SUSTAINABLE DEVELOPMENT OF THE TOOTHING KNIVES

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Abstract

This paper presents the experimental researches obtained at the execution of the toothing knives for the spiral bevel gears with curved teeth on classical machine – tools. The knives' profiling by relief is done in special devices, in which there are achieved a series of channels for holding the knives, similar to the cutters holder. The cutting systems of the curved teeth cutting gears, excepting the toothing through copying, have as a common element: the meshing of the semi-finished products during the gear cutting process, with a flat generating wheel, materialized by the tool's geometry and by the movements of the machine tool. The profile of these knives is formed by complex surfaces that are part of helicoids. In this case the side seating surface of the knives has the directrix curve achieved after an evolvent spiral.

Key words: machine tools, bevel gearings, cylindrical gearings, manufacturing, module.

INTRODUCTION

The relief technology used by the companies that produce machine tools and tools for spiral bevel gears with curved teeth toothing is unknown. The profiling of these knives is difficult, if it is not properly executed; after a number of re-sharpening profile deviations occur, deviations that influence in a negative way the gear cutting process.

The materialization of the imaginary flat generating gear, by the tool, requires certain conditions regarding the necessity that the tool, after the re-sharpening, to describe a generating constant tooth, and on the other side, the geometrical parameters to remain, also, unchanged compared to the optimal values initially adopted (Ştețiu, 1994). These conditions are:

I. The main cutting edge of the inner and outer knives should overlap the normal profile of the imaginary generating gear's tooth;
II. Outer generating diameters D_e and inner D_i should remain constant;
III. Clearance angles should have optimal values along the profile (the third condition, a), values that should remain constant by re-sharpening (III-rd condition, b).

MATERIAL AND METHODS

The profile of the knives

Following the research performed (Pantea, 2004) regarding the simulation of the gear cutting tools through the space meshing method it was designed the execution drawing with the geometrical and structural elements of a knife (fig.1) for milling the concave flank – outer knife, the

holding part is executed after the Hardac model, because the attempts regarding the toothing are done on the Gleason 516 gear cutting machine which is equipped with the ZH 65 head.

The technical requirements imposed for these knives are:

1- Rp 3 STAS 7682 - 91 material forged, hardened and draw-tempered before the relief of the surfaces to the finale rates, at 63-65 HRC.

2- The knife's profile: the side seating surfaces and on the tip of the cutting side is relieved after an evolvent spiral (coincidentally cross feed relief) so as to be preserved in any axial section of the head mounted in the cutter holder support:

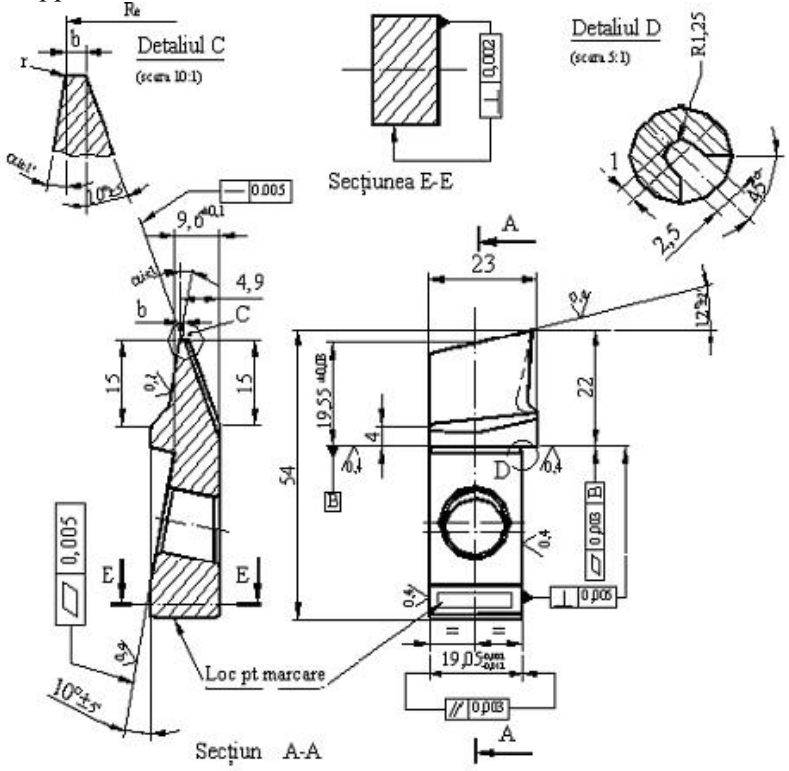

Fig. 1. Toothing knive

- cutting edge straightness;
- the main cutting edges profile's angle with a tolerance ±1';
- tip diameter $2R_e = D_e$ respectively $2R_i = D_i$,
- the clearance angle at the tip and the side clearance angle with the nominal value for which it was designed;
- the clearance angles of the secondary cutting edges will be taken as small as possible from the condition of increasing the dimensions range (modules) of the head.

3 - The elements marked as symbols on the drawing will have the values listed in Table 1.

Table 1

The main geometrical elements of the knives

GEOMETRICAL ELEMENTS OF THE KNIVES						
Outer knife	Gearing angle	α_e	b [mm]	r [mm]	γ_v	R_e [mm]
Version 1	20^o	19^o 00	0,508	0,381	6^o 43	76,581
Version 2	20^o	18^o 30	0,508	0,381	6^o 32	76,581
Inner knife	Gearing angle	α_e	b [mm]	r [mm]	γ_v	Re [mm]
Version 1	20^o	21^o 00	0,508	0,381	7^o 29	75,819
Version 2	20^o	21^o 30	0,508	0,381	7^o 40	75,819

In order to determine the controlling elements of the toothing knives in parallel sections and in the tangent sections to basic circle of the cutting head measurements were done on the coordinate measuring machine JCS – CLY 1086, on which was mounted a dividing electronic table JCS – CLY 1086. The measurements were made for knives with the side seating edges realized after an evolvent spiral directrix curve and original Gleason knives.

RESULTS AND DISCUSSION

The results of these measurements were processed in the computation program for the determination of the cutting edges deviations to the generated knives and were taken into account the deviations of the cutting edges in five regrinding sections. The comparative analysis of the measurements regarding coordinates of the processed side seating surfaces, in the same conditions, but after different directrix curves, are shown in table 2.

Table 2

Deviations of the cutting edges

Evaluated Section	The deviation of the profile to the relieved knives after a evolvent spiral directrix curve δ [mm]	Maximum deviation Δi [mm]	The deviation of the profile to Gleason knives δ [mm]	Maximum deviation Δi [mm]
0	0.045	0.074	-0.012	0.03
1	0.027		-0.025	
2	-0.008		-0.039	
3	-0.027		-0.023	
4	-0.029		-0.009	

CONCLUSIONS

1. In order to determine the controlling elements of the toothing knives in parallel sections and in the tangent sections to basic circle for the knives placement measurements were done on the coordinate measuring machine JCS – CLY 1086, on which was mounted a dividing electronic table JCS – CLY 1086.
2. The measurements were made for knives with the side seating surfaces realized after an evolvent spiral directrix curve and original Gleason knives.
3. The comparative analysis of the measurements regarding coordinates of the processed side seating surfaces, in the same conditions, but after different directrix curves, allows formulating the following findings:
- The geometrical locus of the cutting edges form the seating side edge of the knife;
-The maximum deviation of the cutting edge of the knife having the evolvent spiral directrix curve is $\Delta i = 0.074$ mm;
-The maximum deviation of Gleason knife's cutting edge is $\Delta i = -0.038$ mm;
The maximum deviations of the knives executed after this technology fall within the maximal allowed deviations for the toothing knives 0.08 mm.

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