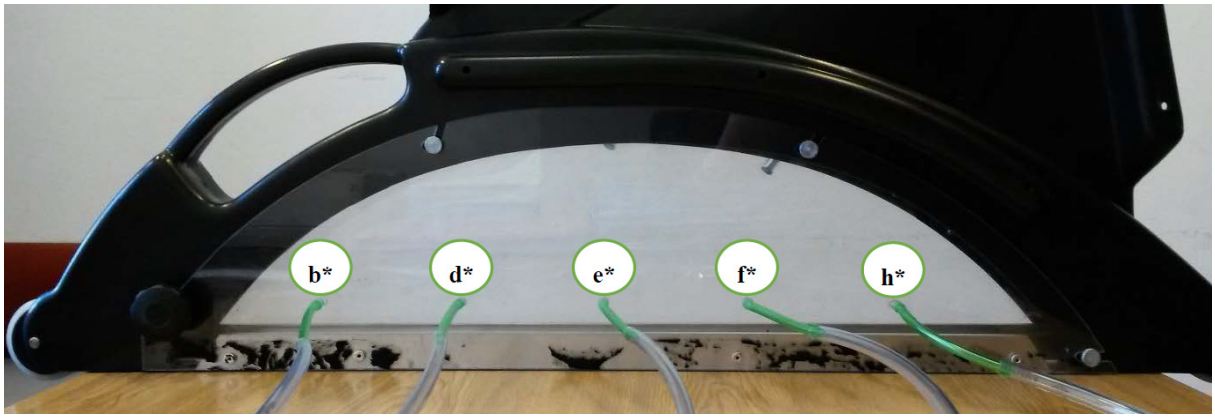

Figure2. Location of measurement points on a narrow cover

Sampling of pressure value measurements was carried out during circular sawing frame machine operation without a material machining. Table 1 shows the parameters of saw blades used during experiments.

Table 1. Parameters of woodworking machine saw blades during experiments

Woodworking machine	Circular saw No. 1		Circular saw No. 2
Tool diameter, D (mm)	∅ 300		∅450
Number of teeth, z	96		72
High of tooth high, h (mm)	9.82		19.63
Overall set (kerf width), S_t (mm)	3.2		4.4
Thickness of saw blade, a (mm)	2.2		3.2
Rotational speed, n (min^{-1})	3500	6000	3500

The relative pressure was measured using a digital multi-function measuring instrument TESTO 480 (TESTO SE & Co., Germany). The results were averaged for 10 seconds at each point. Measuring range was from -10 to +10 kPa, resolution 0.01 kPa and accuracy ±0.3 Pa +1% of measured value in the lower range. Velocity in outlet channel was measured using the same instrument, with a hot wire probe. Measuring range was 0-20 m/s, resolution 0.01 m/s and accuracy ±0.03 m/s + 5% of measured value.

The obtained results were analyzed andwere verified by the experiments performed using different shapes of casing (Fig. 3).

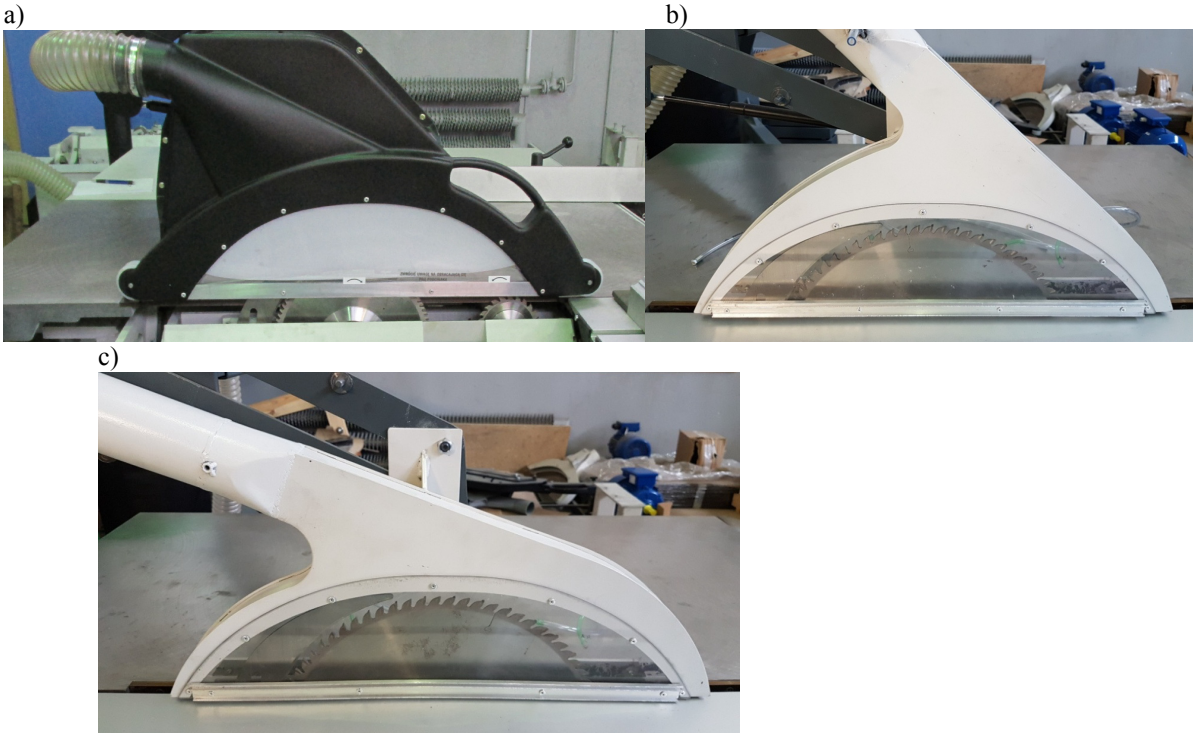

Figure 3. The chosen examples of the upper casing shape: a) base case, b)modified case, c) final case

RESULTS

Results of relative pressure measurements for the wide and the narrow cover of existing system, referred further as "base case", showed that at most of the measurement points there was a vacuum pressure existence, as it was expected.

In order to improve the performance of chip removing system without interfering with the fan structure several modifications were carried out as follows. Firstly, the change of shape of lower shelter, minimizing its leakages as well as modification of the shape of the outlet channel in upper part wereexecuted. The results of pressure distribution after that modificationsare shown for both wide and narrow cover in Fig.4-6 as “modified case”.It canalso be seen in Fig.4-6 (“final case”) that it resulted in satisfactory pressure distribution without modification of the fan structure.

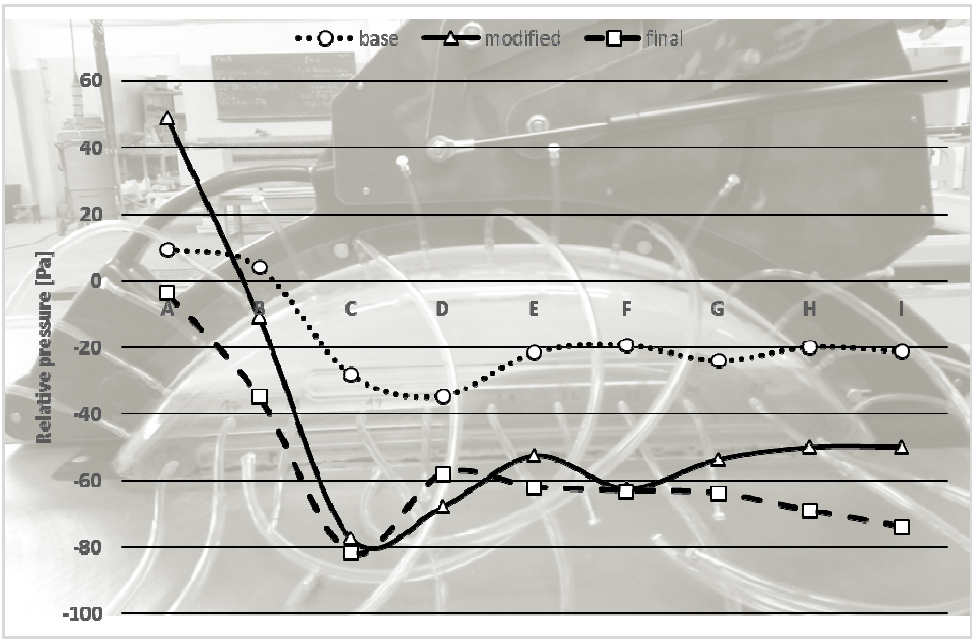

Figure 4. Relative pressure distribution along the upper part of the wide cover

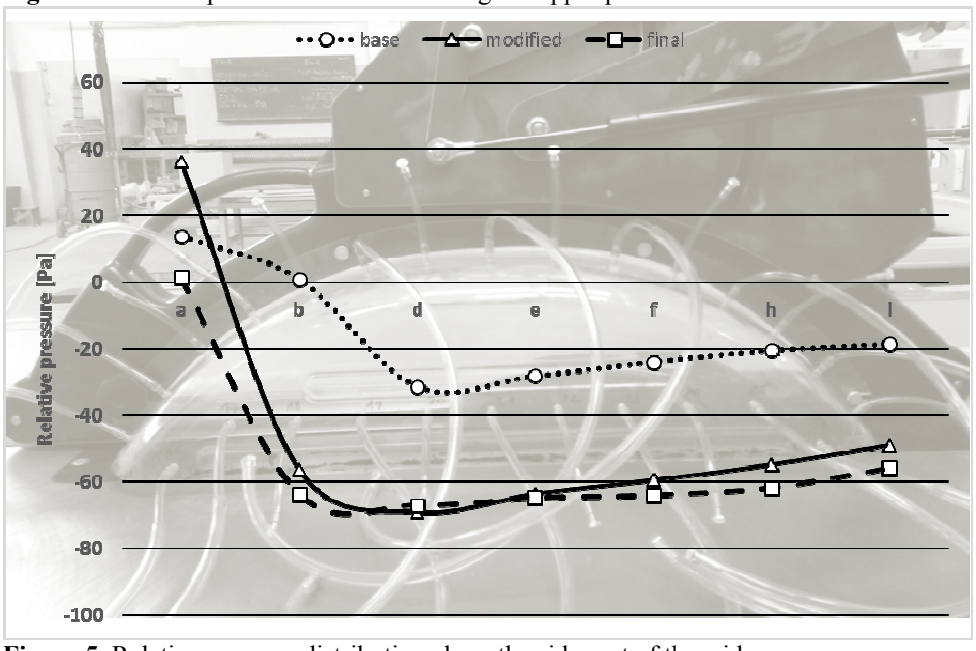

Figure 5. Relative pressure distribution along the side part of the wide cover

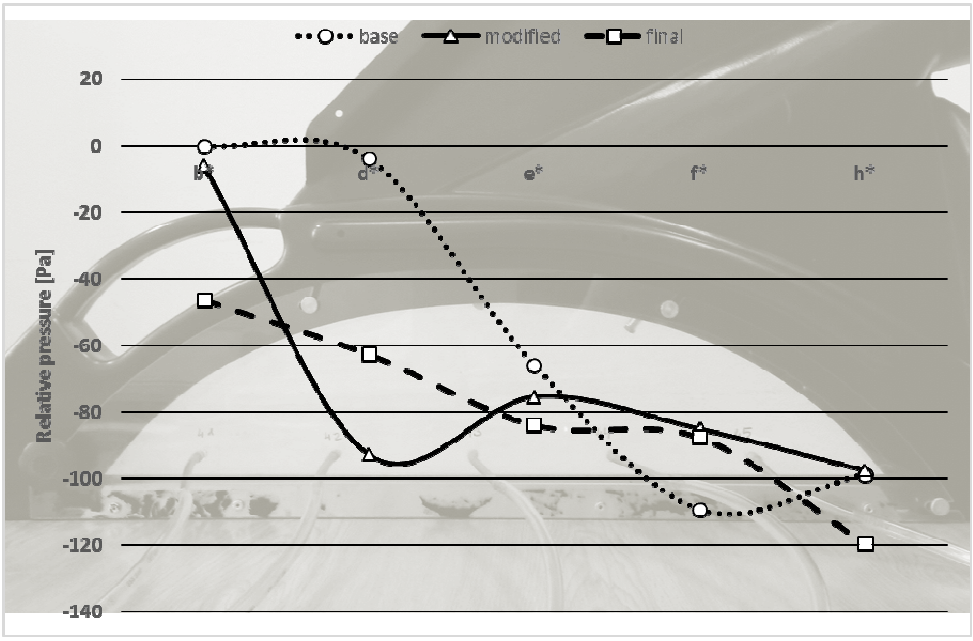

Figure 6. Relative pressure distribution along the side of the narrow cover

Secondly, a new design of the upper casing was proposed. The final construction of the upper casing, which is part of the chip removing system, is shown on Figure7.

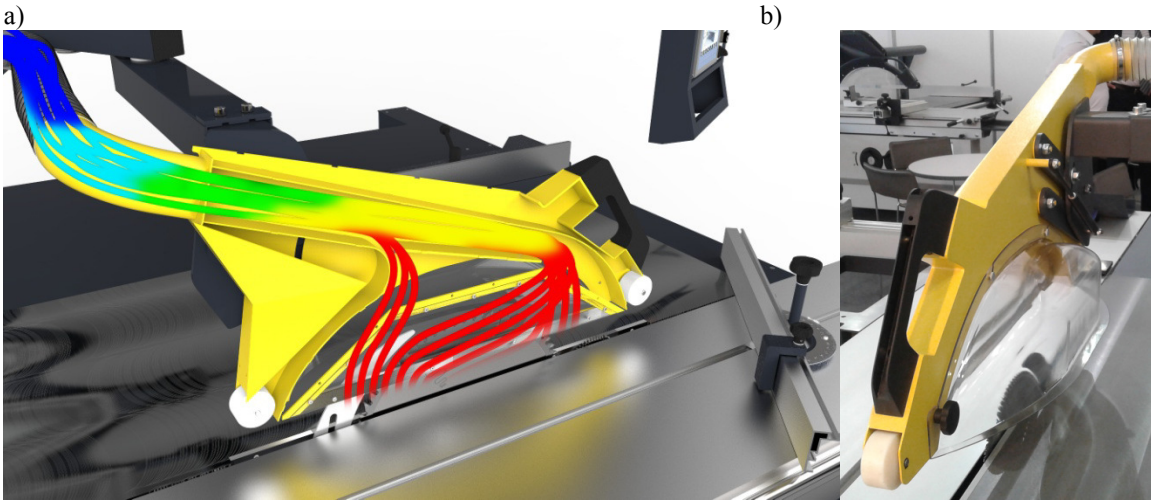

Figure 7. The cross section a) and the view b) of final design of upper casing

Thanks to: a new design of the upper casing and the change of the shape of the lower shelter, minimizing its leakages as well as modification of the shape of the outlet channel in upper part of the panel saw the presented panel saw Fx550 (Fig. 8a) has been a source of the higher vacuum pressure in comparison to the panel saw Fx3. The latter result is a pure proof that the one of the main project goals connected with increase efficiency of chips suction system has been achieved.Therefore, if the vacuum pressure is decreased simultaneously chips removing system operates more efficiently.

In Figure 8b the panel saw Hx3200 is presented. In the design of this machine tool some number of the findings from examination of the panel saw Fx550 have been applied as for example shape of lower shelter,modification of the shape of the outlet channel in upper part of the panel saw. The lower shelter has been designed for optimal dust extraction. Minimization of space below the scoring saw and a shorter outlet socket made possible to

easyof the suction.Innovation of the upper casing is hidden inside. Thrown out wood chips by the main saw are effectively collected by two zones with higher suction parameters applied.

a) b)

Figure 8. Panel saws, where: a) sliding table panel saw Fx550, b) panel saw Hx3200

CONCLUSIONS

The existing chip extracting system in the analyzed woodworking machine did not provide satisfactory chip extraction from the working area. After several changes in the system, especially in the upper casing,all parts of suction system were optimized and modified, except for the structure of the fan, which allowed to achieve efficient performance.

Some number of the findings chosen from analytical and experimental examination of the panel saw Fx550 have been applied in the panel saw Hx3200.

Acknowledgements

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Streszczenie: *Wykorzystanie wyników eksperymentów wbadaniach działania układu usuwania wiórów w pilarkach tarczowych.* W niniejszym artykule przedstawiono wyniki eksperymentów których celem było zoptymalizowanie działania układu usuwania wiórów w pilarce panelowej Fx3 oraz jej następczyni w postaci zmodernizowanej pilarki Fx550. W trakcie badań zwrócono szczególną uwagę na działanie osłony górnej wchodzącej w skład układu usuwania wiórów. W ramach prac dokonano pomiaru wartości ciśnienia w czasie pracy pilarki tarczowej dla wybranych wartości prędkości obrotowej z wykorzystaniem pił o średnicach odpowiednio ∅ 300 mm i ∅ 450 mm. Analiza otrzymanych wyników badań umożliwiła określić miejsca, w których występowało podciśnienie o w niewystarczającej wartości utrudniające odpowiedni transport wiórów i zoptymalizować konstrukcję osłony górnej w układzie usuwania wiórów.

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