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USING THE 3D MODEL IN THE MANUFACTURING AND CONTROL PROCESS OF THE CYCLOID PROFILE WHEELS

Abstract: *In the vibroacoustic performances of the cycloid gear reducer, major influences have the technological parameters: the shape errors of the wells' tooth and the roughness of the active cycloid profile. The classic manufacturing process of the cycloid profile involves important technological problems. Therefore, in this paper we propose a computational method of manufacturing the cycloid real profile of the cycloid wheels, also a control process, based on the theoretical 3D model obtained in CAD program. The same computational method can be used in generating and control process of other complex profile assuring the precision of the real profile related to the theoretical 3D model.*
Key words: *cycloid gear' profile, 3D solid, Coordinate centre 3D, Coordimeter 3D.*

1. INTRODUCTION

Numerous experiments point out that a major influence in the vibroacoustic performances of the cycloid gear reducer has the precision of the cycloid profile of the satellite wells. Therefore, to obtain the complex form of the cycloid profile, we propose to use a computational method of cycloid profile generation.

The resulting 3D model of the cycloid wheels is also used in precise manufacturing and final control process. The technological process is based on the capabilities of the new generation of Coordinate centre 3D. The computational method of measurement of the cycloid profile parameters is realised on the Coordimeter 3D.

2. THE CYCLOID PROFILE OF THE SATELLITE WHEEL

The behavior of the cycloid gear reducer is influenced by the constructive parameters of the cycloid satellite wheel [2]. Also, a major influences have the technological parameters: *the shape errors of the wells' tooth* and the *roughness of the active cycloid profile*. The classic manufacturing process of the cycloid profile involves important technological problems.

Therefore, in this paper we propose a computational method of manufacturing the cycloid real profile of the cycloid wheels based on the theoretical 3D model obtained in CAD program.

The cycloid profile of the satellite wheel of the cycloid gears has a complex form obtained through generating of the equidistant curve to an epi-cycloid curve. The theoretical studies and the practical experiences give as the necessary modification applied to the bottom and the peak of the teeth to obtain the improvement of the working conditions. Therefore, the resulting equidistant is modified to the beginning and to the end of the active cycloid profile of the teeth obtaining a complex form of the wheel profile.

To improve the real complex profile obtained by classical technology, we propose the using of 3D model in the manufacturing and control process of the cycloid profile wheel.

In figure 1 we present the steps, the necessary machines and soft to manufacture and to control a complex cycloid profile. The same computational method can be used in generating and control process of other complex profile, assuring the precision of the real profile related to the theoretical 3D model.

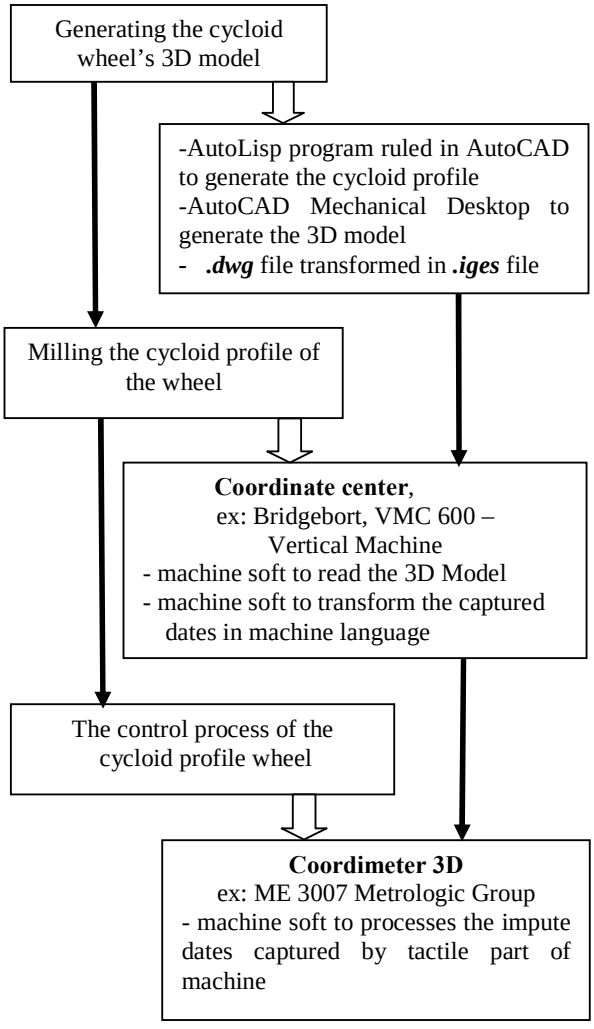

Fig. 1 The necessary machines and soft in manufacturing and control process of the cycloid profile.

3. THE GENERATING OF THE CYCLOID WHEEL'S 3D MODEL

The wheel's cycloid profile is generated in a program writhed in AutoLisp, ruled in AutoCAD utilitarian program [1, 3].

The 2D complex form of the wheel profile and the 3D model of the cycloid wheel is obtained in AutoCAD Mechanical Desktop, figure 2.

The resulting *.dwg* file is transformed in *.iges* file using the command File < Export from the main Menu.

With this extension, the 3D model of the cycloid wheel well be read by the machine program of a Coordinate centre 3D machine.

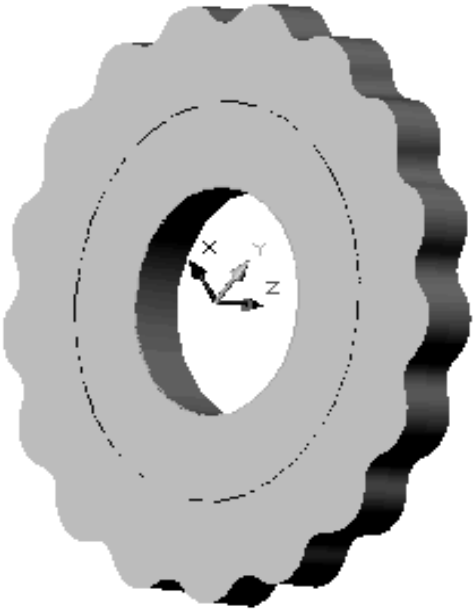

Fig. 2 The 3D model of the cycloid wheel.

4. THE MILLING OF THE CYCLOID PROFILE

In this paper we propose a computational method of milling the cycloid real profile using the 3D Model on a **Coordinate center**, (ex: Bridgebort, VMC 600 – Vertical Machine).

In the process of transferring the dates from the *.iges* file of the 3D Model to the coordinate center machine, two utilitarian programs are involved:

- a machine program (ex: PowerMILL3.1) who „reads" the 3D Model of the cycloid shape of the wheel and generates the points that the peak of the milling cutter go through – the preprocessor stage;
- a machine program (ex: Heidenhain 370) who transform the dates in machine language and transmitted them like „extern data imput" –***postprocesor*** stage.

With this technology is assured the precision and the quality of the complex cycloid shape.

The solid 3D generated in CAD programs is considerate model in coordinate center machine language.

5. THE CONTROL PROCESS OF THE CYCLOID PROFILE WHEEL

The precise measurements of the cycloid profile can be obtained using a Coordimeter 3D machine (ex: **ME 3007 Metrologic Group)**, figures 3, 4. The impute dates captured by tactile part of machine are processed by machine soft (ex: **Metrolog II.** ***v2.60)***

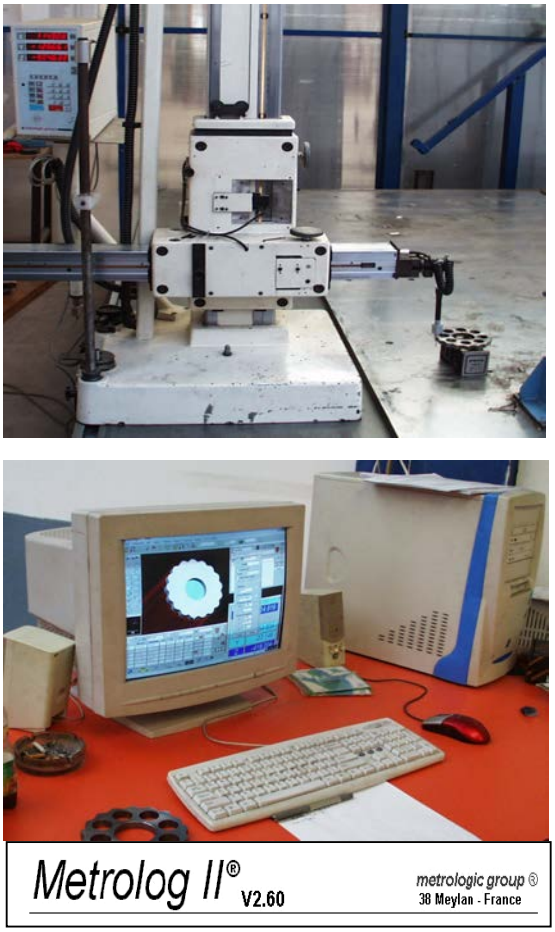

Fig. 3 Coordimeter 3D machine used to measure the parameters of the cycloid profile wheel.

The measured values are:

- the X,Y coordinates of the cycloid profile's points;
- the disposal radius of the wheel's holes centre;
- the disposal angle of the wheel's holes centre.

The two last measured values represent the polar coordinate of the wheel's holes centre. Through the machine soft, the measured values are compared with the *.iges* 3D Solid file of the cycloid wheel.

The results of measurement followed by comparison with theoretical 3D solid of the cycloid wheel point out:

- the maximum of the wheel's holes centres circle's eccentricity;
- the maximum angular error of wheel's holes centres disposal;
- the errors of the real cycloid profile in different points related to the theoretical 3D Solid cycloid profile.

These results are registered in data base files and also can be printed related to the solid. For the before mentioned measurements, we present, in figures 5, 6, 7 the processed results for a used cycloid wheel obtained in the classic manufacturing process.

Fig. 4 Coordimeter 3D machine used to measure the profile wheel points' coordinates.

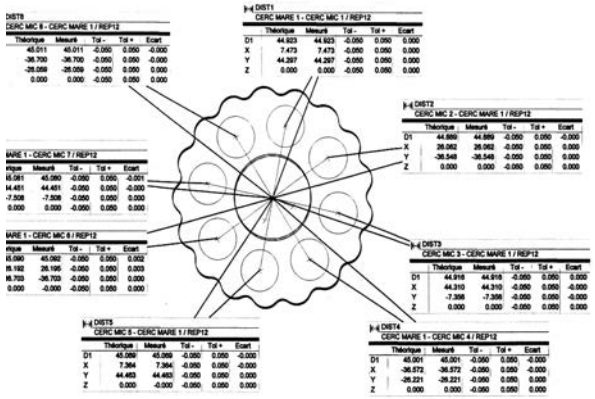

Fig. 5 The wheel holes centres circle' s eccentricity.

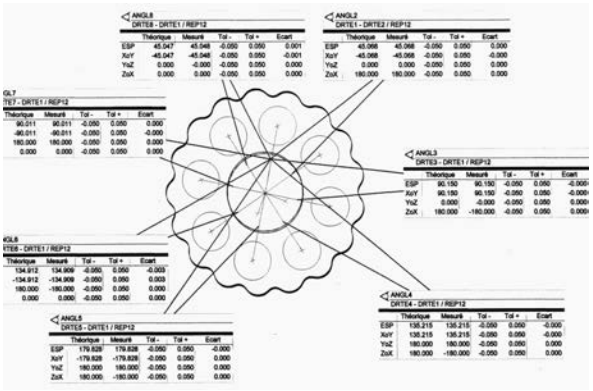

Fig. 6 The angular errors of wheel holes centres disposal.

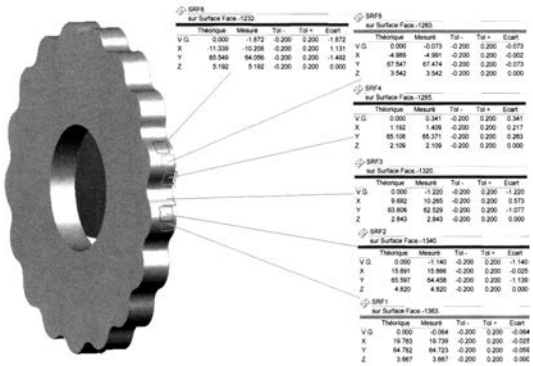

Fig. 7 The radial errors of the real cycloid profile.

The measured points' coordinates are included in table 1 related to the theoretical points' coordinates. Also, we got information about tolerance, radial errors and ,,tendance".

Table 1

The measured values of the points coordinate

refer	nominal	mesure	tol-	tol+	ecart	tendance
SRF1	Pt. Surf. sur Surface Face.-1363.					
V.G.	0.000	-0.064	-0.200	0.200	-0.064	
X	19.763	19.739	-0.200	0.200	-0.025	
Y	64.782	64.723	-0.200	0.200	-0.059	
Z	3.667	3.667	-0.200	0.200	0.000	
SRF2	Pt. Surf. sur Surface Face.-1340.					
V.G.	0.000	-1.140	-0.200	0.200	-1.140	-0.940
X	15.891	15.866	-0.200	0.200	-0.025	
Y	65.597	64.458	-0.200	0.200	-1.139	-0.939
Z	4.820	4.820	-0.200	0.200	0.000	
SRF3	Pt. Surf. sur Surface Face.-1320.					
V.G.	0.000	-1.220	-0.200	0.200	-1.220	-1.020
X	9.692	10.265	-0.200	0.200	0.573	0.373
Y	63.606	62.529	-0.200	0.200	-1.077	-0.877
Z	2.843	2.843	-0.200	0.200	0.000	
SRF4	Pt. Surf. sur Surface Face.-1285.					
V.G.	0.000	0.341	-0.200	0.200	0.341	0.141
X	1.192	1.409	-0.200	0.200	0.217	0.017
Y	65.108	65.371	-0.200	0.200	0.263	0.063
Z	2.109	2.109	-0.200	0.200	0.000	

The distribution of the radial errors of the cycloid profile points' position in different tolerance intervals is presented in percentage of number of points in each interval from total number of measured profile' s points, table 2.

Table 2

The distribution of the radial errors

În lim. tol.	**≤0,050**	**0,050÷ 0,100**	**0,100 ÷ 0,500**	**0,500 ÷ 1,000**	**1 ÷ 1,5**
47,5%	7,5 %	2,25 %	10,25 %	11,25 %	21,25%
47,5%	9,75 %		10,25 %	32,5%	

For an easy understanding of the radial errors distribution of the measured points' coordinates, we build the diagram form presented in figure 8.

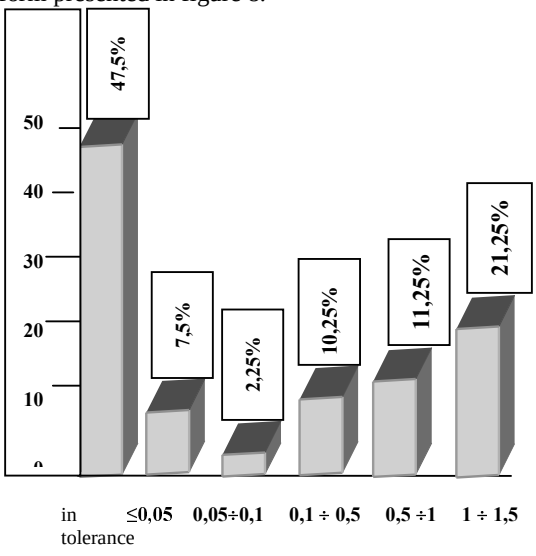

Fig. 8 The distribution of the radial errors of the measured profile' s points.

The radial errors distribution diagram allows appreciating the quality of the real profile related to the 3D Solid theoretical profile. The results are compared with the standards demands. The shape error of the wells tooth and the roughness of the active cycloid profile have a major influence on the performances of the cycloid gear reducer.

6. CONCLUSION

The classic fabrication process of the cycloid profile involves important technological problems.

Major influences have the technological parameters: *the shape errors of the wells tooth* and the *roughness of the active cycloid profile*. Therefore, in this paper we propose a computational method of manufacturing the cycloid real profile of the cycloid wheels based on the theoretical 3D model obtained in CAD program.

Also, we propose the using of 3D model in the control process of the cycloid profile wheel.

The same computational method of manufacturing and control process can be used in generating and control process of other complex profile assuring the precision of the real profile related to the theoretical 3D model.

7. REFERENCES

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