THE HONING PROCESS ANALYSIS IN THE ASPECT OF TREATED GEAR - WHEEL INVOLUTE PROFILE FORMING

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Abstract: This article represents analysis of tools – honing machine cooperation with treated gear wheel. Specified amount of contact points of cooperating pair: tool – gear wheel. It was established variable distribution of forces that exists with cooperation honing machine – gear wheel. Based on established forces vicissitude listed the turnover of gear wheel involute profile deviation. The results of theoretical consideration have been endorsemented by operative research.
Keywords: gear wheel, honing process, tooth profile deviation

1. Introduction

Regular increment of operating necessitates set to every sort of machines and attachments makes, that their component parts shall be performed with supremely preciseness. Specially high requirements are set to gear wheels concidering their reliability working capacity. One of the significant elements whereupon concentrates operative researching is the brand of involute surface, but first of all it`s the gear wheel involute profile. Increasing requirements set to gear wheels concentrate on major power displacement, prominent speed increase with simultaneous noise level decrease – loudness working space, by conducting their pacticular tenacity. In operative research the very important parameter having a big influence upon gear wheel cooperation is a quallity of meshing profile. In extent standards of various countries there are given out the permissible valuations of gear wheel involute profile deviation depending on characteristic of the gear working space.

In technological trials of gear wheels are presented the ways of obtaining the tooth profile together with terminal valuations in a given kind of treatment. One of the mentioned kinds of receiving the highest precision of gear wheel involute profile is honing process. The tenet of the gear wheel honing process is built up to cooperation of two toothed elements, one of them is a treated gear-wheel and the secondis a gear-wheel-shaped tool. Cooperation of the

wheels with a tool may suit to the gear with outer or inner meshing. Hereof this development work represents the results of cooperation of the gear with outer - meshing. Using the following honing process enable to obtain the profile with better surface quality, increases intimate contact marks of cooperating surface, and first of all decreases loudness of working gear.

2. Problem analysis

Realizing the research trial of gear-wheel honing it`s needed to count a number of tool and gear-wheel contact points and prescribe the distribution of forces operating therein cooperation. One of conditions of receiving the positive results by honing process – i.e. receiving the correct involute is condition: the meshing between the tool and treated wheel has to act by even number of contact points. Even amount of contact points assure of a steady forces distribution in confoguration tool – object, what vouchs even allowance removal on the involute gear-wheel surfaces.

In case of odd number of the contact points, there exists a variation of intermeshing forces what cause the gear-wheel profile deviation. Estimating in turn following positions of the tool and gear-wheel in period of their cooperation, there is possibility to define the formed wheel profile deviation. For example fig.1 (a–f) represents various configurations the number of cooperating surfaces with a distribution of forces on teeth surfaces.

The configurations of the tool tooth surface and gear - wheel surface cooperation represent drawings 1a - 1f. These drawings illustrate in turn displacing following phases of point „1” aside the tooth, form top „K” to tooth root „F”. On drawings those bold points list the contact points of tool tooth surface with threated gear wheel. On diag.1a point „1” has dislocated on the tooth surface by segment „m”, and on the flank pitch line of value „m1”. During this displace via all along there were 4 contactpoints. As the point „1” displaces onward the tooth surface there are another contact spots cooperating with. Configuration tool – gear wheel assume two, three or four contact points. On number of contact points depends the other distribution of forces. Depending on force value occurring in configuration tool – threated gear wheel follows slicing of diversified material from threated gear wheel involute. Listed distribution of contact points enebles the analisys of forming the gear wheel surface with profile deviation (figg.2). Figure 2 represents theoretical process of forming the tooth profile deviation.

Beginning analysis of meshing from the tooth tip (point „K”) to tooth root (point „G”) it was found that, at the place, which responds to the origin of meshing, exists the distribution of forces engendering lesser maschine cutting forces. The tool on this line segments slices a lesser

layer. The tool`s tooth displacing onward gets to three contact points therefore on the one tooth there`s a larger slicing force and on both extant points lesser. Therefore, there will be different thickness of slicing layer. Going futher there will occur a change of contact points amount and thickness of slicing layer. The following profile of involute should have a stepped character (fig. 2a). However, taking into consideration the existing elastic strains in the whole technological system, the tooth profile has a curvilinear progress, closing to sinusoidal (fig. 2b). Following theoretical consideration has been verified by practical industrial research. Some results of industrial research over involute profile are presented below in fig. 3 and 4. Figure 3 represents the results of tooth profile measurements after honing process for the following contact points configuration: 4-3-2-3-4-3.

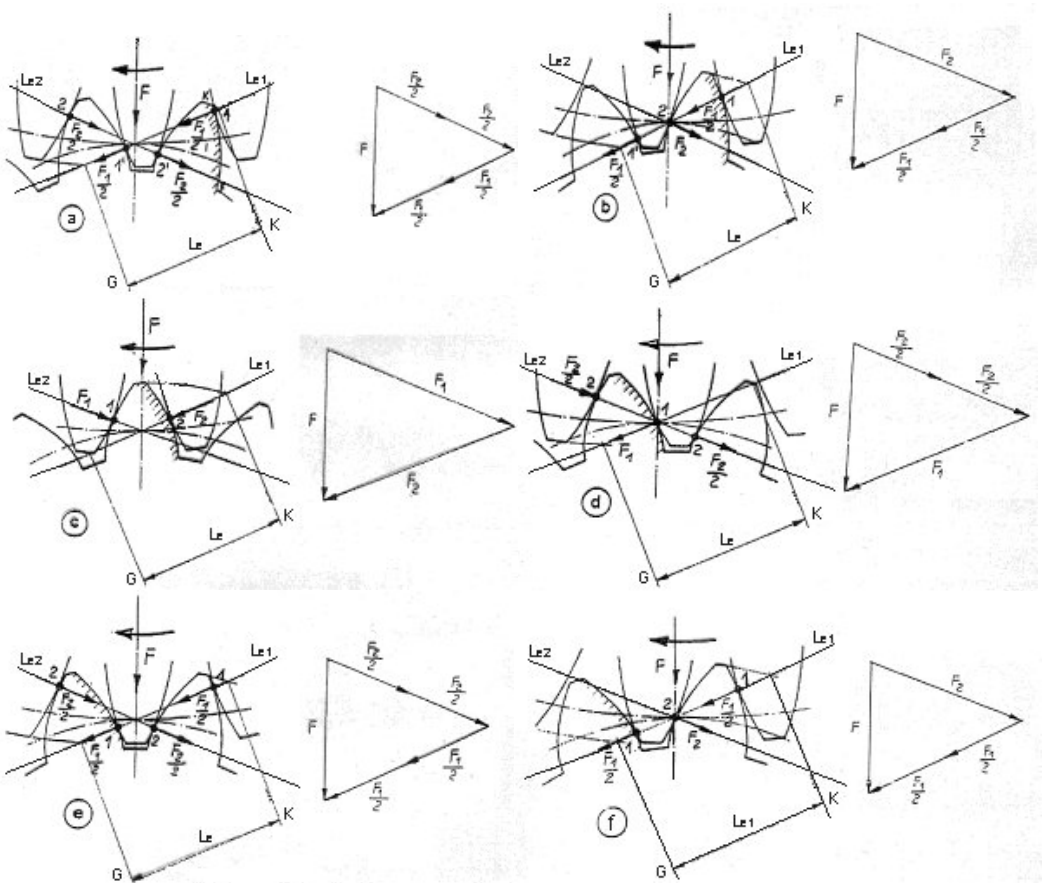

Fig. 1 (a-f). Variants of tool and gear-wheel cooperation: a – even amount of contact points, force distributes evenly, b – odd amount of contact points, non-uniform distribution of forces, c - even amount of contact points, equipartition of forces, d – odd amount of contact points, non-uniform distribution of forces, e – odd amount of contact points, equipartition of forces, f – even amount of contact points, non-uniform distribution of forces. F – force, G – root of tooth, K – crest of tooth, L_e – distance from tip G to tooth on the contact line. L_{e1}, L_{e2} - contact lines

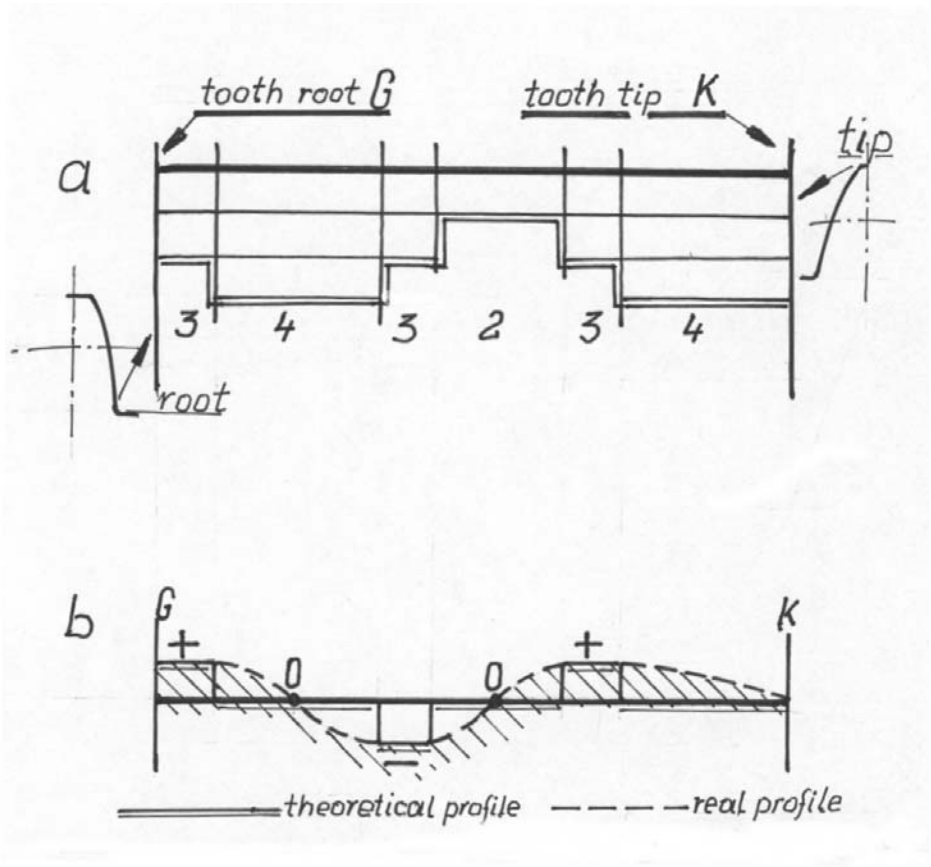

Fig.2 Theoretical process of tooth profile deviation forming from tooth root (G) to tooth tip (K): a – diagram of points distribution on the contact fine, b – theoretical and real tooth profile, 2 – two points on two contact lines [Fig.1c], 3 – three points on one contact line [Fig.1b, 1d, 1f], 4 – four points on two contact lines [Fig .1.a, 1.e], G – tooth root, K – tooth tip

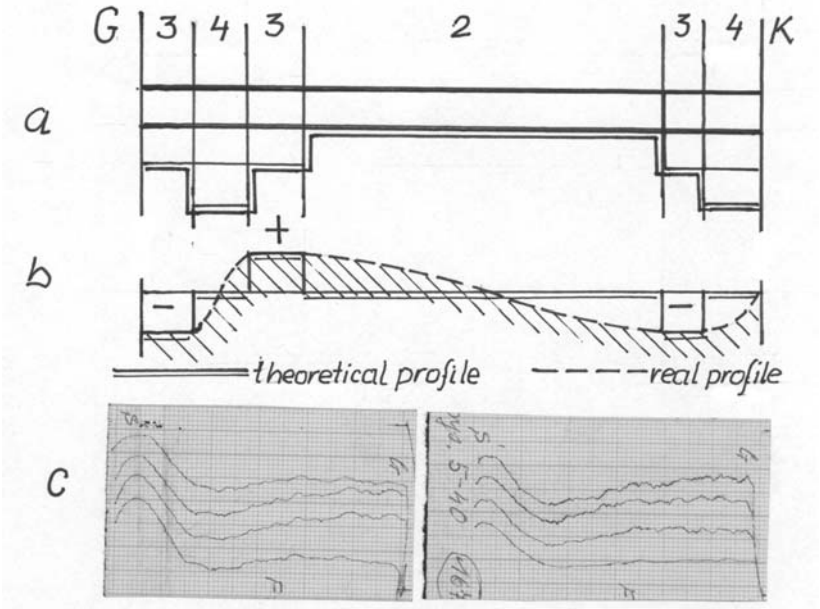

Fig. 3. Graphs of tooth profile measurements after honing process for contact point's configuration: from root (G) to tooth tip (K) 4-3-2-3-4-3, a – diagram of points distribution on the contact line, b – theoretical and real tooth profile, c – the results measurements of tooth profile after honing process

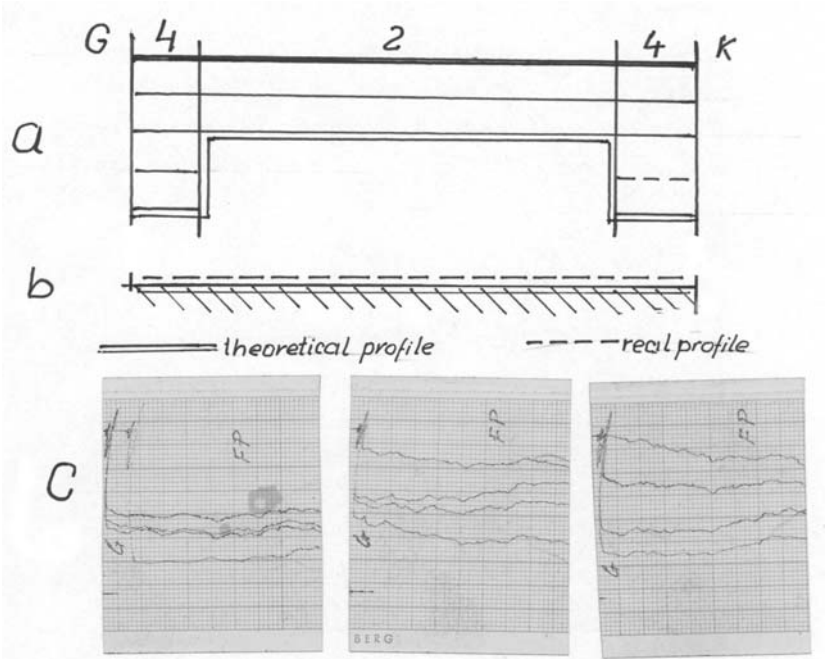

Fig. 4. Results of tooth profile measurements for contact points: 4-2-4: a – diagram of points distribution on the contact line, b – theoretical and real tooth profile, c – the results of tooth profile after honing process

Figure 4 represents the results of tooth profile measurements after honing process for contact point's configuration 4-2-4. Proceeding assessent of theoretical distribution (configuration 4-2-4), wherein the lesser significant values deflects were revealed, has been substainted by practical research. Vouches research operative. The real deviations in this configuration are essentially lesser.

3. Conclusion

Represented theoretical consideration and its operative verification allow to certify, that there is a possibility of anticipation and forecasting the tooth profile deviations in outer honing process with cylindrical-roller-tool. Taking into concideration obtained results of theoretical analisys, exist a possibility of acting on a honing workmanship through tool selection. In this case, it`s necessary to specify an amount of contact points for cooperation of the tool and treated gear wheel, in order to avoid ocurring odd amount of contact points. The odd number of contact points is one of the most important reasons for occuring gear wheel involute profile deviation.

4. References

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