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The Influence of the Geometry of the Lathe Tool on the Surface Condition at the Processing of the Polyamides

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ABSTRACT

As it is known, the surface condition has two constituents: dimensional accuracy and roughness of the machined surface. In this study it is presented only the condition of the machined surface from the roughness point of view. As regards the geometry of the lathe tool, this study presents only the influence of radius of the tool point. The polyamide in this discussion is PA 66 – MoS2 and the lathe tool is with an attachable tipped.
Keywords: *polyamide, lathe tools, radius of the tool point, end cutting edge angle.*

1. Introduction

As it is known, the surface condition is set off by the dimensional accuracy and by the roughness of the machined surface. Between the two constituents of the surface condition, in this study it is presented only the roughness of the machined surface. As it results from the title, the processing operation is the turning, and particularly it is talked about the straight turning (of rough cutting and of finishing).
As regards the geometry of the lathe tool, this study presents only the influence of the radius of the tool point r_ε.

The parameters of turning, this study presents the influence of: the cutting speed, v [m/min], the work advance, s_1 [rot/min] and the cutting depth, t [mm].

2. Experimental

Polyamide PA 66– MoS_2 is a material based on a polyamide PA 66 to whom it was added 1% molybdenum disulphide (MoS_2). The material used features be presented in table 1.

Table 1

Mechanical properties of the materials used [1]

Properties	Unit	PA 66 MoS_2
Density	g/cm^3	1,16
Breaking strength	MPa	78
Breaking elongation	%	25
Resistance to shock	KJ/m^2	3,5
Ball test hardness	N/mm^2	160

The experimental assays established in basis of a research plan having as input variables the parameters of the cutting conditions (table 2), were performed in the following conditions:

- turning tool (lathe tool) for each processing method, with the geometry presented in table 3;
- the machine – tool: normal parallel lathe MSZ 5022;
- the measuring instrument: Surtronic 4;
- the processing were made without cooling;
- the ambient temperature: 20^0 C;
- the semi-products utilized had a diameter of 50 mm;
- the lathe tool with the geometry presented in table 3

Table 2

Parameters of the cutting conditions

Parameters \ Processing		Roughing	Finishing
Cutting depth, t [mm]	Minimum	0,4	0,1
	Medium	0,7	0,18
	Maximum	1,2	0,3
Advance, s_1 [mm/rot]	Minimum	0,4	0,1
	Medium	0,6	0,15
	Maximum	0,9	0,225
Cutting speed, v [m/min]	Minimum	29,83	117,75
	Medium	41,605	166,42
	Maximum	58,875	235,5

The mathematical pattern from which we started is of the type:

$$R_a = A_0 \cdot v^{A_1} \cdot s^{A_2} \cdot t^{A_3} \quad [mm] \qquad (1)$$

where:
$A_{0 \ldots 3}$ – coefficients.

Table 3

The cutting tool used

Processing / Parameters		Roughing	Finishing [2,3]	
Material	mm	Rp_3	Ceramic	
Clearance angle	^{0}	8		
Rake angle	^{0}	30 [2,3]		
Nose radius	^{0}	1	0,4	0,8
Entering /end cutting edge angle	^{0}	45		

3. Results and discussions

To emphasize this influence i have started from a orthogonal centered experimental plan of the type 2^3, in which the independent variables are: the cutting speed, v [m/min], the work advance, s_1 [mm/rot] and the cutting depth, t [mm].

The data obtained in the wake of the experimental researches, in the above mentioned conditions, led, in base of technical literature [1, 2 and 6], to the determination of some empirical relations between the roughness of the machined surface and the input parameters of the processing process.

These relations are:

A. For ceramic cutting tools (radius r = 0,4 mm):

- for the longitudinal rough turning (with Rp3 cutting tool):

$$R_a = 44,67 \cdot v^{-0,106} \cdot s^{0,524} \cdot t^{0,051} \text{ [µm]}; \qquad (2)$$

- for the longitudinal finish turning:

$$R_a = 5,95 \cdot v^{0,375} \cdot s^{0,211} \cdot t^{0,775} \text{ [µm]}; \qquad (3)$$

B. For ceramic cutting tools (radius r = 0,8 mm):

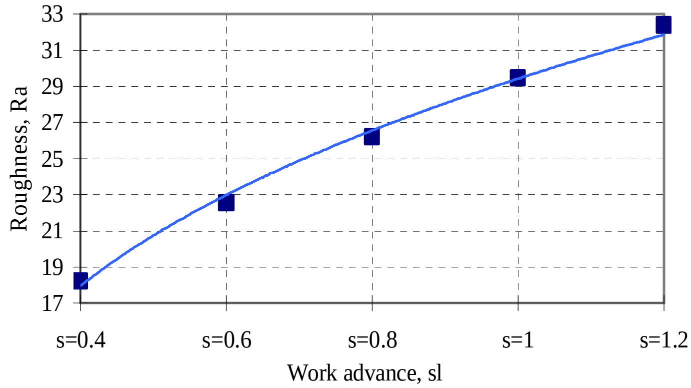
- for the longitudinal rough turning (with Rp3 cutting tool):

$$R_a = 44,67 \cdot v^{-0,106} \cdot s^{0,524} \cdot t^{0,051} \text{ [µm]}; \qquad (4)$$

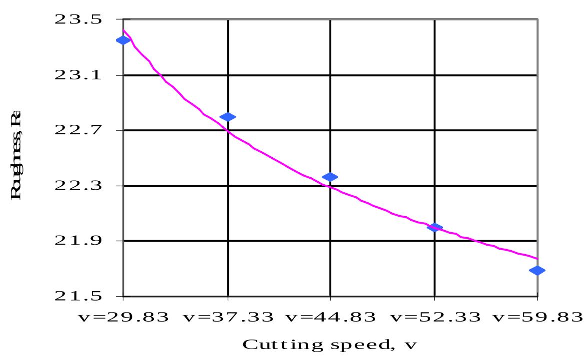
- for the longitudinal finish turning:

$$R_a = 5,614 \cdot v^{0,156} \cdot s^{0,932} \cdot t^{0,099} \text{ [µm]}; \qquad (5)$$

On base of the relations (2), (3) and (5) there have been raised graphics (figures 1, 2, and 3) to emphasize the dependence between the roughness of the machined surface and the input parameters of the processing process.

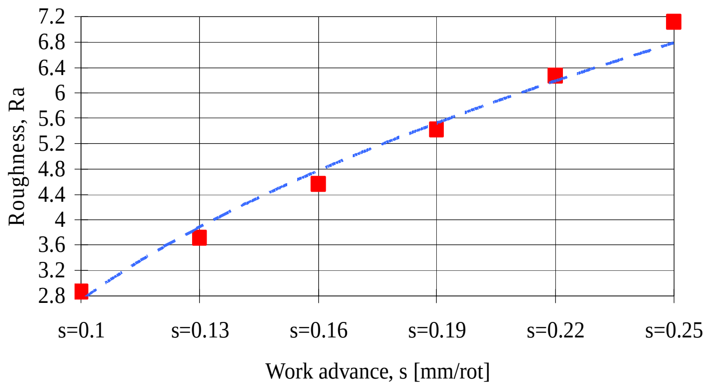


a)

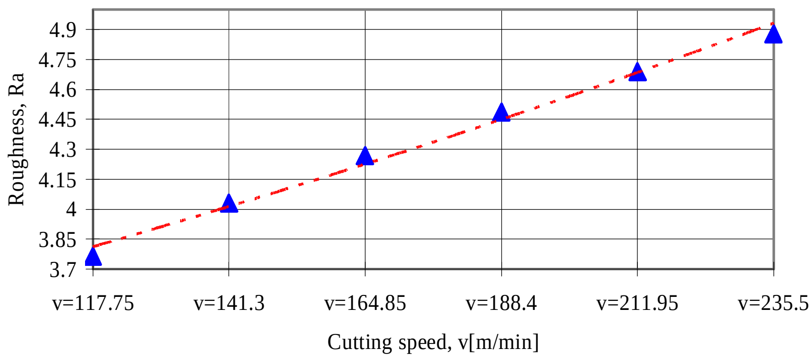


b)

Figure 1. *Dependence between Ra, [µm], and a) s, [mm/rot], (v, t = const.); b) v, [m/min], (s, t = const.), for roughing with Rp3 cutting tool*

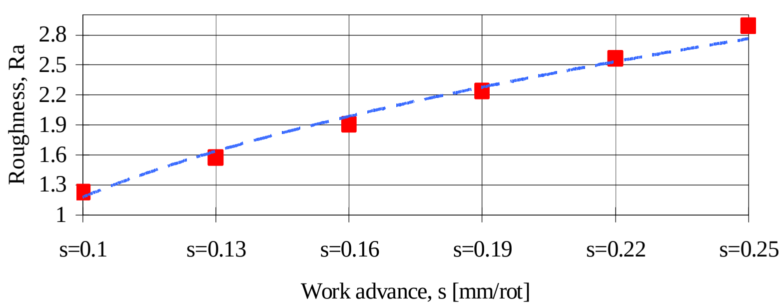


a)

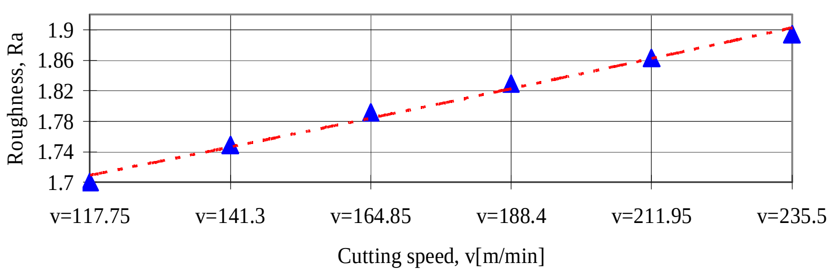


b)

Figure 2. *Dependence between Ra, [μm], and a) s, [mm/rot], (v, t = const.); b) v, [m/min], (s, t = const.), for finishing with Rp3 cutting tool*



a)



b)

Figure 3. *Dependence between Ra, [μm], and a) s, [mm/rot], (v, t = const.); b) v, [m/min], (s, t = const.), for finishing with ceramic cutting tool*

It can be observed, from these graphics, that the biggest influence on the surface roughness, between the parameters of the cutting conditions, has the work advance, s_l, followed by the cutting speed, v, and, with a very small influence, the cutting depth, t.

4. Concluding remarks

After the results we draw the following conclusions:

- it can be observed, from the figure 4, that the radius of the tool point has a positive influence on the roughness of the machined surface, which means that when the radius of the tool point increases the roughness subtracts;

- in the case of processing with a facet attachable tipped cutting tool, it can be noticed that the variation slope of the Ra parameter function of the cutting speed, v, is about 0,05 degrees and is a positive slope, that is at cutting speed increase the roughness, Ra, increases, when the other parameters of cutting conditions (the cutting depth, t, and the cutting advance, s, are constant). Because of the very low value of the angle of fall (lead angle), we can conclude that this dependence is a linear one.

- in the case of processing with a facet attachable tipped cutting tool, it can be noticed that the variation slope of the Ra parameter function of the work advance, s, is about 88 degrees. The influence of this parameter is very important and primordially.

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Influenţa geometriei cuţitului de strung asupra stării suprafeţei la prelucrarea poliamidelor

Rezumat

După cum se ştie, starea suprafeţei are două componente: precizia dimensională şi rugozitatea suprafeţei prelucrate. În această lucrare se prezintă doar starea suprafeţei prelucrate din punct de vedere al rugozităţii.

In ceea ce priveşte geometria cuţitului de strung, acest studiu prezintă doar influenţa razei la vârf a acestui cuţit. Poliamida analizată este PA 66 – MoS2, iar scula este un cuţit de strung cu plăcuţă ataşată.

L'influence de la géométrie de l'outil à charioter sur les conditions de la surface dans le profilage du polyamide

Résumé

En général les conditions de la surface ont deux components : la précision dimensionnelle et la rugosité de la surface à profiler. Dans notre travail on présente les conditions de la surface profilée du point de vue de la rugosité.

Du point de vue de la géométrie de l'outil à charioter, notre étude présente l'influence du rayon à la pointe de d'outil. Le polyamide analysé est PA 66-MoS2 et l'outil à charioter à plaque attachée.