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# THE CHARACTERISTICS OF CHIPS CREATED AS A RESULT OF OAK WOOD TURNING WITH SPRT KNIFE

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**Abstract**

*Wood machining is connected with waste creation. Among them a significant participation constitutes sawdust (dust and chips). Turning is also a process during which are created material particles that can be emitted to atmosphere. Knowledge of the grain composition of sawdust created during wood turning with self-propelled disco knife gives possibility of choosing an appropriate kind of dedusting. A characteristics of chips and dust created during turning with SPRT knife. was produced. The results obtained concerned oak wood at different feed speed of staight turning fn and depth of cut* $a_p$.

**Key words:** *chips, SPRT knife, oak wood, granulometrics*

## INTRODUCTION

Current trends in design /mainly in furniture industry/ maintained interest in products with turned elements. If one takes into consideration other products such as sport equipment (Fig.1), small wood products (lamps, hangers, candle sticks etc), toys, wood elements used in construction industry (different parts of stairs) and elements used in garden architecture one can notice many turned products especially in garden equipment as well as in playing grounds for children. Investigation in the field of productive machining of wood material by turning to research of new turning tools, which were able to match more and more difficult productive-quality requirements. One of the possible ways of turning is usage of Self-Propelled-Rotary-Tools.

Fig. 1. Wood rolls prepared for palling in STOLMED Factory

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It is also characterised by substantial temperature reduction in the machining area. The above mentioned characteristics of these tools let effectively solve the problem soft machining especially articles having large machining surfaces which should be machined without any brakes in machining process. The SPRT tool work principle is show in Fig. 2.

Usage of exchange edges is especially desirable as they can be produced from materials more wear out resistant (growing dull) than popular tool steels.

The above mentioned factors caused interest in knives with circular edges having curved shape of machining edge and constant curvature radius. [5,6,7].

## WORK KINEMATICS OF SELF-PROPELLED DISC KNIFE EDGE

Self-propelling of an edge in machining process appears because of friction forces which are created in the line of contact between surface of disc edge and machined surface. In case when the angle of inclination of edge axis $\lambda=0°$ then the edge during machining desn`t turn but if only $\lambda\neq 0°$,self-propelling of disc edge appears. A significant participation in self-propelling of edge has also friction of moving chip on the rake surface. From dependences quoted in literature [1,3,6,7,9,10,12] it results that rotational speed of the edge $v_0$ is directly proportional to machining speed $v$ and angle of inclination of cutting edge λ.
So when angle λ rises the rotational speed of knife $v_0$ rises as well.

However one should keep in mind that angle $\lambda < 20^0$ does not guarantee steady rotation of the edge additionally in some cases knife during machining with very small angle of inclination λ can even hardly rotate at all.

For self-propelling of knife to take place during turning its inclination is vital. It is of major influence self-propelling speed at changing angle of inclination of edge and constant turning parameters.

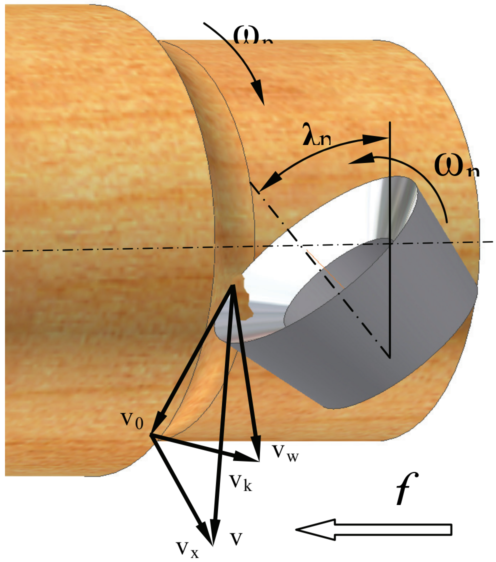


Fig.2. Kinematic dependences during machining with self-propelling disc tool.
$\omega_p$ – angular velocity of turned roll,
$\omega_n$ – angular velocity of tool edge
$\lambda_s$ – inclination of cutting edge
f – feed rate of suport with tool,
v – average cutting speed,
$v_0$ – speed tangent to circuit of tool,
$v_k$ – speed of tool edge,
$v_w$ – speed of chip flow from edge,
$v_x$ – element of cutting speed

Depending on the cause raising self-propelling of disc tool during machining, tools with round bit ca be divided into two groups:

- tools with forced rotation of edge, put in motion by special drive,
- Self-propelling tools put in motion by friction forces which occur between tool flank and machined surface [5,6,8,9,10].

From dependences shown in literature (for example: VASILKO 2007) follows that peripheral speed of a tool $v_0$ is proportional to cutting speed v and inclination angle of cutting edge $\lambda_s$. So when angle $\lambda_s$ growth, also growth peripherial speed of knife $v_0$.
Fig. 2 shows kinematic parameters during turning with SPRT knife [12].

## CHARACTERISTICS OF CHIPS ARISING DURING TURNING WITH SPRT KNIFE AT DIFFERENT FEED AND TURNING DEPTH

Wood machining is connected with waste creation. Among them a significant participation constitutes sawdust (dust and chips). Turning is also a process during which are created material particles that can be emitted to atmosphere. Knowledge of the grain composition of sawdust created during wood turning with self-propelled disco knife gives possibility of choosing an appropriate kind of dedusting */.

The chip itself and its shape informs us about the turning process, edge condition etc. [3,4,10,11]. Inclination. is essential for self-propeling to take place. It has vital influence on size of chips and dust created during turning. In what follows are presented data obtained from beech dust investigation during turning. In the process of rough turning most often are used edges having $r_\varepsilon$ rounded corner which have values range 20 -30 mm.
The chip itself and its shape informs us about turning process, edge condition and so on [3,4,10,11,13,14]. For self-propelling of edge to take place during turning vital is its inclination.
It has crucial influence on chip and dust granularity (size) arising during turning. SPRT knives affect machined material with relatively large cutting surface (during productive machining ) and create a chip of sickle shape. Through work of rotating edge the arising chip can have different shape and size. During rough turning the most frequently used are edges having rounding radius $r_\varepsilon$,ranging from 15 – 40 mm.

Fig. 3 shows arising of chip as a result of cutting with round knife. For this case cutting depth equals corner radius $r_\varepsilon = a_p$ and thickness of a chip changes from 0 mm to $h_{max}$. The width of a chip equals length $b_D$ of cutting edge arc being in contact with material [1,3,5,8,11,15] together with inclination angle growth λ, the surface of created chip is shrinking.

## RESEARCH METHODOLOGY OF SAWDUST FRACTION

During working cycle connected with turning of different types of wood with SPRT conducted in Departament of Woodworking Machinery and Basic Machine Constructions University of Life Sciences in Poznań and West Pomerania University of Szczecin and Technical University in Zvolen, a sieve analysis of dust and chips was implemented and grain composition was determined according to widely approved standards [2,3,5] The paper shows data obtained during turning of oak wood when humidity was ranging 9 -12 %.[2,12].Turning was performed on laboratory stand on metal lathe TSB-20 – using disc edge – (Fig.7) with different $\lambda = 20^0$ inclination angles to axis of turned roll.

*/ Sawdust – polidispersive free-flowing powder consisting of thick and medium thick chip fractions [5] is a free-flowing material with grain over 0,5 mm but there is possibility of appearance of smaller fractions containing smaller sizes of sawdust.

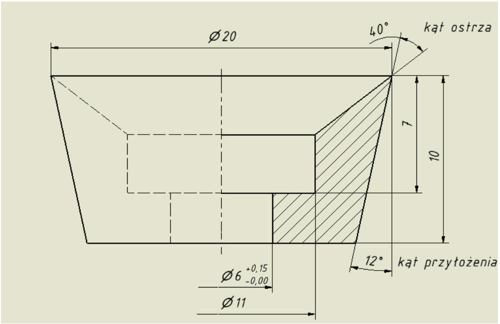


Fig.4. Parameters of cutting edge of SPRT used for research.

Fig.5.

Sawdust obtained during turning with fixed knife and SPRT.

Wood turning was performed at rotation speed of n = 1120 rot/min of machined article and feed speed $f_n$ = 0,5, 1, 2, 4 mm/rot. and cutting depth $a_p$ = 1; 2, mm, these parameters were chosen because of earlier conducted research. [4,7,8,12].

For the purpose of analysis of grain composition of obtained dust and chips samples laboratory jolt-moulding machine RETSCH AS 200 was used. The machine was equipped in a set of six sieves having mesh dimensions; 2,0; 1,0; 0,5, 0,25, 0,125, 0,08, 0,063, 0,032, .< 0,032 [mm] which enabled for all turning options determine mass shares in seven divisions of dimensions. The obtained data of grain composition at different cutting edge inclination are inserted in Fig. 6 – 12.

## THE RESUTLS OF GRANULOMETRIC RESEARCH

The research showed that dust granulation was at each cutting option not smaller than 0.032 mm. However on sieves with mesh size ranging from 0.032 to 0.125mm there was dust in quantity not exceeding 1% of the whole dust quantity.

Only in two cases the size of 1.61 and 2.95% of chips was obtained; for turning variants of low feed speed. Bigger value of small dust particles share fraction were found out on sieve mash 0.25 mm, feed 0.5 and 1.0 mm/rot. The share was 16.52% ,18.66% and 6.88% of all dust obtained during turning.

The biggest share of chips was observed for:

- small feed speed of turning fractions on sieves 0.5 and 1.0 mm
- bigger feed speed of turning fractions on sieves 1,0. and 2,0 mm.

The biggest fraction share from 60% to 86% was found out on sieve mash 2.0 mm.

Commentary to obtained results of sieving:

- The shape of the particles: FLAT, FIBROUS and ISOMETRIC dust fraction,
- Samples 2,0/1 and 2,0/2 - COARSE-GRAINED with a share about 10 % MEDIUM FRACTIONS, without DUST and EXPLOSIVE DUST
- Samples 4,0/1; 4,0/2, - COARSE FRACTIONS, without EXPLOSIVE DUST.
- To sum up one can conclude that the share of a given fraction in the whole quantity of obtained dust and chips is influenced mainly by feed speed on one rotation.

This conclusion is true for machining analysis of turning at depth $a_p$ up to 2mm. The "fine" fractions observed can be created by SPRT edge.

Table 1

| Fractions in the dry oak sawdust [%] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| sieve mash [mm] | Fraction | feed $f_n$ = 0,5; 1,0; 2,0; 4,0 mm/rot // cutting depth $a_p$= 1, 2, mm. | | | | | | | |
| | | 0,5/1 | 0,5/2 | 1,0/1 | 1,0/2 | 2,0/1 | 2,0/2 | 4,0/1 | 4,0/2 |
| 2,000 | coarse | 0,50 | 3,77 | 38,73 | 28,85 | 57,11 | 60,69 | 80,62 | 86,77 |
| 1,000 | | 29,92 | 22,35 | 44,42 | 42,37 | 31,39 | 27,64 | 14,73 | 10,61 |
| 0,500 | medium coarse | 51,28 | 51,96 | 12,88 | 17,74 | 8,99 | 7,76 | 3,18 | 1,85 |
| 0,250 | | 16,52 | 18,66 | 2,52 | 6,88 | 1,99 | 2,30 | 0,70 | 0,52 |
| 0,125 | fine | 1,61 | 3,03 | 0,78 | 2,95 | 0,39 | 1,13 | 0,43 | 0,17 |
| 0,080 | | 0,06 | 0,22 | 0,43 | 0,87 | 0,09 | 0,49 | 0,31 | 0,08 |
| 0,063 | extra fine | 0,11 | 0,01 | 0,07 | 0,18 | 0,04 | 0,00 | 0,04 | 0,00 |
| 0,032 | | 0,00 | 0,00 | 0,18 | 0,17 | 0,00 | 0,00 | 0,01 | 0,00 |
| <0,032 | | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 | 0,00 |

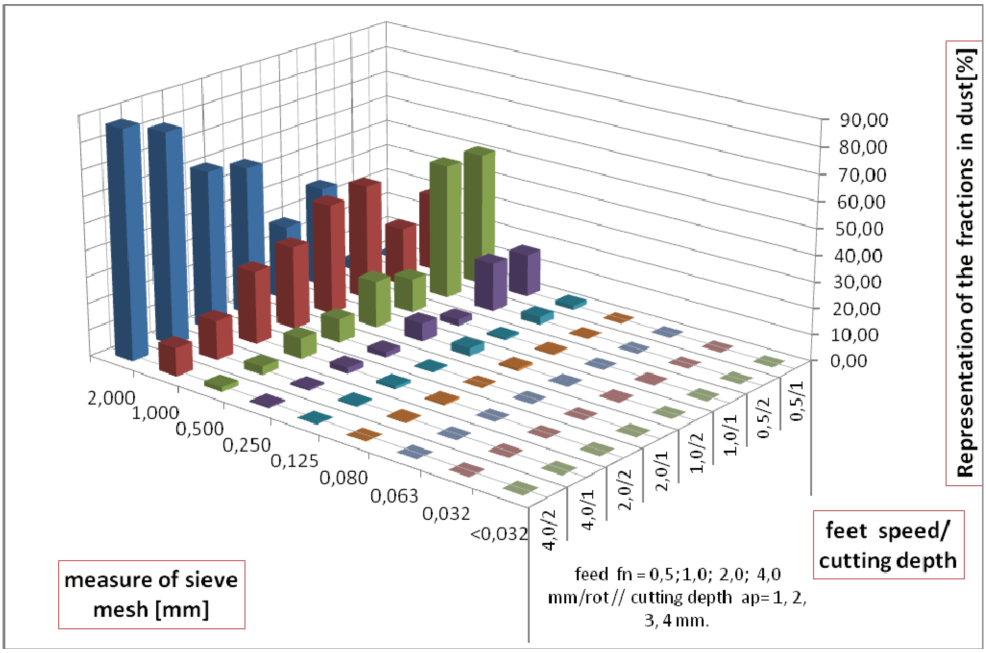


Fig. 6. The granulometric share of chips and dust of oak wood obtained during turning with SPRT at different feed speeds and cutting depth.

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