

**5<sup>th</sup> INTERNATIONAL MEETING OF THE CARPATHIAN REGION SPECIALISTS  
IN THE FIELD OF GEARS**

**COMPARATIVE ANALYSIS OF THEORETICAL AND  
EXPERIMENTAL VALUES OF ROLLING WORM GEARS  
EFFICIENCY**

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***Abstract:** Taking in account the lower values of classical wormgears efficiency, the studies of the wormgears with rolling elements is important. The paper presents theoretical and experimental results regard the values of efficiency in various function conditions.*

***Key words:** special worm gears, rolling friction, efficiency*

## **1. INTRODUCTION**

The increasing efficiency of the worm gears is from a long time preoccupation of the specialists in gears. In time, were found some solutions for these, like: Buckingham-Ryfel solution, Litvin-Niemann solution or constructive solutions for ameliorating of the friction conditions.

One of these solutions is using rolling elements between active surfaces of the worm gear. So is possible to change the sliding friction with the rolling friction, more favorable.

This paper presents the experimental results obtained by the authors testing efficiency of a worm gear with rolling elements.

## **2. THEORETICAL ASPECTS ABOUT WORM GEAR EFFICIENCY**

The theoretical study of the rolling and sliding worm gears was made taking in account the real and specific conditions in which developed the experimental work (load, speed, dimensions range, materials and lubrication).

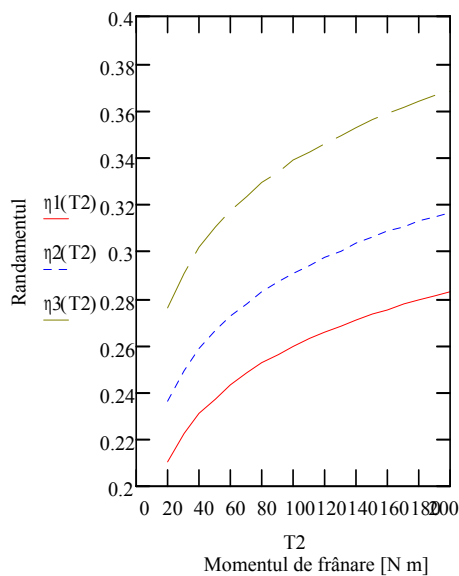
For the both of variants (sliding worm gear and rolling worm gear) we considered mineral grease RUL 100 Ca3 STAS 1608. For the rolling worm gear we had following dates:

- the balls' surface roughness was  $R_z$  0.4 $\mu$ m,
- the worm's rolling way roughness -  $R_z$  1.6 $\mu$ m,
- the wheel's rolling way roughness -  $R_z$  1.6 $\mu$ m,
- the balls' diameter 9.525mm,
- the helix angle's variation is in the experimental determined range – 4°...6°,
- the contact angle between balls and rolling ways - 40°,
- the same active balls number,
- the rolling circle in the strangulation section -  $d_{01}$ =40mm,
- the wheel's rolling circle -  $d_{02}$ =96mm,
- elastic modulus of the rolling ways and balls -  $E=2,3 \times 10^5$ MPa.

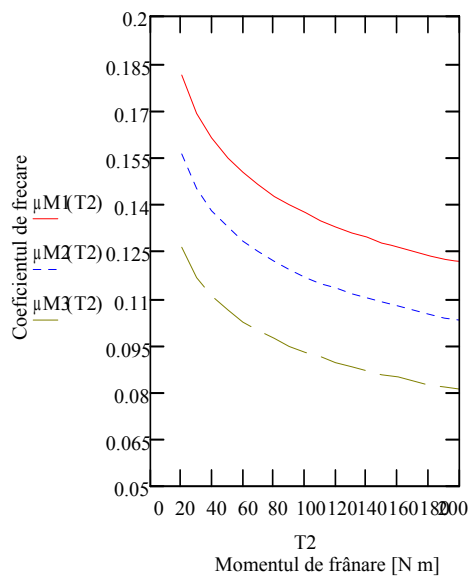
The calculus of efficiency was made with formula (1):

$$\eta = \frac{P_2}{P_1} = \frac{\left( \cos \gamma_0 - \frac{\mu}{\cos \alpha_n} \cdot \sin \gamma_0 \right) \cdot d_2}{\left( \sin \gamma_0 + \frac{\mu}{\cos \alpha_n} \cdot \cos \gamma_0 \right) \cdot d_1 i_{12}} \quad (1)$$

The theoretical calculus of the efficiency with (1) must taking the friction coefficient for the real conditions in which the experimental work passed and contact type in the two situations: rolling contact and sliding contact. Calculus for these conditions was made pursuant to [7], [8], [9] in MathCAD.



**Fig.1**



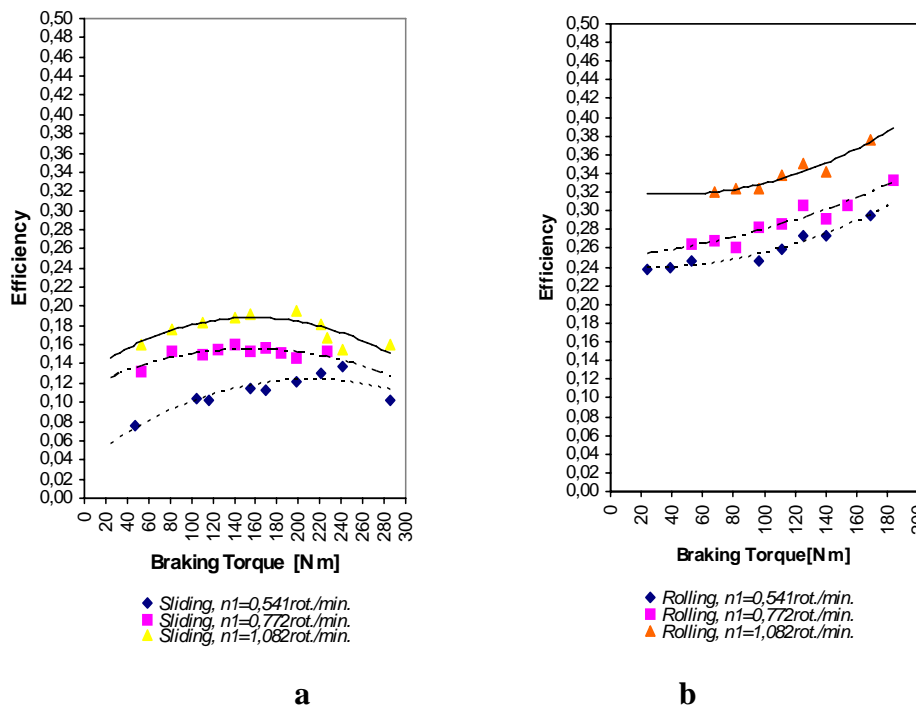
**Fig.2**

The calculated efficiency for the rolling solution, for three revolutions, is presented in figure 1, in concordance with the experimental loaded range.

The friction coefficients variation is presented in figure 2. We can observe that we have a continuous decreasing curve.

### 3. EXPERIMENTAL RESULTS

The experimental results are synthesized in figure 3. Figure 3b presents the variation of the rolling worm gear with load and worm's revolution variation.



**Fig. 3**

We can observe the correspondence between the experimental curve and the theoretical curves, which show efficiency variation for applied load domain. In the experimental case we also obtain the increasing of the efficiency value.

If we analyze figure 3a and figure 3b it's evident that the efficiency values for rolling worm gear is greater. Also, it possible to see that we obtained different variation of the efficiency curves for rolling and sliding gear.

If we compare figures 3 and figure 1, we have the confirmation of the obtained experimental curves tendency. In the both situation is the same tendency for efficiency increasing in correlation with entrance revolution. The tendency it's explicable due a better lubrication conditions at greater rev.

The values low for efficiency is explicable for a little helix angle and low sliding speeds. For such values, we have some examples in [5], [6], [7]. Therewith we have a decreasing for efficiency with decreasing of revolution.

The same tendency we founded at the rolling worm gear in diagram on formula from §2 based.

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