Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 88, 2014: 261-264
(Ann. WULS - SGGW, For. and Wood Technol. 88, 2014)

Tool life observed during milling as the indicator of MDF machinability

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Abstract: *Tool life observed during milling as the indicator of MDF machinability.* The tool life in the wood industry is very different, depending on the cutting material and therefore tool life is one of the most important criteria for assessing the machinability. In the article this aspect of MDF machinability was tested and characterized. The results of experiments can be used in future for the comparing other materials to MDF in terms of machinability.

Keywords: milling, tool life, cutting speed, MDF, machinabilityr

INTRODUCTION

Machining is a technological process in which the workpiece is formed as a result of the removal part of the material by tool to obtain expected size, shape and surface quality [Kuryjański 2011]. The machinability of wood-based materials is a very important problem from a scientific and a practical point of view [Górski, Podziewski, Szymanowski 2010]. The machinability of wood-based materials can be estimated according to several criteria: tool life, quality, cutting resistance or shape and dimension of chips. There are many views on which criteria are more important.

One of the most important criteria for assessing the machinability is the tool life, and more specifically: the effect of cutting speed on tool life life [Jemielniak 1998, Miernik 2000]. Classic formula of above relationship (tool life- cutting speed) is well known as a “Taylor formula”:

$$T = f(V) = C/(V)^k$$

where:
V [m/s] - cutting speed;
T [min] - tool life;
C [min] and k [-] – constant coefficients;

One of symptoms of high level of machinability is a long life of the cutting blades. Tool life of the cutting blades is in practice very important information characterizing wood-based materials. This information may be helpful in designing technological processes.

MDF (medium-density fibreboard) is one of the most used wood-based materials in wood industry. This material is characterized by a homogeneous structure and a lack of defects (occurring in wood).

In this article the machinability of MDF based on the tool life (standard and special tools) was characterized. For this purpose Taylor formula for VBmax=0,2 and VBmax=0,15mm was determined. Moreover additional machinability indicators (based on tool life) were calculated. Different variants of the machinability assessment were different in terms of material and time-consuming.

MATERIALS AND METHODS

The experiment was conducted on an industrial milling center Busselato Jet 130. The machine was equipped with a single point milling head. The diameter of the milling cutter was 40mm. Milling head was equipped with a variety of knives (standard and special). Standard blades are made of carbide-KRC 08. Special knives are made of steel HS50. In the experiment the grooves in typical MDF board were formed (MDF properties are shown in Table 1.)

Table.1. Selected mechanical and physical properties of MDF

Density	Brinell hardness	Swelling after 24h	Flexural strength	Modulus of elasticity
750 [kg/m^3]	3,95 [HB]	19,0 [%]	33,9 [MPa]	4180 [MPa]

The experimental procedure contained five variants of spindle speeds, based on generally accepted recommendations [Jemielniak 1998] (Tab.2). The wear rate was determined using the tools VBmax indicator. The criterion of tool life was 0,2 mm for standard tool, and 0,5 mm for experimental tool. The tool wear was measured on the microscope Mitutoyo TM-505.

Table.2 Cutting parameters

Numer of tool	Cutting speed [m/s]	Rotation of spindle [obr/min]	Feed per revolution [mm]	Feed [m]	Depth of milling [mm]
1	20,93	10000	0,15	1,5	6
2	25,12	12000	0,15	1,8	6
3	29,31	14000	0,15	2,1	6
4	31,49	16000	0,15	2,4	6
5	37,68	18000	0,15	2,7	6
6	37,68	18000	0,15	2,7	6

Additional indicators of machinability which were calculated:

T1 [min] - the average tool life of standard blades (KRC 08) calculated on the basis of the results obtained during the classic determination of Taylor formula for n = 10000÷18000 [rpm] and for VB = 0.2 mm.

T2 [min] - the average tool life of standard blades (KRC 08) calculated on the basis of the results obtained during the classic determination of Taylor formula for n = 10000÷18000 [rpm] and for VB = 0.15 mm.

T3 [min] - the average tool life of special blades (HS50) calculated on the basis of the results obtained during the classic determination of Taylor formula for n = 10000÷18000 [rpm] and for VB = 0.5 mm.

T4 [min] - the life of standard blades (KRC08) determined for n = 18 000 [rpm] and for VB = 0.2 mm.

T5 [min] - the life of standard blades (KRC08) determined for n = 18 000 [rpm] and for VB = 0.15 mm.

T6 [min] – the life of standard blades (KRC08) determined for n = 18 000 [rpm] and for VB = 0.125 mm.

The presented above different variants of the machinability assessment were extremely different in terms of material and time-consuming.

RESULTS AND DISCUSSION

The basic results of the experiments are shown in Fig.1 The figure shows the Taylor formulas determined by means of three different ways. The results obtained by the classical method with standard knife (KRC 08) and special knife show a quite high coefficient of determination. Table 3 shows the detailed Taylor's equation's determined during milling MDF.

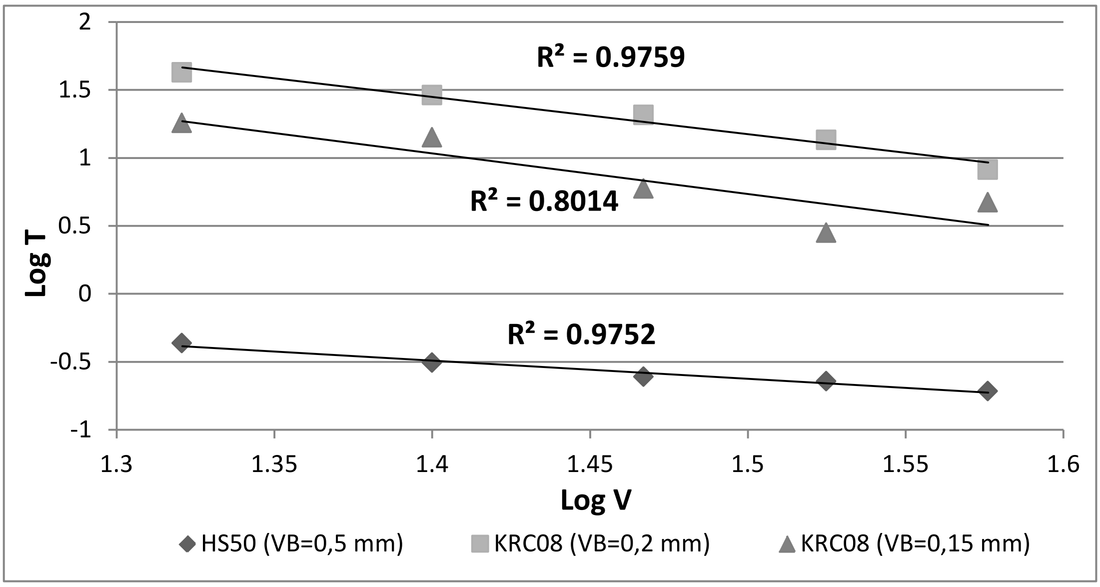

Fig1. The effect of the cutting speed V [m/s] on the tool life T [min] for different variants of experiment.

Table.3 Taylor's equations

Taylor method	**Material of blades**	**VBmax [mm]**	**Equation**
Classic	KRC08	0,2	$T=918000/(V)^{2,58}$
Natural wear	KRC08	0,15	$T=505708/(V)^{2,54}$
Classic	HS50	0,5	$T=479/(V)^{1,54}$

Fig.2 shows the additional machinability indicators based on the life of the tool.

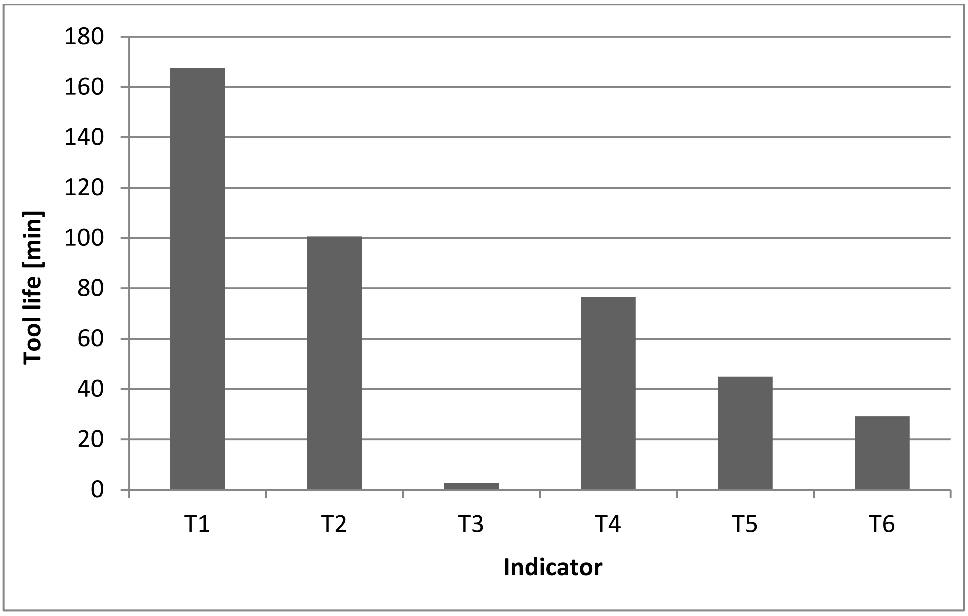

Fig.2. Additional machinability indicators based on tool life.

CONCLUSIONS

The tool life in the wood industry is very different, depending on the cutting material and therefore tool life is one of the most important criteria for assessing the machinability. In the article this aspect of MDF machinability was tested and characterized. The results of experiments can be used in future for the comparing other materials to MDF in terms of machinability.

BIBLIGRAPHY

KURYJAŃSKI R., 2011: Obróbka skrawaniem i obrabiarki. Warszawa 2011

GÓRSKI J., PODZIEWSKI P., SZYMANOWSKI K. 2010: Fundamentals of experimental studies of wood and wood based materials machinability. In: GÓRSKI J., ZBIEĆ M. (red):

JEMIELNIAK K., 1998: Obróbka skrawaniem. Oficyna Wydawnicza Politechniki Warszawskiej

MIERNIK M., 2000: Skrawalność metali. Metody określania i prognozowania. Oficyna Wydawnicza Politechniki Wrocławskiej

Streszczenie: *Trwałość narzędzi tnących jako wskaźnik skrawalności MDF*. Różnorodność stosowanych w przemyśle drzewnym materiałów obrabianych sprawia, że narzędzia mają różną trwałość i dlatego trwałość ta jest jednym z najważniejszych aspektów skrawalności. W artykule ten właśnie aspekt skrawalności MDF był badany i charakteryzowany. Wyniki eksperymentów mogą być w przyszłości wykorzystywane do porównywania innych materiałów do MDF pod względem skrawalności.

Słowa kluczowe: frezowanie, trwałość narzędzia, prędkość skrawania

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