RESEARCH OF RADIALLY-CIRCULAR GENERATING METHOD OF GEARS CUTTING USING A SOLIDWORKS PROGRAM

Hrytsai I., ***D.Sc. prof.,*** **Zinchenko D.,** ***M.Sc.***
Lviv Polytechnic National University

Gears and gear drives belong to the most common parts of modern machines that produced of large amount. However, due of the teeth crown, they are considered to be parts of increased complexity.

The hobbing is main method of spur and helical gears cutting. The hobs are among the most complicated by a shape and the most expensive cutting tools used in mechanical manufacturing presently. Herewith the hob milling operations are of a restricted productivity compared to the remained of a manufacturing operations. This cause why by 50% of the total amount of machine tools in the machine-cutting equipment park are the hobbing maching tools.

However, for today it's known another method of external tooth manufacturing, using the simplest cutting tool as thin disk-tipe milling cutter – radially-circular generating method (RCG-M). Its specificity is an eccentricity of the milling cutter mounting, while the process is carried out on the hobbing machine tool as well as in conventional hobbing process [1,2].

The objective presented in this paper is to compare of the process parameters of two mentioned methods when machining gears under the same initial conditions. The investigations have shown the following.

1. The cost of a disk-milling cutter is much less comparing of a hob's one. In addition, the eccentricity at the RCG-method can be varied smoothly over a wide range, that is adequate by changing the amount of module. Thus one single milling cutter, can replace 4-5 hobs of different modules.

Taking into account that at the price of gears, almost half of the costs are spent for a tools, this makes RCG-method ten times less expensive, and the cost of gears cutted by a disc miller will be 30-50% less.

2. For quantitatively study of gearing process, numerical models to simulate the spatial undeformed chips geometry and other process parameters of the RCG-method have been established. Shape of chips, as well as its cross section parameters, in successive gaps generating, continuously change and contain key information about this complited process.

For this goal, the algorithm to reproduce the kinematics of the tooth cutting process in the RCG-method has been developed using SOLID WORKS system. According Due to this algorithm, graphical constructions of splines were performed, which reproduced the formation of 3D shape of undeformed chips on all the successive teeth of the tool.

The composition of the splines in each discrete position of the tool and the workpiece in angular positions, relevant to angles of profiling $\psi = \frac{360}{Z_g \cdot Z_{d\_m}}$ allows to decompose complex RCGM kinematics into elementary components and eventually to calculate the required parameters of three-dimensional chips.

At the same time, with the help of system of computer-aided rheological modeling Deform 2 the shear strain in form of the shear strain ratio was identified [3]. The combination the solid geometrical data of cutting layers and the results of rheological modeling allowed the thrust force in the RCG-method as a spatial force field determine (Fig); $P = [\tau] \cdot \xi \cdot S$, where $[\tau]$– work gear material shear stress limit, MPa; S – chip cross section, mm^2 ; ξ - shear strain (cutting) ratio.

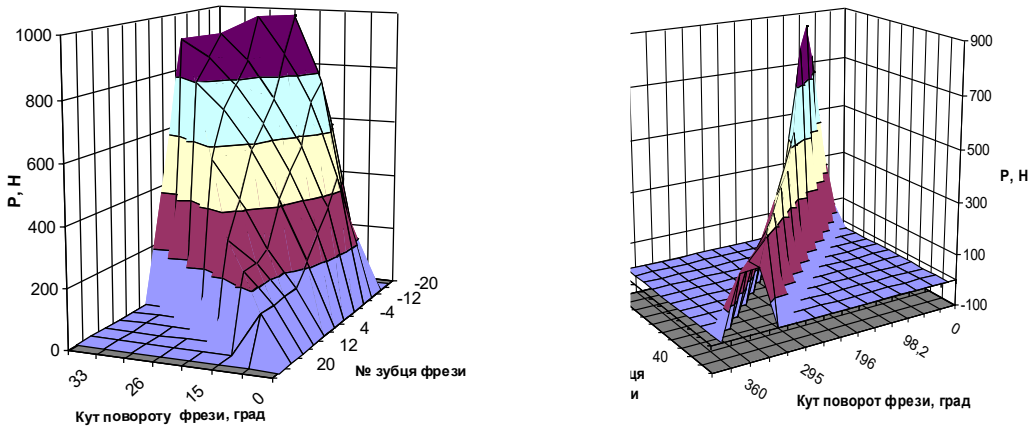

Fig. Spatial force field of hobbing (a) and RCG proxesses

Investigation have shown when equal cutting force, the shear strain ratio while the disc mill gearing (ξ = 1.4) is 35% less compared of the hobbing (ξ = 2.15) due to the greater chip thickness and conseqently the axial feed by 40% higher (respectively, 3 mm / rev and 5 mm / rev). This indicates a reduction of duration and, in general, a significant increase in the efficiency of the RCG gearing method.

References

I.Hrytsai. Gears with the asymmetric tooth profiles and a new alternative method of its manufacturing // Ukrainian Journal of Mechanical Engineering and Materials Science. - 2017. - Volume 3, Number 2. - pp. 32-37.

2. Hrytsay, J.Lytvynyak. Pidvyshchennya tekhniko-ekonomichnoyi efektyvnosti protsesiv vyrobnytstva zubchastykh kolis poyednannyam tradytsiynykh ta novykh sposobiv formoutvorennya. [Tekst] // Visnyk Natsional'noho universytetu «Kharkivskyy politekhnichnyy instytut». Zbirnyk naukovykh prats. - № 26.- Kharkiv. Vyd-vo NTU "KHPI".- 2010.- S.30-35.

3. Hrytsay I. Doslidzhennya synusoyidalnykh zubchastykh peredach / I..Hrytsay, V.Stupnytskyy // Pidyomno-transportna tekhnika – 2007. №4(24). – S.55-64.