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INVESTIGATION OF TRIBOLOGICAL PROPERTIES OF ENGINEERING PLASTICS IN GEAR TRANSMISSIONS

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Abstract: *A series of engineering plastics have advantageous mechanical properties, which all together recommend them for gear transmissions. However, the tribological behavior of plastics can vary (while sharing the same mechanical properties), a fact highlighted by the tribological testing made on the following materials: PA6 – Mg, PA6 – Na, PA66 GF30, POM – C, PETP – TX (polyamide 6 obtained through Mg catalysis, polyamide 6 obtained through Na catalysis, polyamide 66 armed with glass - fiber, polyacetal – copolymer, polyethylene terephtalate). In this project, PA6 – Mg and PA6 – Na materials are compared.*

Key words: *plastic, gear transmission, tribological testing,, wear.*

1. INTRODUCTION

The properties that make the use of engineering plastics possible in gear transmissions are the following:

- high mechanical strength, hardness, and toughness;
- high impact strength;
- high heat deflection temperature;
- high mechanical damping ability;
- good fatigue strength;
- good sliding properties;

- good chemical resistance.

For the testing of tribological properties, the method called "cylinder on disk" has been used, the relative movement being ensured by a rotative metal disk. The tests have been made on a stand located at the University in Gödöllő.

2. PRESENTATION OF THE STAND AND WORKING METHODS

The stand (see figure 1) is basically composed of the support table 1, the rotative disk 2, the movement mechanism 3, the load application device 4, driving engine of the disk 5, measurement and data stocking unit.

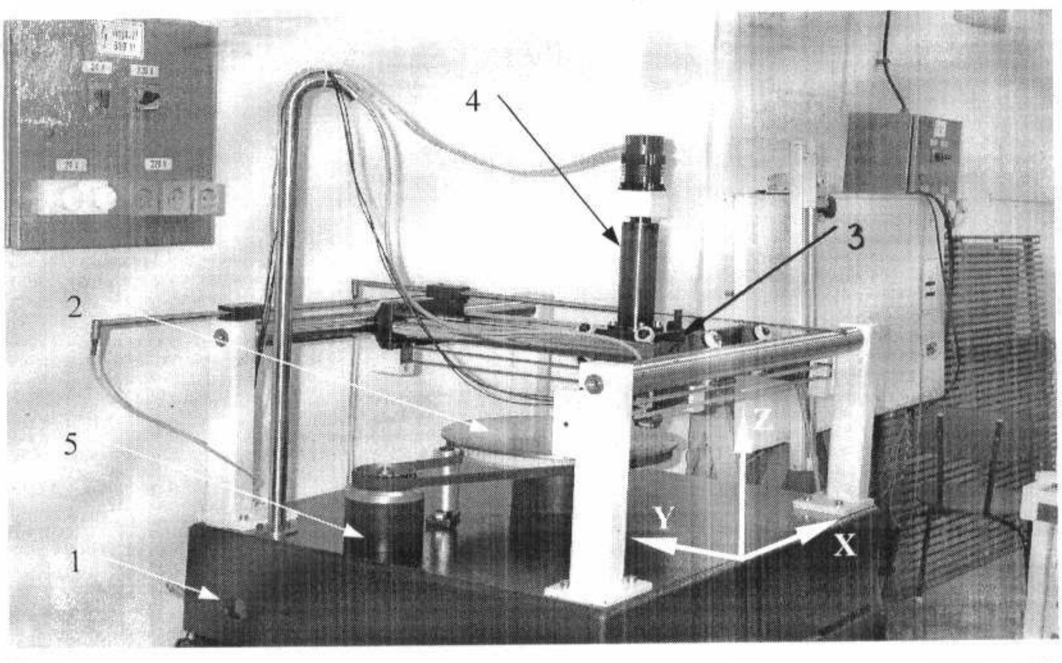

Fig.1. The stand

The plastic cylindrical shaped samples (Ø 8 x 10) (see figure 2) have been put on the surface of the disk, so that the contact to be made behind the generatorix (straight line) (see figure 3). The plastic sample has been fixed in an adequate holding device, located at the extremity of the load application system. By this type of contact (in a straight line) between the rotative disk and the fixed plastic sample, the simulation of sliding, that appears in the case of two gearing sprockets has been tried.

Tests have been effectuated for two different loading sets: $P_1 = 55N$ and $P_2 = 87N$ and for a peripherical speed (in the middle of the generatorix) of 0,25m/s.

The tests for both loading sets lasted 15 minutes.

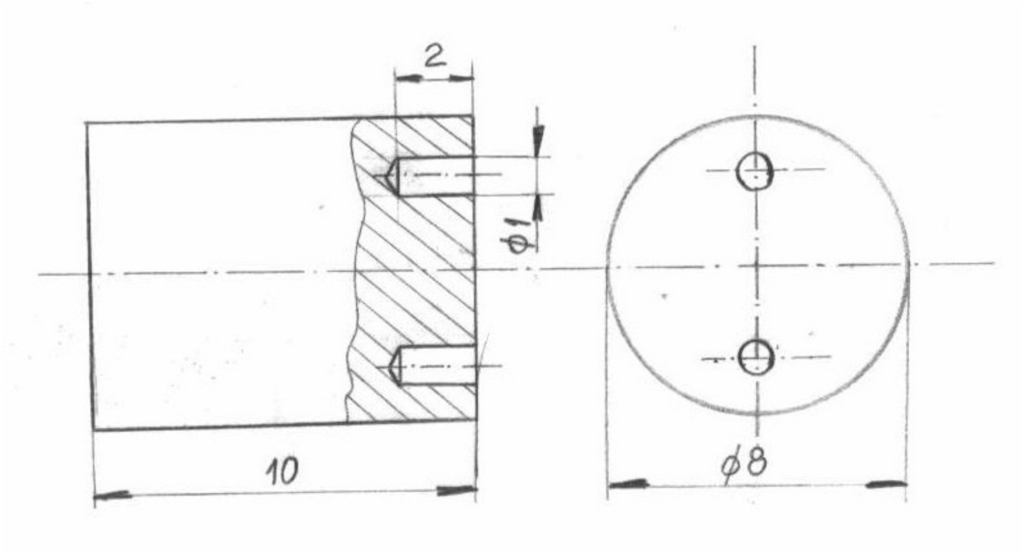

Fig.2. The sample

The load (the contact pressure) and the peripherical speed have been chosen so that the result of the p · v multiplication (contact pressure multiplied by peripherical speed) to be visually possible for the tested materials.

Ruggedness of the rectified rotative disk has the following values presented in table 1.

Table 1. Superficial ruggedness of the disk

Ruggedness	**Ra (µm)**	**Rz (µm)**
Parallel to the rectification direction	0,05……0,1	0,31……0,93
Perpendicular on the rectification direction	0,07……0,15	0,48……1,18

During testing, the Fx, Fy, Fz forces have been measured. These forces operate on the plastic sample (with dynamic tensometer stamps) and with their help the friction coefficient has been calculated by the following method:

$$F_f = \sqrt{F_x^2 + F_y^2} \quad (1)$$

$$F_N = F_z \tag{2}$$

$$\mu = \frac{F_f}{F_N} = \frac{\sqrt{F_x^2 + F_y^2}}{F_z} \tag{3}$$

It has also been measured the wear of the plastic sample (with a measuring device without contact) and the temperature in the friction area.

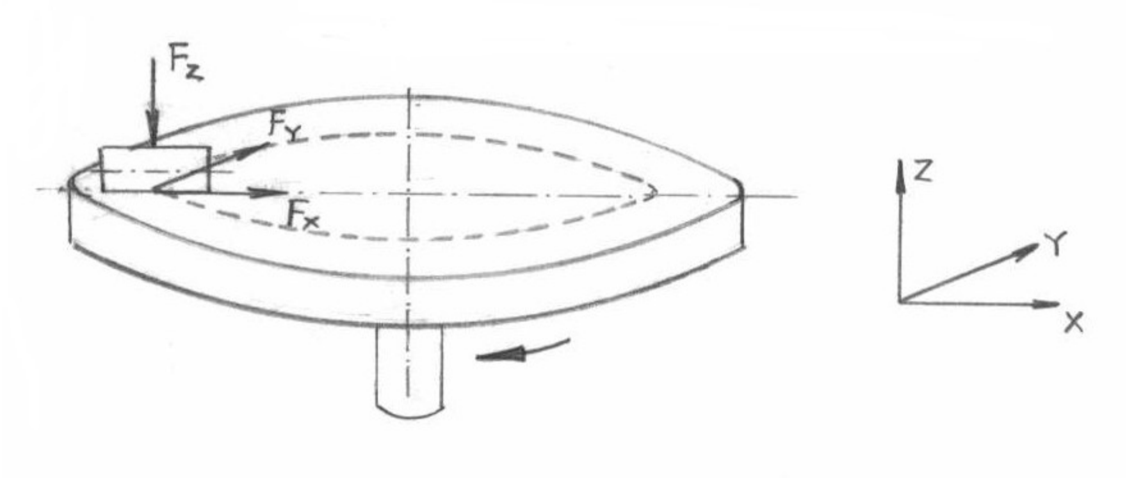

Fig.3. Cylinder on plate contact – forces measuring

3. THE FINAL RESULTS

Below are presented the variation diagrams of friction, wear, and temperature coefficients in the contact area, for POM-C and PA 66 – GF 30 materials.

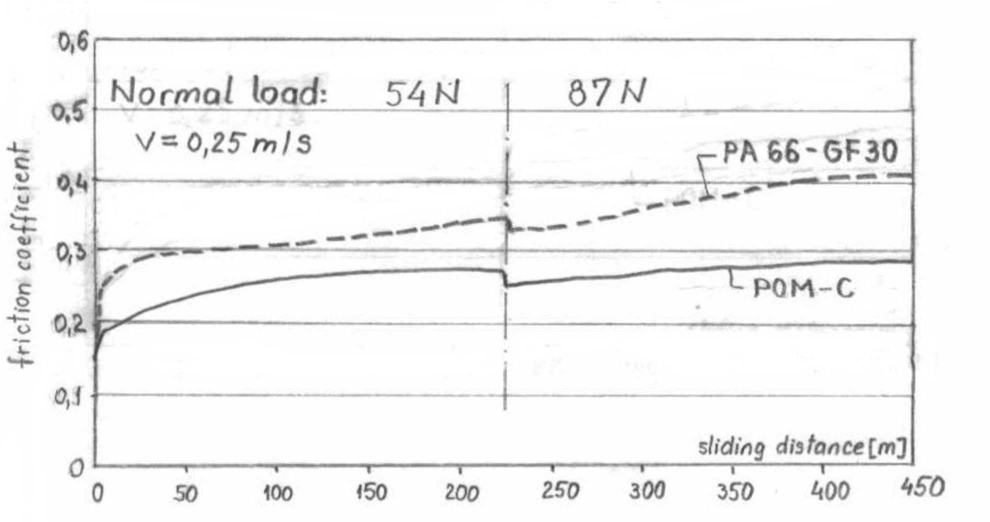

Fig.4. Friction coefficient in the function of sliding distance

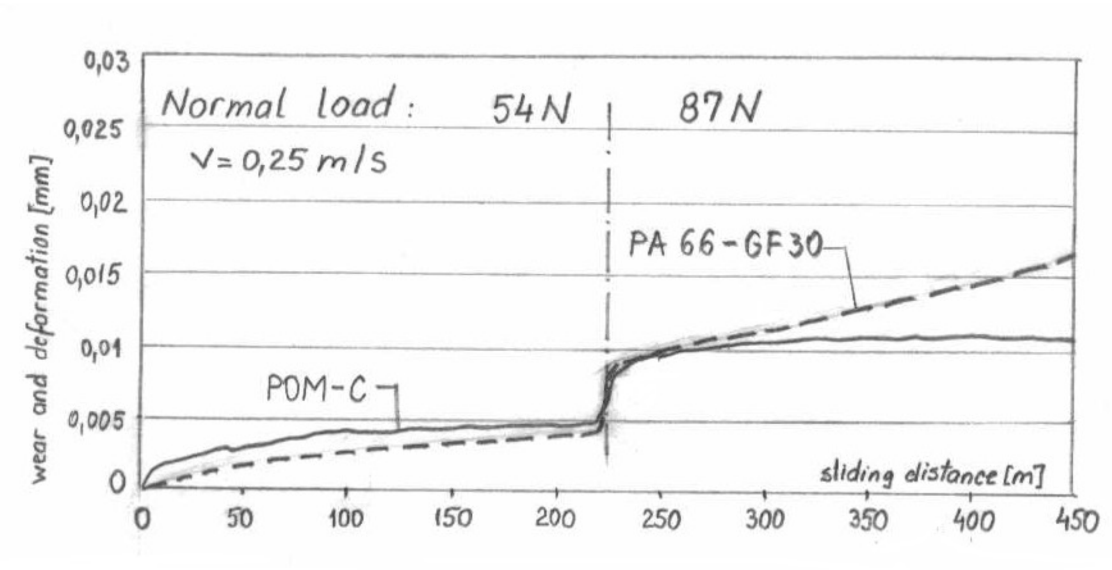

Fig. 5. Wear and deformation in the function of sliding distance

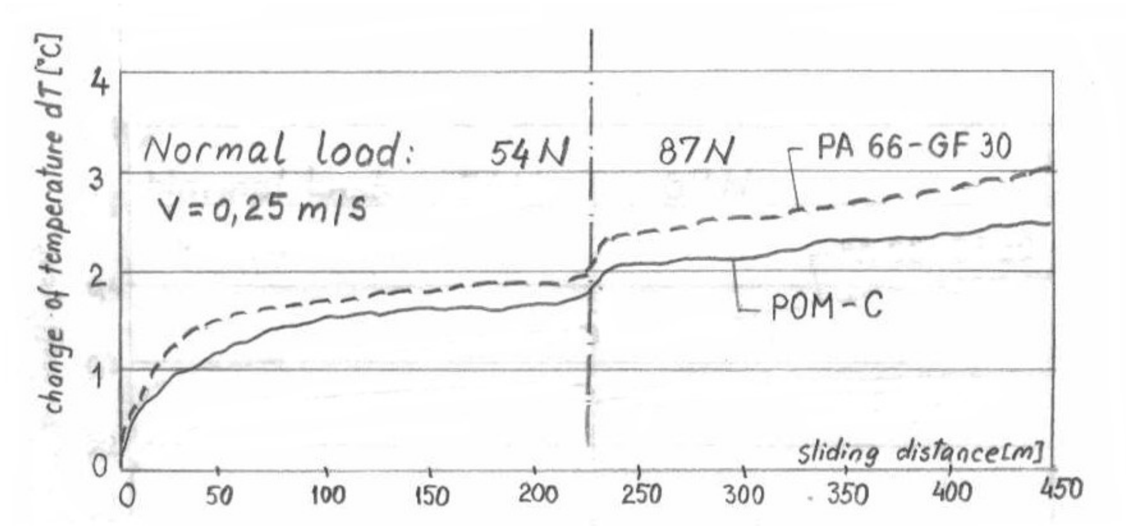

Fig. 6. Change of temperature in the function of sliding distance

4. CONCLUSIONS

- ✓ In adhesive systems the PA 66 – GF 30 natural material against steel surface (Ra = 0,08 ÷ 0,14 μm), V = 0,25 m/s showed 0,25 ÷ 0,42 friction values. The POM-C natural material performed lower values: 0,18 ÷ 0,28.

- ✓ At lower load condition, there is no significant difference in wear between the PA 66 – GF 30 natural and POM - C natural materials. At higher load, the wear of PA 66 – GF 30 increases significantly.
- ✓ At lower load, the PA 66 – GF 30 alternative is preferable (it is cheaper), while at higher load, the POM - C alternative is more advantageous.
- ✓ As far as the friction temperature is concerned, there is no significant difference between the two types of materials (The change of temperature for PA 66 – GF 30 is higher).

5. FURTHER RESEARCH

Beside the comparative research on the tribological behaviour of the 5 types of plastics presented in the introductory part of the project, we suggest the measuring of forces and wear that appear in the case of real gearing of cylindrical sprocket wheels having straight sprockets (one of the sprocket wheels being made of steel and the other one being made of plastic).

6. REFFERENCES

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