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1st SYMPOSIUM ON MULTIDISCIPLINARY STUDIES OF DESIGN IN MECHNAICAL ENGINEERING

DESIGN OF THE NEW GEAR TOOTH PROFILE OF THE TROCHOIDAL GEARING

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1. INTRODUCTION

Methodology for selection of optimal shape of trochoidal gear tooth profile applied at gerotor pumps is presented in the paper. The first part of the paper presents the general procedure for generation of gearing with profiles described by epitrochoid equidistant and corresponding coupled envelope. Next, geometrical and kinematical conditions which should be fulfilled by profiles were defined in order to achieve proper coupling. Dependences between geometrical gearing parameters and functional characteristics of the pump were determined. In order to assess maximal contact stresses, analysis of forces and moments is conducted with application of analytical and numerical methods. The influence of the profiles with technological gaps on volumetric losses of the pump was identified through investigation of profile characteristics. In order that derived models and functional dependences for determination of output parameters may be used as flexible and reliable as possible, their generalization is conducted. Described methodology is illustrated on the example of the actual pump and the obtained solution is proposed as optimal for given conditions [1]. Based on theoretical considerations, physical models of gears were made and simulation experiment performed, wherewith the results of the analysis of the functional characteristics of the pump and described methodology were entirely verified.

2. MATHEMATICAL MODEL OF GEARING

In Fig 1. it is shown that during the relative moving of pitch circles, when the point *D* is generating epitrochoid, the point *P* is generating equidistant.

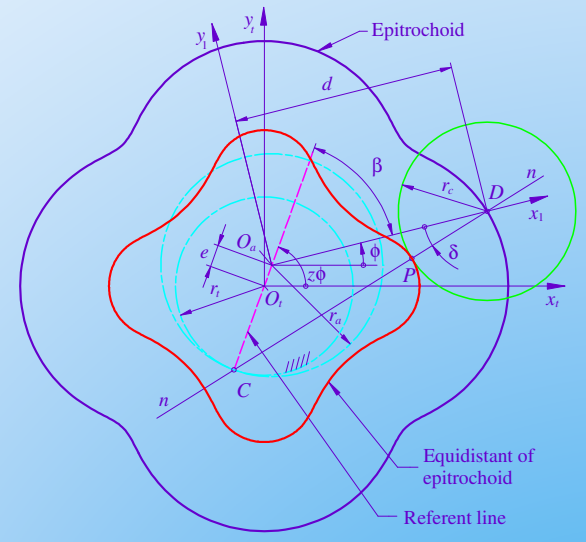

Fig. 1: *Generating of unmodified and modified epitrochoid*

The angle signified as δ is an angle between the normal *n-n* and radius vector of the point *D*, and can be defined as leaning angle [2]. Coordinates of the contact point *P* in the coordinate system of epitrochoid can be written as:

$$\vec{r}_t^{(t)} = \begin{bmatrix} x_t^{(t)} \\ y_t^{(t)} \\ 1 \end{bmatrix} = \begin{bmatrix} e\left[(\cos z\phi + \lambda z \cos\phi) - c\cos(\phi+\delta)\right] \\ e\left[(\sin z\phi + \lambda z \sin\phi) - c\sin(\phi+\delta)\right] \\ 1 \end{bmatrix} \quad (1)$$

where:

- λ is coefficient of trochoid, which defines relation between the values of the trochoid radius and the radius of moving circle, $\lambda = d/ez$
- *c* is coefficient of equidistant, which defines relation between values of trochoid radius and eccentricity, $c = r_c/e$

Based on geometrical relations from the Fig.1, the formula for determination of angle δ can be obtained:

$$\delta = \arctan\frac{\sin(z-1)\phi}{\lambda + \cos(z-1)\phi} \quad (2)$$

Mathematical model of gearing gives possibility to analyze the quality parameters of the gear pair constructive solution.

3. DESIGN AND COMPUTER GENERATING OF PROFILE

Based on the mathematical model is created the computer program in the standard programming language AutoLISP to the calculation of the given curves coordinates and to their automatic generating.

Fig. 2: *Models of tested gear pairs*

As result of program testing are obtained the conjugate gear pairs of gerotor mechanism. For obtained internal gear pair developed 3D geometrical models by the application of the Part Design module of the computing program CATIA. Using of presented mathematical model is defined the methodology for selection of the optimal model of gearing. In the Fig 2. are given the tested gear pairs, which are made of steel and find application in gerotor pumps.

CONCLUSION

Based on the results of analysis and research in PhD dissertation [1] and in [3, 4, 5] and also generating of the new model of the gear tooth profile can be obtained the following conclusions:

- Functional limits obtained at the definition tooth profile gives elimination of the different kind interference and on the base of that is possible right function and montage of the gear pair;
- From the kinematical aspect, new designed tooth profile is giving the same wear of the meshing tooth profile;
- Obtained results determinate the conditions to decrease of the extremely high values of the specific sliding;
- Through the application of internal equidistance modification comes to the small dimensions and at the same time to increase of the working volume of the gerotor pump.

REFERENCE

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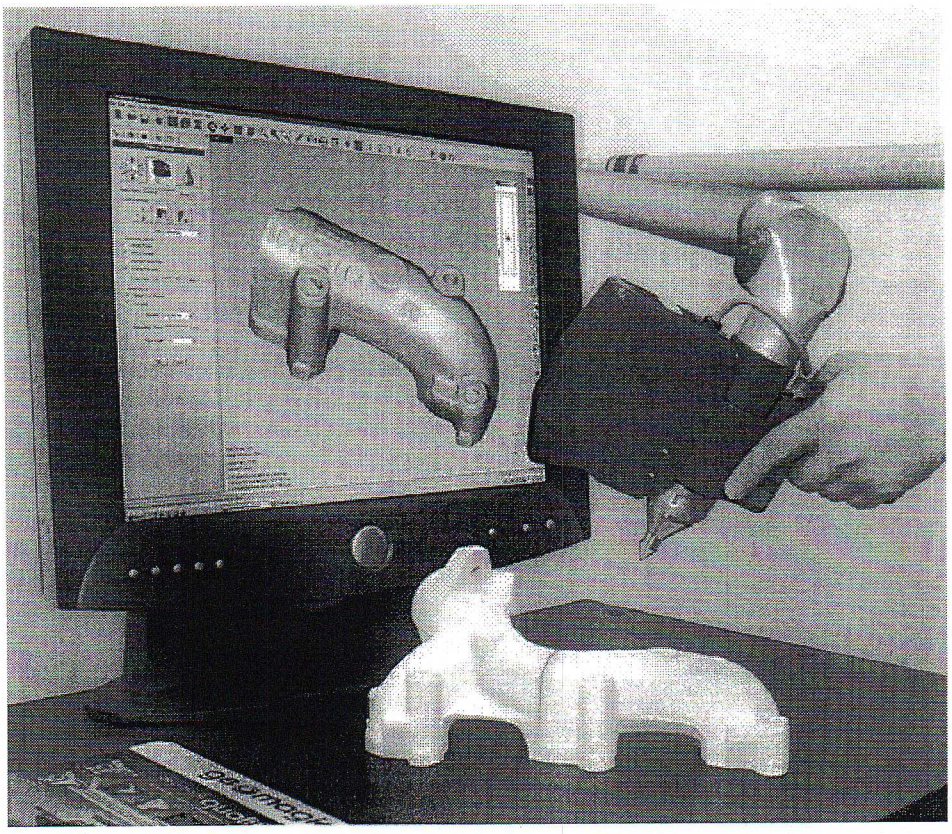

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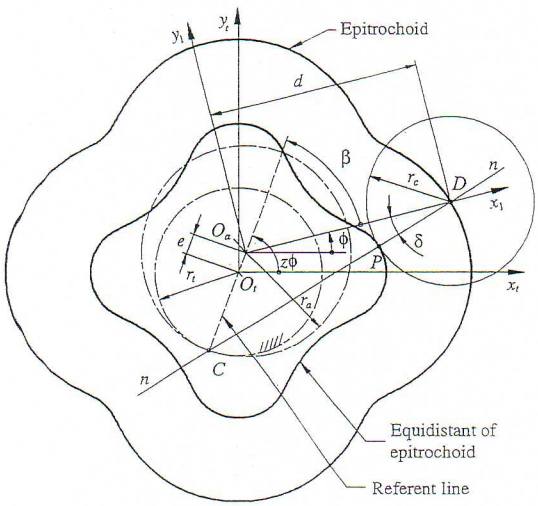

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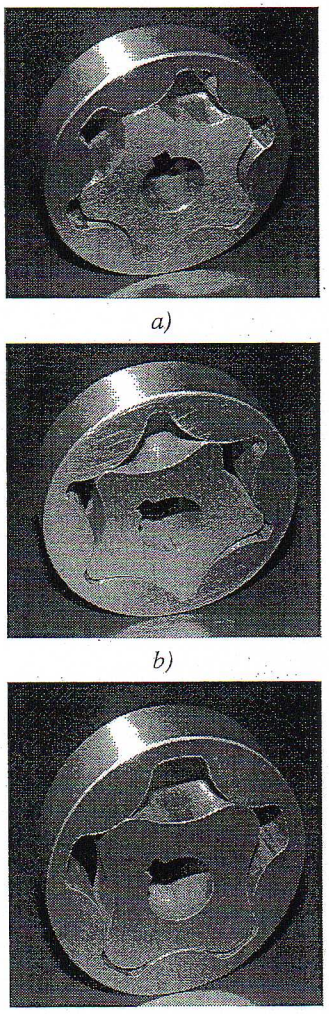

Fig. 2: Models of tested gear pairs: a) GP-375, b) GP-675, c) GP-850

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