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SUSTAINABLE USE OF CLASSIC MACHINE – TOOLS

Pantea Ioan*

* University of Oradea, e-mail: ipantea@uoradea.ro

Abstract

The paper presents a study regarding the optimization of the directing curves necessary in the process of relieving the lateral positioning surfaces of knives used for toothing conical gears with curved teeth. These surfaces are part of helixes and cannot be perfectly wrapped by the cylindrical or conical abrasive tools. The chipping edge of the knives is obtained by intersecting the positioning surface with the reliving plane, and the maximum admitted deviations of the edge in relation to a line passing through its extreme point cannot exceed 0.08 mm.

Key words: directing curves, relieving, Archimedes' spiral, toothing knives.

INTRODUCTION

The reference literature indicates from a geometrical point of view the following directrix curves to tools relief as it follows: logarithmic spiral, Archimedean spiral, straight line, broken and circular arc (Mihăilă, 2004). The side seating edges of the cutting tools are ruled surfaces, generated by a straight line or a curve line which moves on these directrix curves.

The straight line materialized by the cutting edge must realize with the cutter holder an angle equal with the gearing α_n angle.

MATERIAL AND METHODS

The ruled surface having the directrix curve, one of the above mentioned, and the generating straight line inclined to an angle α, constant to the head axis is part of a helicoid. The helicoids are bodies that cannot be generated (through grinding) with abrasive tools having cylindrical or conical shape, but with tools mutually enveloped (worm). The abrasive worm after the re-sharpening (diamond dressing/milling) no longer retains its geometrical characteristics (regarding the very big size worms the tooth height, the pitch of the tooth, diameter etc.)

In figure 1, (Ștețiu, 1994) the outer radius of the milling head O_1A_1 distance, distance that must be constant for all the blades. In a horizontal plane passing through A1, the S curve represents an Archimedean spiral and C a circle. Between S and C there is the ε angle. D curve is a circular helix whose axis is of the cutting head, inclined with the δ angle respect C. The clearance surface is grinded under the i angle. Between these curves it must be written the relation:

$$tg\varepsilon = tg\delta \cdot tg\alpha \quad (1)$$

At relief, the execution of the directrix curves, the straight line and the circle arc do not raise any issue from the perspective of the technology.

The constant maintenance of the α angle implies the use of the logarithmic spiral directrix curve that has the property that its tangent makes with the normal to the radius vector a α constant angle. If the directrix curve is a logarithmic spiral, (fig.2), r = ρ = $ae^{m\theta}$, through derivation it can be seen that any straight line passing through O pole cuts the spiral in the same β = arctg(θ) angle and the tangents at the intersection points are parallel.

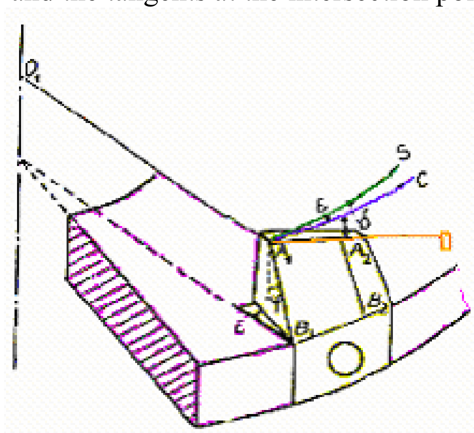

Fig. 1. Directrix curves at relief

It can be obtained:

$$\frac{d\rho}{d\theta} = \rho' = \frac{\rho}{tg(\beta)} = \rho \cdot m \quad (2)$$

The trigonometric tangent of this curve is:

$$tg(\beta) = \frac{\rho \cdot d\theta}{d\rho} = \frac{1}{m} \quad (3)$$

so that the tangent of the αangle will be:

$$tg(\alpha) = \frac{1}{tg(\beta)} = m = \text{constant} \quad (4)$$

in any point of the spiral.

The logarithmic spiral satisfies the condition of constant maintenance of α the angle, but it is not used in engineering, from two reasons:

- technical difficulty for achieving this trajectory;
- the α angle variation along the generating profile.

Due to these reasons it is used as directrix the Archimedean spiral, (fig.3), $\rho = a\theta$. The tangent of the angle is:

$$tg(\alpha)=\frac{1}{tg(\beta)}=\frac{d\rho}{\rho d\rho}=\frac{1}{\theta} \quad (5)$$

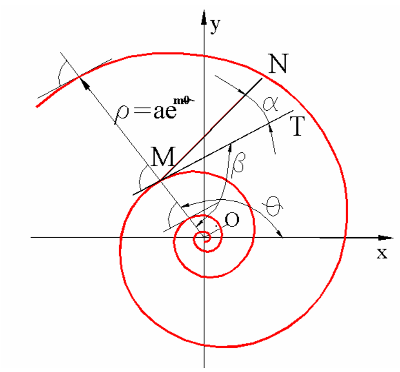

Fig. 2. Logarithmic spiral

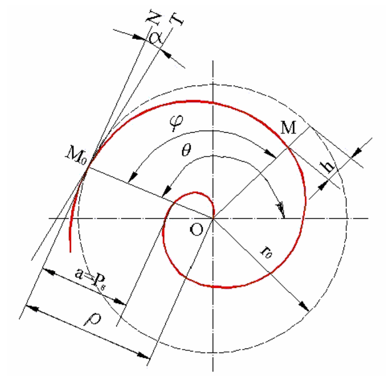

Fig. 3. Archimedean spiral

that means that the α angle is variable at the decreasing of the θ angle. Although the α angle increases, the variation of the angle is permissible within certain limits in the cutting process (Minciu, 1995).

RESULTS AND DISCUSSION

The profiling of the knives through relief is done in special devices, in which are achieved a series of channels for knives holding, similar to the cutter holder support.

Obtaining the Archimedean spiral directrix curve trajectory can be achieved by:

- radial relief;
- angular relief;
- relief with helix.

For the relief of more complex tools as for example worm mills, the directrix curve is a cylindrical or conical helix, the conical one being the general case of relieving, from which by means of particularizations, resulting all the other cases of relieving used in practice (fig.4).

In the case of radial clearance, angular (oblique or front) the pitch of the P_{e1} helix is zero, for the relief of tools with linnear channels P_{e2} is infinite.

In the case of relief with helix P_{e1} pitch is the p_1 pitch of the thread, and in the case of relief with advance, $P_{e1}$is equal with the s size of the advance per revolution.

The relationships that characterize the directrix curves for the relief technology are given in table 1.

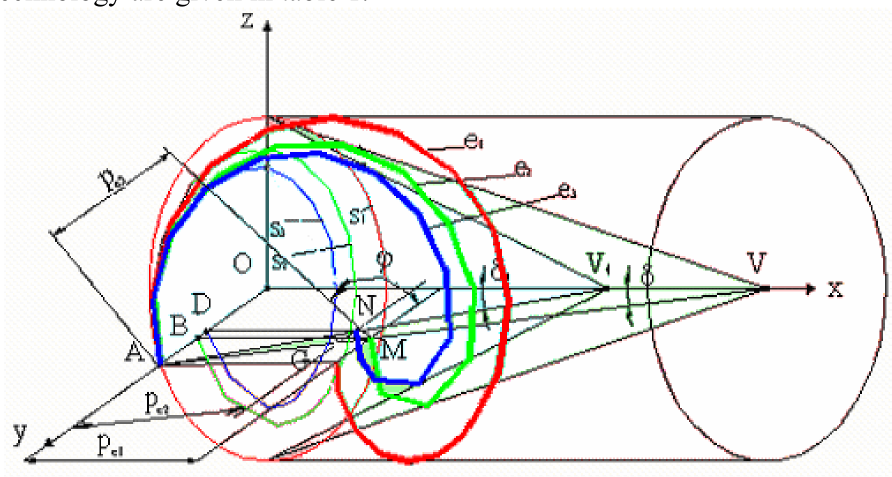

Fig. 4. Relief with helix

Table 1

Directrix curves at relief

Elicea conica $\rho = r - \frac{(P_{e1} tg(\delta) + P_S \cos(\varphi))\theta}{2\pi}$ $X = \frac{(P_{e1} - P_s \sin(\varphi))\theta}{2\pi}$	ρ - radius vector; [mm] θ - the current angle that characterises the helix e3; [º] P_{e1}- cylindrical helix pitch; [mm] P_S – the Archimedean spiral pitch after which the relief should be done the Archimedean spiral pitch after which the relief should be done MN_1; [mm] φ - the oriented angle made by the relief direction with the radial direction; [º] δ - semiangle of the cone with the generating VA and VO axis. [º]	
Particular cases		
1. Radial relief $P_{e1} = \delta = \varphi = 0$ $\rho = r - \frac{P_s \theta}{2\pi}$		In X=0 plane Archimedean spiral with P_S pitch.
2. Oblique relief $P_{e1} = 0$ $\varphi = -\left(\frac{\pi}{2} - \delta\right)$ $\rho = r - \frac{P_s \sin(\delta) \cdot \theta}{2\pi}$		The conical helix on a X=const. plane is an Archimedean spiral with $P_S \sin(\delta)$ pitch. δ is the semiangle of the directrix cone;

$X = \frac{P_s \cos(\delta) \cdot \theta}{2\pi}$	tg (δ)=$\frac{\sqrt{P_{e2}^2 - P_{e1}^2}}{P_{e1}}$
3. Frontal (axial) relief $P_{e1} = 0$ $\varphi = -\left(\frac{\pi}{2}\right)$ $\rho = r$ $X = \frac{P_s \cdot \theta}{2\pi}$	The directrix trajectory is a cylindrical helix with P_s pitch arranged on a cylinder with r radius.
4. Relief on cylindrical helix $\delta = 0$ $\rho = r - \frac{P_s \cdot \theta}{2\pi}\cos(\varphi)$ $X = \frac{\left(P_{e1} - P_S \sin(\varphi)\right)\theta}{2\pi}$	In the plane X=const Archimedean spiral $\delta = \mathrm{arctg}\frac{P_S}{P_{e1}}$
5. Relief on conical helix $\varphi = 0$ $\rho = \mathrm{r} - \frac{\left(P_{e1} tg(\delta) + P_S\right)\theta}{2\pi}$ $\varphi = \delta$ $\rho = \mathrm{r} - \frac{\left(P_{e1} tg(\delta) + P_S \cos(\delta)\right)\theta}{2\pi}$ $tg(\delta) = \frac{P_{e1} tg(\delta) + P_S \cos(\varphi)}{P_{e1} - P_S \sin(\varphi)}$	In the plane X=const Archimedean spiral X=$\frac{P_{e1}\theta}{2\pi}$ $\delta_2 = arctg\frac{tg(\delta) + P_S}{P_{e1}}$

CONCLUSIONS

1. The relief technology used in present by the the companies specialized in producing the cutters for the spiral bevel gears with curve teeth, is not published in the specialized magazines and is protected by both the company and the international regulations on intellectual property rights.

2. The profile of these cutters is part of the helicoids, it cannot be wraped by cylindrical or conical grinding tools; under service conditions, is taking part in a complex manufacturing process through rolling or copying etc., as well as in a degradation process, which modifies the normal profile of the toothed wheel/gear tooth.

3. The blades relieved in our country, by current methods, do not meet the quality conditions conditions of the originals. After only 10 or 20 regrindings, the active profile of these falls aut of the tollerance field imposed by the gear cutting machine, affecting the precision of the cutting gear and the contact spot.

4. Of the studied side surfaces, from a geometricall point of view, the most convenient is the helical surface. In a refference system, of whose Oz axis is the cutting head, the deviations of the cutting edge from a straight line which passes through the edges extreme points are minimal and they fall within the allowed tollerance limitations (0.08 mm).

REFERENCES

1. Aron, I. s. a., 1999, Angrenaje conice cu dinți curbi. Editura Casa Cărții de Știință, Cluj-Napoca,.
2. Botez, E., 1969, Cinematica maşinilor unelte. Bucureşti, Editura Tehnică.
3. Guja, N., Tendințe şi noutăți în domeniul angrenajelor. Construcţia de maşini 1/1999.
4. Henriot, G., 1971, Traite theorique et practique des engrenages. Paris, Ed.Dunod.
5. Lăzărescu, I. ş.a. Contribuții în legătură cu geometria cuțitelor pentru prelucrarea danturii roților dințate conice în arc de cerc. Bucureşti, Revista Institutului de Mecanică Aplicată, nr. 3/1959.
6. Litvin, F.L., 1994, Gear Geometry and Applied Theory. University of Illinois, Chicago. PTR Prentice Hall.
7. Mihăilă, I., 2004, Tehnologii mecanice. Ed. Universității Oradea.
8. Minciu, C., Scule aşchietoare. Îndrumar de proiectare. Bucureşti, Editura tehnică, 1995.
9. Pantea, I, Stanasel, I. & Blaga, F. 2008. The Simulation of the Profiling Technology of Toothing Knives, Annals of DAAAM for 2008 & Proceedings of the 19th International DAAAM Symposium, Vienna, Austria, p1015-1016. http://www.conftool.com/daaam2008/
10. Pantea, I., 2004, Contribuții privind tehnologia sculelor de danturat roți dințate conice cu dinți curbi.Teză de doctorat, Universitatea din Oradea(RO) Contributions regarding the technology of the tools used for bent teeth bevel gears teething. Doctorate Thesis, University of Oradea, p 48-52.
11. Ștețiu, G. ş.a. 1994, Practice and theory of cutting tools, vol. I, II, III. Editura Universității Sibiu, ISBN 973-95604-3-1, Sibiu
12. Târziu, H., 2001, Cercetări teoretice şi experimentale privind detalonarea capetelor de frezat dantura roților conice cu dinți curbi pe maşini de rectificat universale. Teză de doctorat, Universitatea Transilvania din Braşov.