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TAGUCHI METHOD OPTIMIZATION OF THE TOTAL POWER CONSUMPTION DURING CHIPBOARD CUTTING WITH THE PANEL SAW MACHINE

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Abstract

This work presents Taguchi method used in order to optimize overall power consumption of panel saw machine Holzma HPP 300 during sawing of laminated particleboards. Single boards and gathered in package of two and three sheets with thickness 18 mm were cut. There were used three feed speeds, namely: 50, 100 and 120 m/min. Influence of two factors (amount of sheets machined in one cycle and feed speed) on overall power consumption during cutting. Moreover, optimum values of this parameters within analyzed parameter range were pointed out. Feed speed turned out not to be important regards to overall power consumption during machining at all. However, amount of boards in package sawed in one cycle was in great importance.

Key words: *particleboard, sawing, total power, Taguchi method*

INTRODUCTION

Taguchi method is counted to industry ways of production optimization occurs more and more often in wood and furniture industry, too. There are accessible a lot of scientific works concerned this subject. Some of the examples could be works of following authors: Basavarajappa et al. (2008), Davim and Reis (2003), Gaitonde et al. (2008), Tsao and Hocheng (2004, 2007), Wilkowski et al. (2011, 2012). The aim of this methodology is not creating of process model but estimation of such a parameters that ensure obtaining the best quality of product according to earlier defined criterion (Ross 1996). Fast procedures of summarizing of different factors importance causes economical and technological advantages. This situation appears in case of overall power consumption during sawing with usage of panel saw machines. In this type of machines significant influence which affects the process are height of board package and feed speed. Listed above factors are directly responsible for effectiveness of sawing. Commonly, rotational spindle speed is constant and therefore is not taken into account as a control factor.

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MATERIAL AND METHODS

Experiments were carried out in industrial conditions at polish company Mago involved in production of furniture components and service for small companies engaged with furniture assembling. Three layers particleboard with thickness 18 mm finished with melamine decor layer was used in researches. This type of wood-based material is widely disseminated in industrial furniture production. The samples with dimensions 500x350x18mm were machined. Experiments were conducted on panel saw machine Holzma HPP 300 (Fig.1). Machine was equipped with main saw with HW edges (D=350mm, z=72) and grooving saw equipped with edges made of DPI (D=180mm, z=32).

As was mentioned earlier, Taguchi method is based on the signal-to-noise S/N (ETA) ratio in order to assess influence of given factors. As optimum values of control factors are assumed in this way that it lead to minimize overall power consumption during sawing of examined boards. The S/N ratio characteristic for the smaller the better in Taguchi method can be expressed as follows:

$$\eta = -10 \log [1/n \, \Sigma y^2]$$

where η is the observe value (dB), y the experimental data, n is the number of observations (Tsao and Hocheng 2007). Two factors (amount of sheets sawed in one cycle and feed speed), each on three level were showed in Tab 1. A L_9 orthogonal array was employed (Tab.2).

Tab.1. Factors and levels

Code	Factor	Levels		
		1	2	3
u	Feed speed	50 m/min	100 m/min	120 m/min
h	Amount of boards	1 pc	2 pc	3 pc

Assumed levels of factors are as high as possible (extreme values are allowable for this kind of machining with usage of analyzed machine). Maximum permitted feed speed during sawing amounts 120 m/min while maximum value of cutting height was set on package of three boards with thickness 18mm each (3x18mm).

Tab.2. L_9 orthogonal array

Trial	Levels of input factors	
	u	h
1	1	1
2	1	2
3	1	3
4	2	1
5	2	2
6	2	3
7	3	1
8	3	2
9	3	3

Machining was carried out according to predicted earlier scheme showed in Tab.2 with triple repetition for each variant. During sawing overall power consumpiotion was

registered due to standard devices installed in this type of machines. Morover, quality of edges was visualy inspected after each cycle.

Fig.1. Panel saw machine Holzma HPP 300

RESULTS AND DISCUSSION

Statistical results analysis was carried out in software Statistica 10. There were mean values S/N (ANOM) subjected to analysis what in consequence gave optimum levels of these factors [Ross 1996]. The result of ANOM is represented in the response diagram as shown in Fig.2.

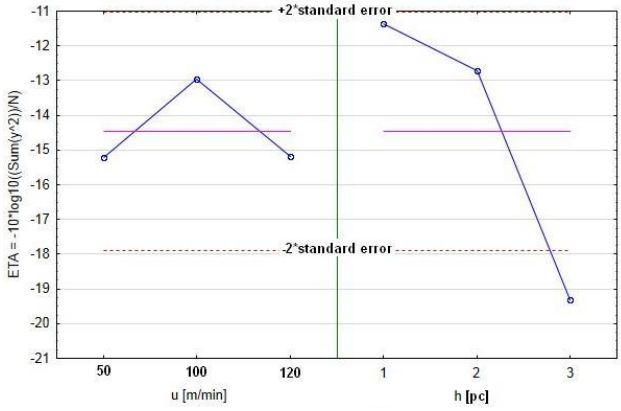

Fig.2. Response diagram of S/N (ETA) ratio for the total power

The optimum level of factor is the level that gives the highest S/N ratio [Gaitonde et al. 2008]. Regards to overall power consumption of the machine during sawing, optimum cutting parameters are following: feed speed u= 100 m/min, amount of boards sawed in one cycle h=1 pc. Additionally, there was no direct linear relationship between value of feed speed and overall power consumtion and variability of this factor did not exceed ±2*standard error, what suggests lack of pratical usefulness of this one. Differently situation took place in case of second factor that is to say the amount of sheets sawed in one cycle (single sheet, two sheets in package and three sheets in package). That is clearly visible the

variety of obtained results. With increasing of the amount of sawing boards decreases S/N ratio what means that this factor has pratical usefulness (variability of S/N ratio exceed ±2*standard error). In general, is advised to cut single boards. This variant could be beneficial according to as well overall power consumption as machining quality. Visual quality assesment after sawing proved that in case of single board, amount of laminate chipping on board edges is the smallest. Usage of grooving saw avoid laminate chipping. During sawing in package consisted in two sheets, two small damages appeared on lower layer of the board which was on the top of the package at the highest feed speed whereas in package with three boards the biggest damages were observed on lower layer of the board which was in the middle.

CONCLUSION

According to obtained results can be formulated following conclusions:

- Relevant factor from practical point of view which influences on overall power consumption during sawing turned out amount of boards machined in one cycle whereas non important factor was feed speed. Optimum cutting parameters were received during sawing single board with feed speed 100 m/min.
- Edges of boards free of damages (laminate chipping) were received during sawing of single board, independently from feed speed.

REFERENCES

1. Basavarajappa S., Chandramohan G., Davim J.P., 2008: Some studies on drilling of hybrid metal matrix Composites based on Taguchi techniques. *Journal of Materials Processing Technology* 196: 332-338.
2. Davim J.P., Reis P., 2003: Drilling carbon fiber reinforced plastics manufactured by autoclave – experimental and statistical study. *Materials and Design* 24: 315-324.
3. Gaitonde V.N., Karnik S.R., Davim J.P., 2008: Taguchi multiple-performance characteristics optimization in drilling of medium density fibreboard (MDF) to minimize delamination using utility concept. *Journal of Materials Processing Technology* 196: 73-78.
4. Ross P.J, 1996: Taguchi techniques for quality engineering. McGraw-Hill, New York.
5. Tsao C.C., Hocheng H., 2004: Taguchi analysis of delamination associated with various drill bits in drilling of composite material. *International Journal of Machine Tools & Manufacture* 44: 1085-1090.
6. Tsao C.C., Hocheng H., 2007: Parametric study on thrust force of core drill. *Journal of Materials Processing Technology* 192-193: 37-40.
7. Wilkowski J., Czarniak P., Grześkiewicz M., 2011: Machinability evaluation of thermally modified wood using the Taguchi technique. COST Action FP0904 Workshop "Mechano-chemical transformations of wood during Thermo-Hydro-Mechanical (THM) processing" Bern University of Applied Sciences. February 16-18, 2011 Biel, Switzerland:109-111.
8. Wilkowski J., Borysiuk P., Czarniak P., Rousek M., 2012: Taguchi analysis of cutting power and thrust force in drilling of polyethylene bonded particleboards. *Ann. WULS–SGGW, For and Wood Technol.* 80: 187-191.