# THE DESIGN OF THE TOOTHED KNIVES

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**Abstract:** The most important element of the head cutter holder is the cutter or cutters which represents the active part of the tool. Ensuring the geometric shape of the cutting edge and the right profile, after reshaping the cutter, represents the main problem of the design and manufacture of the knives. The technology for relieving, used by the specialized companies, it is unknown, and the catalogs contain only the presentation of the finished product and part of the geometry. The side surfaces of the outer and inner toothed knives, both the cutting ones and the non cutting, are processed in specially buit technological devices. The straight edges of the knives can be obtained processing the helical or conical side surfaces. To establish an accurate relation between the model and the process it is required the use of an appropiate software, as the simulation program as part of the programming model MATHCA 2000 PROFESIONAL and SOLID EDGE 10.

## 1. Introdution

The results of the research regarding the numerical optimization of the profile cutter grinding technology, demonstrates that the minimum deviation from a straight cutting edge is resulting from the processing with abrasive stone – cylindrical disk. Processing, the setting surfaces of the knives into the designed device, through grinding, the relieving technology, is simplified with undeniable advantages; the simultaneous relieving of a large number of knives; with a single grip knives are being processed on left and right side; elimination of the errors due to shocks and vibrations, the processing is continuous; the adjustment- device – piece – tool set is easier; elimination of the cams; less processing time. Correction is made on Nilles type worm milling machine for relieving. Equipped with the grinding device with which is endowed. By tilting the device in the horizontal plane is obtained a surface with guidelines after the archimedical spiral or φ and β in vertical plane, the seating surface will result after an involute curve guideline. The correction of the lateral surfaces of the knives can be made on the thread grinding machines tool. The diameter of the cylindrical grinding wheel results from the calculation program. The advantages of the cylindrical grinding stone correction are: large number of diamond dressings of the stone; small variations of the cutting edge deviation at the decreasing of the diameter. Running the optimization program for the gear cutting head diameters starting with 3 ½'', size from which are executed with adjustable knives it is possible to observe that diameter of the stone results optimal, it falls within the inside diameter of the processing head for inner surfaces.

## 2. Contributions to the design and implementation of the toothed knives

The materialization of the imaginary generating plane wheel, by the tool, imposes certain conditions related to the need that the tool, after grinding, to describe a constant generating tooth and, on the other side, the geometrics parameters to remain, also, unchanged from the optimal values initially adopted. These conditions are:

I. The main cutting edge of the inner and outer knives to overlap the normal tooth profile of the imaginary generating wheel;

II. The inner and outer generating diameters De and Di to remain constant;

III. The positioning angles must have optimal values along the profile ( condition III, a), values that have to remain constant through grinding ( condition III, b).

The optimal shape of the seating surfaces of the knives should result as a mathematical synthesis, of the three conditions imposed above. Was designed the work drawing with the geometry and constructive elements of an milling knife the concave side – outer knife, the gripping part is made after the Hardac model, because the attempts regarding gear cutting are made on the gear cutting machine Gleason 516 (Stimin, Oradea) endowed with ZH 65. The knives are processed on conventional milling machines including roughing roll followed by the tempering heat treatment. The technical conditions imposed on these knives are: 1- forged Rp 3 STAS 7682 - 91 Material, hardened and tempered before final corrections of the surfaces at the final rates, to 63 65 HCR; 2-The cutter's profile: the side seating surfaces and on the top of the cutting part are relieved after a cylindrical helix( with advance relieving coincidence), so as to keep in any axial section of the mounted knife on the cutter carrier head: -the straightness of the cutting edge; - the angle of the main cutting edge profile with a tolerance ±1'; tip diameter $2R_e = D_e$ respectively $2R_i = D_i$ ,for the knives with the Hardac type gripping part; for the knives without a gripping hole this condition is no longer met because of the advantage we obtain by the possibility of individually grinding of the knives; the positioning angle at the tip and the side positioning angle with the nominal value for which was designed; positioning angles of the secondary cutting edges will be taken as small as possible from the requirement to increase the range of available size ( modules) of the head; 3 - the cutting edges of the knife's body will become dull at 0.3x45°; 4- fine implementation according to STAS 2300-91; 5 – the knives will be demagnetized after the last surface grinding operation; 6 – the items marked as symbols on the drawing will have the values listed in Table 1 and Table 2.

**Table 1 Main geometry of the outer knives**

| **Geometrical elements of the inner knives on the right** | | | | | | |
|---|---|---|---|---|---|---|
| **Outer Knife** | Angle Gear | $\alpha_e$ | b [mm] | r [mm] | $\gamma_v$ | $R_e$ [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 |
| Version 3 | $20^o$ | $17^o$ 30 | 0,635 | 0,508 | $6^o$ 09 | 76,708 |
| Version 4 | $20^o$ | $16^o$ 30 | 0,762 | 0,635 | $5^o$ 47 | 76,835 |
| Version 5 | $20^o$ | $15^o$ 30 | 1,016 | 0,635 | $5^o$ 25 | 76,962 |
| Version 6 | $20^o$ | $14^o$ 30 | 1,270 | 0,6,5 | $5^o$ 03 | 77,089 |

**Table 2 Main geometry of the inner knives**

| Geometrical elements of the inner knives on the right | | | | | | |
|---|---|---|---|---|---|---|
| Inner knife | Angle Gear | $\alpha_e$ | b [mm] | r [mm] | $\gamma_v$ | $R_e$ [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 |
| Version 3 | $20^o$ | $22^o$ 30 | 0,635 | 0,508 | $8^o$ 04 | 75,692 |
| Version 4 | $20^o$ | $23^o$ 30 | 0,762 | 0,635 | $8^o$ 28 | 75,565 |
| Version 5 | $20^o$ | $24^o$ 30 | 1,016 | 0,635 | $8^o$ 52 | 75,438 |
| Version 6 | $20^o$ | $25^o$ 30 | 1,270 | 0,6,5 | $9^o$ 16 | 75,311 |

To determine the elements of control of the toothed knives in parallel sections and in tangent to the base circle sections measurements were made on the co-ordinate measuring machine JCS – CLY 1086 at STIMIN Oradea, on which was mounted an electronic divider table CARL ZEISS JENA. The measurements were made for the knives with the side positioning surface made after the guiding curve archimedical spiral, involute and original Gleason knives. The results of these measurements are presented in the Mathcad program. Were drawn the diagrams shown in figures 1 and 2.

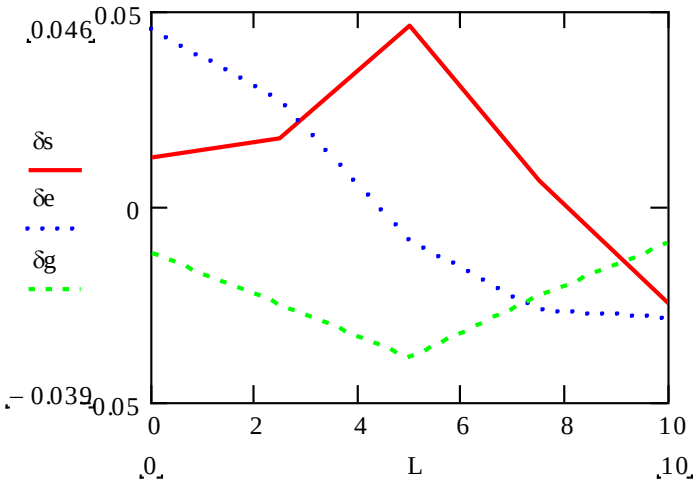


***Figure 1 Deviation of knife profile in the grinded sections***

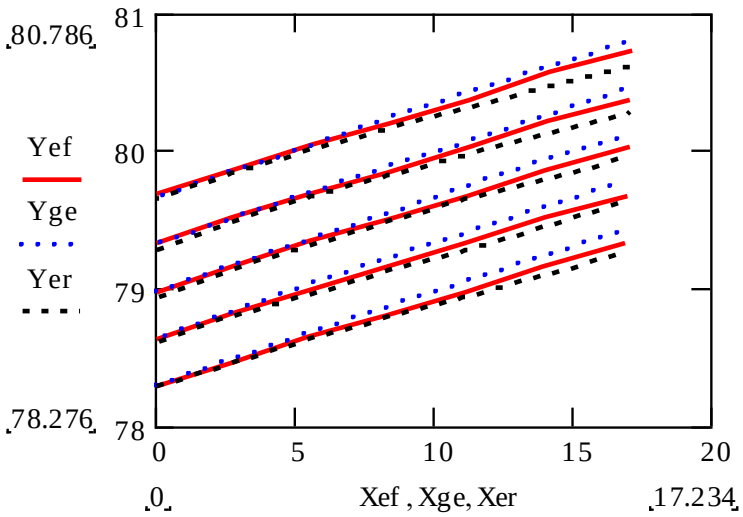


***Figure 2 Comparison of coordinates of the outer positioning surfaces of the Gleason toothed knives, of corrected ones after an archimedical and involute spiral***

## 4. Conclusions

In order to stimulate the technology of execution of the toothed knives for the curved teeth bevel gears it has to be indetified,according to the methods of relieving, in the idea of establishing a link as precise as possible between the model and the process.

The theoretical research related to the simulations of the methods for relieving of the side positioning surface of the toothed knives presented, was made to determine the deviations of the cutting edge from a theoretical straight line which passes through its extreme points.

In order to establish a link as accurate as possible between the model and the process it is required the use of an appropriate software, as it is the simulation program part of the programming model MATHCAD 2001 PROFESSIONAL AND SOLID EDGE by which, through a computer program based on the relationships presented, it is possible to generate in 3D and to measure the surfaces, the obtained results can be compared.

## References:

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