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Definition Errors in Sprocket Ring on Passages at Gear Shaving

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Abstract

Sprockets with small number of teeth are widely applied in oil pumps, planetary transfers, and hydro engines. The Gear-Shaving process of such sprockets undergoes a difficulty in the manufacture, especially when accuracy of a process with more than 8-th degree is required, and when classical methods are applied. However, at processing of Sprockets Gear-Shaving, the factor of overlapping in tool grapping changes within the limits of 1.1 ...1.2. Therefore, the properties of the involutes of gearing shown clearly. Much works are devoted to study of sprockets with small number of teeth processed by Gear-Shaving operation, but no attempt has been carried out to define errors on each passage.

Experimental results indicate that the change of crossbreeding angle of axes on each passage allows reducing number of draft passages. However, it shown that the errors of general length depend segnifically on previous process errors. The effect of preparation errors also taken under consideration in present study.

Thus, reducing errors of gear ring of Sprockets may be consider as an important task for improving the loading ability of issue and technical level of the product.

Keywords: Gear-Shaving, error, Shaver, conjugation of surfaces, accuracy.

INTRODUCTION

Sprockets with small number of teeth are widely applied in oil pumps, planetary transfers, and hydro engines. The Gear-Shaving process of such sprockets undergoes a difficulty in the manufacture, especially when accuracy of a process with more than 8-th degree of accuracy is required, and when classical methods are applied. However, at processing of Sprockets Gear-Shaving, the factor of overlapping in tool grapping changes within the limits of 1.1 ...1.2. Therefore, the properties of the involutes of gearing are shown clearly. Much works are devoted to a question of sprockets with small number of teeth processed by Gear-Shaving operation, but no attempt has been carried out to define errors on each passage [1,2,3,4].

Using the classical Gear-Shaving methods, the experimental researches of the mechanism of error occurrence in gear ring elements and through the measurements on passages, were investigated depending on the following accuracy parameters:

1. Error in a tooth direction.
2. Error in tooth profile.
3. Fluctuation of general normal length.
4. Palpation on one tooth.

The forgoing errors confirm the geometrical kinematical reason, which represent, mainly, unconjugation between the surfaces of Shaver and Sprocket teeth. In addition to the former reason, the palpation on one tooth may be caused by dynamic changes. Reduced errors of gear ring of sprocket can be an important reserve of increase the loading ability of issue and the factors of technical level of the product. It is known, that the increase of passages number causes the accuracy of a sprocket gear ring to be increased.

For definition of necessary number of draft, passages with the purpose of maintenance of the necessary quality of a gear ring the experiments and statistical processing of results of measurement were carried out. Processed sprockets of Hydro-transmission gear pump, which in use in agricultural machines, the preparations before gear shaving had grinding teeth [5, 6].

MATHEMATICAL MODELING:

The gap produced by processing of a ring of gear wheel is considered as initial accuracy of the processed wheels [1, 2, 3, 4, 5]. It is necessary to search for certain ways to improve the accuracy of a gear ring. For this purpose, it is suggested to change the crossbreeding angle of surfaces axes on each passage corresponding to each interaxial distance by using the following formula [5, 6]

$$\Delta\Sigma_i = \frac{2\cos^2(\Sigma-\beta_1)}{m_n z_1 \sin(\Sigma-\beta_1)}\Delta a_{wi} \qquad (1)$$

Where:

Δa_{wi} - Change of interaxial distance, mm;

$\Delta\Sigma_i$ - Change of crossbreeding angle of axes, mm;

EXPERIMENTAL WORK

Processed sprockets of Hydro-transmission gear pump, which in use in agricultural machines, are used in the present study. Before processing, the preparations of Sprockets have been polished teeth. The specifications of the Sprocket and the Shaver are as follows:

Parameters of the Sprocket:

Number of teeth $z_1 = 10$

The module $m_n = 3mm$

Factor of mixture $x = 0.24746$

Tooth slopping angle $\beta_1 = 0$.

Parameters of the Shaver:

New Shaver with right direction

Number of teeth $z_0 = 53$

Outside diameter $d = 180mm$

Slopping angle of a tooth $\beta_0 = 15$

Number of draft passages until machining to process N = 7.

Parameters of Sprocket accuracy before Gear-Shaving:

An error of a direction of a tooth $F_{\beta r} = 0.005\ mm$

Palpation on one tooth $F_{ir} = 0.01mm$

Fluctuation of general length $F_{vWr} = 0.014mm$.

In the first series of experiments, the value of crossbreeding angle of Shaver and Sprocket axes is taken to be $\Sigma = const = 15$. After each pass, an error of a direction of a tooth, palpation on one tooth and fluctuation of general length are measured. Measurements carried out on three details for each passage. The results of measurement are shown in fig.1.

The fitted correlations of measurement results are identified for the specified errors of a gear ring, depending on the number of draft passes. Thus, equation 1, 2, 3 represents the fitted equations that relate each error with axial distance:

$$F_{\beta r} = -2.60416\Delta a_w^2 + 0.6980\Delta a_w + 0.000846 \quad (2)$$

$$F_{ir} = -1.756776\Delta a_w^2 + 03250\Delta a_w + 0.03290 \quad (3)$$

$$F_v W_r = -0.61011\Delta a_w^2 + 0.1027\Delta a_w + 0.015369 \quad (4)$$

In second series of experiments, crossbreeding angle of axes Shaver and wheel is taken as variable value, $\Sigma \neq const$.

Referring to equation 1, the change of crossbreeding angle is calculated for each passage.

The results shown in fig. 2, which explain the change of crossbreeding angle of axes at respective change of interaxial distance a_w. Clearly, the accuracy is seen to be increased. The experimental results is correlated as in the equations below,

$$F_{\beta r} = -0.3869\Delta a_w^2 + 0.1125\Delta a_w + 0.000197 \quad (5)$$

$$F_{ir} = -0.0595\Delta a_w^2 + 0.025\Delta a_w + 0.010095 \quad (6)$$

$$F_v W_r = -0.0595\Delta a_w^2 + 0.0133 \quad (7)$$

CONCLUSIONS:

1. The change of crossbreeding angle of axes on each passage allows reducing number of draft passages.
2. It is necessary to take into account that the increase of the module cause the error of general length to be increased which in turn depends essentially on initial size of this error.

The preparation should has an error appropriate to the minimum of it rating value, especially for Sprockets with small number of teeth, as this error is very badly eliminated by Gear-Shaving.

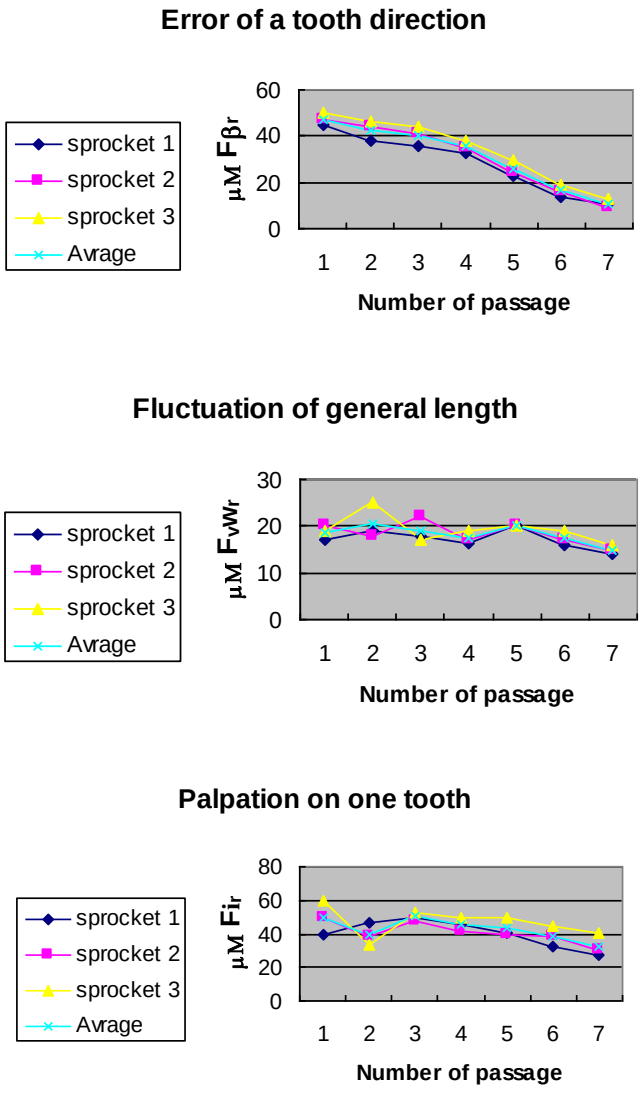

Figure 1. Changing of accuracy parameters gear ring on passages when $\Sigma = const$

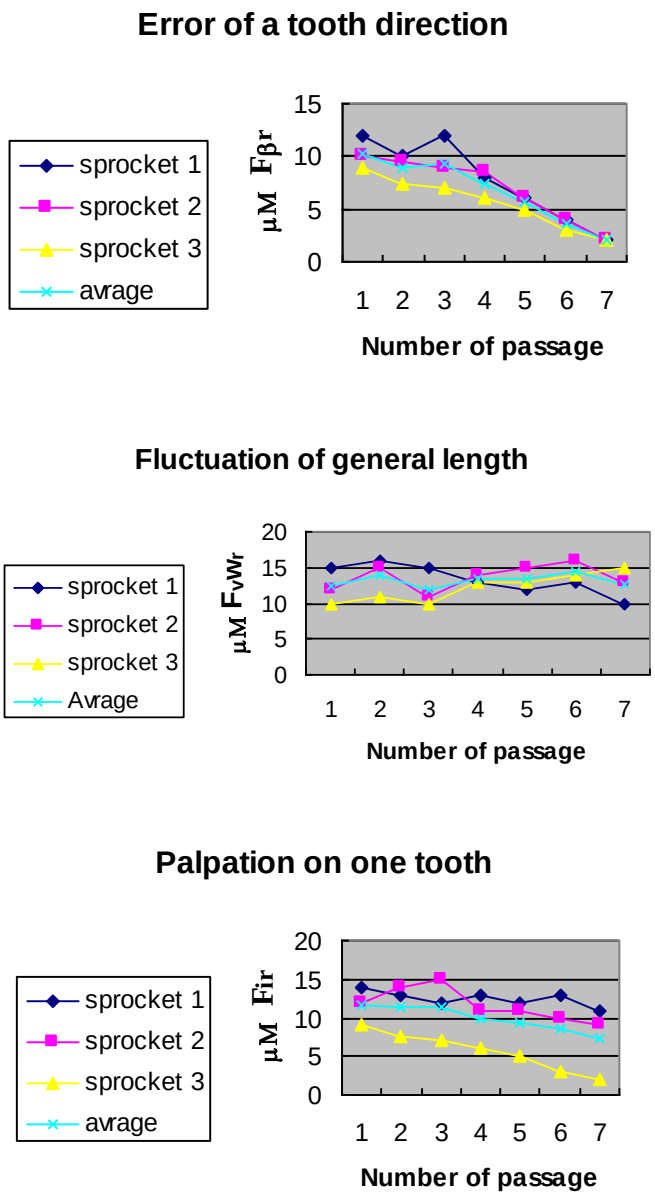

Figure 2. Changing of accuracy parameters gear ring on passages when $\Sigma \neq const$

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