# Frictional study of the polyamide/rubber contact materials

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**Abstract.** The actually researches focused on finding technical solutions with ecologically friendly impact on the environment are include new materials which are characterised by low energy consumptions (loses) during their manufacturing process and their usage. One class of materials characterised by these energy loses conditions is represented by the polyamides. The study regarding the frictional loses of the polyamides being in mobile contacts with steel made spare parts show that they have a good tribological behaviour. The applications domains (mechanical transmissions, tap armatures, food industry, medicine) and the lack of the studies, gives the opportunity of the research in the field of the frictional behaviour of the polyamide/rubber mobile contacts. The paper presents tests regarding the frictional behaviour of the PA46 and PTFE added PA46 polyamide/rubber contacts under different loadings and relative speeds. The tests are performed on a tribometer equipped with a pin-on-disc module. Finally there are highlighted important conclusions regarding the applications and working conditions where the polyamide/rubber couple of materials may be used, in order to get small frictional energy loses.

## 1. Introduction

Actually solutions regarding the design of spare parts used in wide areas as engineering, medicine, entertainment industry, food and agriculture industry, include materials characterised by low energy consumptions and ecological impact with the environment while they are produced or used. The research of these materials is split, according to the materials typology, in two huge categories: research on metallic materials (steel alloys) and research non-metallic materials (plastics, rubbers, woods etc).

In the field of plastic materials characterised by ecological impact with the environment during their usage and production, the research follow mainly the area of polyamides. These materials, characterised by eco-friendly interactions with the environment during their manufacturing process, are used in combination with metallic made spare elements (in gear or chain drive transmissions, in mechanical transmissions with applications in medicine or food industry where the lubrication is not allowed [1, 2, 3]) or with non-metallic spare elements (polyamides or rubber) in the construction of mechanical transmissions (made from polyamides), in the construction of elastic couplings with rubber made elastic elements (figure 1 [4, 5]) or in polyamide made tap armatures which contain rubber made sealing devices (figure 2 [6]).

One of the criteria which are considered in order to claim that a material is an eco-friendly one, is referring to the energy loses caused by the frictional properties of it. Currently researches are focused on the direction of studying the frictional behaviour of materials; the aim is to find out materials or materials combinations with good frictional properties which assure small energy loses during their usage in combination with other materials.

a)

b)

**Figure 1.** Polyamide made couplings [4, 5].

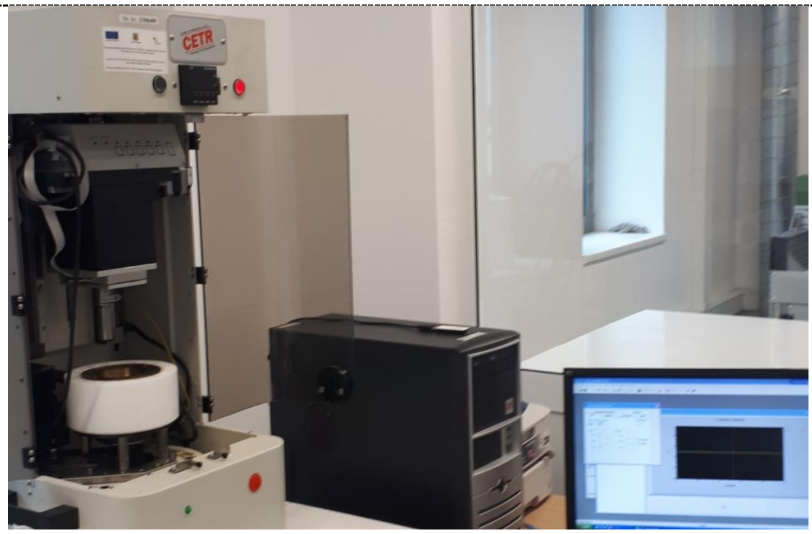
The tribological researches of the polyamides show that these materials are characterised by small frictions in combination with other polyamides or with steel made elements, reduced wear and small variations of their properties with the increasing of the temperature [1, 2, 3, 7, 8, 9, 10].

**Figure 2.** Polyamide tap armature [6].

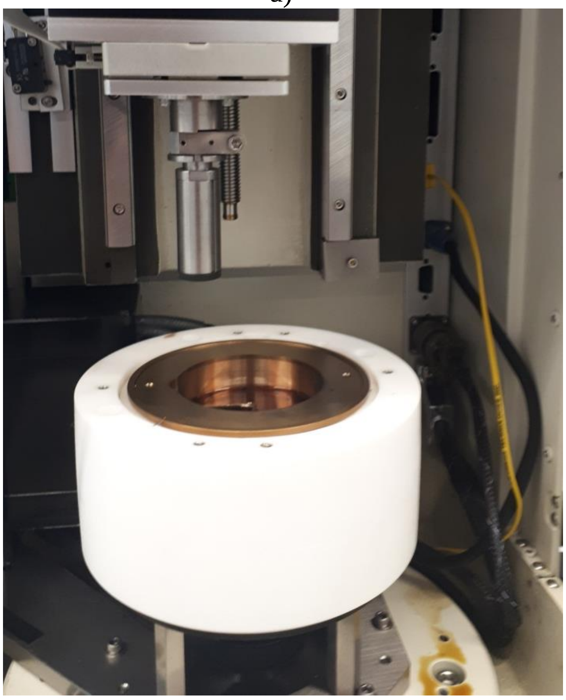
One of the studies regarding the frictional properties of the rubbers is referring on dry conditions for rubber-made elements being in contact with steel parts [11]. Depending on the amount of the carbon black content of the EPDM rubbers there are performed pin-on-plate and roller-on-plate tests (steel-made pin and roller and rubber-made plate) under different test conditions. The conclusion is that the tribological properties of the rubbers are optimised with the increasing of the amount of the carbon black. The friction and wear properties of the rubber elements in contact with surfaces with different roughness's are studied in [12]. According to the literature, the rubbers friction has two components: the adhesive type friction and the hysteresis type friction.

The specific literature is weak in studies regarding the frictional behavior of polyamide on rubber type materials; due to the existence in techniques of the mechanical contacts between polyamide and rubber made elements (mechanical couplings, tap armatures etc) it is necessary to make studies regarding the friction of these technical solutions. According to this, the paper presents the frictional behavior of the polyamide/rubber made parts contacts under different loadings and speeds.

## 2. The tests




a)



b)

**Figure 3.** The tribometer with the pin-on-disc module.

The friction tests are performed on an UMT tribometer – figure 3 – equipped with a pin-on disc module which allows tribological tests with variable input parameters as: the normal force, the rotational speed of the disk, the temperature of the oil bath. The variation of the normal force and of the oil bath's temperature may be described continuously, under different variation curves. The values of the rotational speed may be set-up for discrete values.

The tests are performed for two type of materials being in contact: a rubber plate in contact with a P46 polyamide disk and a rubber plate in contact with a PTFE added PA46 polyamide disk (figure 4). The test parameters are represented by: a set of rotational speeds equal with: 500 rpm, 1000 rpm, 2000 rpm and 3000 rpm; the normal equal with:1 N ... 5 N. Each test is performed at the room temperature of 22 ºC and has the duration equal with 10 minutes.

a) b)

**Figure 4.** The polyamide disks in contact with the rubber plate.

## 3. Results and conclusions

The results present the variation of the friction coefficient with the rotational speed of the disk and with the normal force.

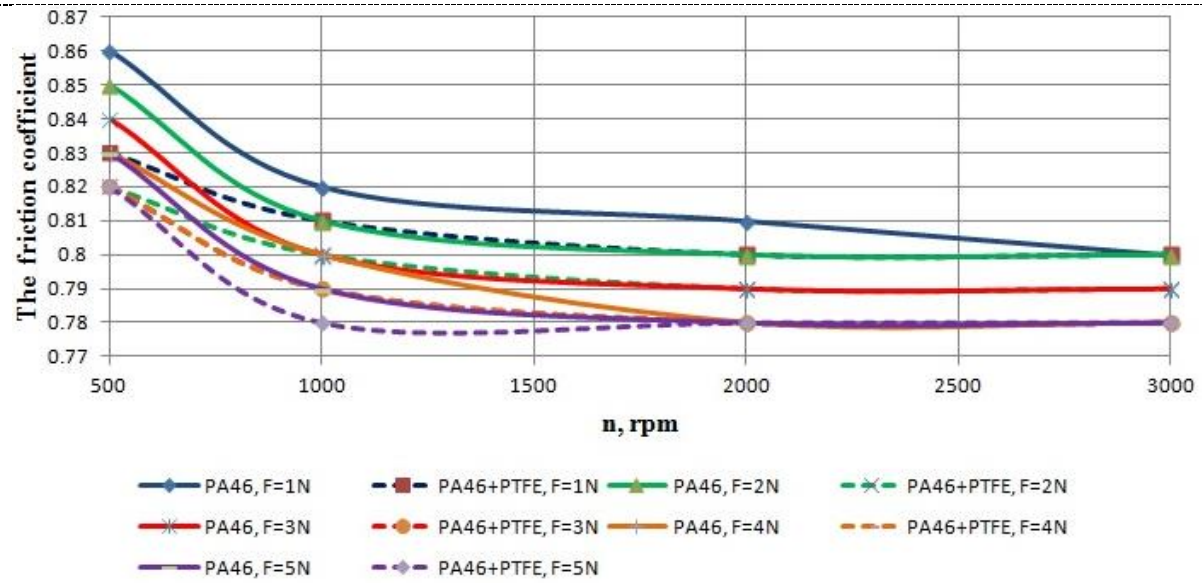



**Figure 5.** The variation of the friction coefficient with the speed, in the case rubber/PA46 and rubber/PTFE added PA46.

Figure 5 shows the variation of the friction coefficient with the rotational speed for different values of the normal force. The friction coefficient decreases with the increasing of the speed and has smaller values in the case of the contact between the rubber and the PTFE added PA44 polyamide than the contact between the rubber and the PA44 polyamide. After a speed of 2000 rpm, the value of the friction coefficient is stabilised and there are no differences between the rubber/PA46 and the rubber/PTFE added PA46 polyamides.

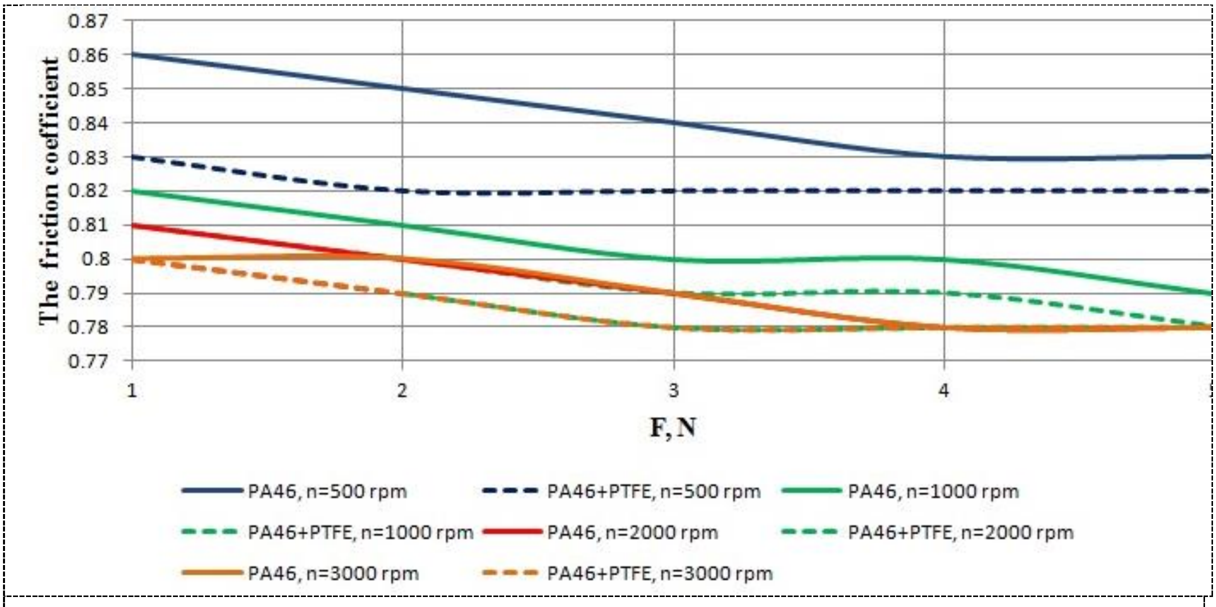



**Figure 6.** The variation of the friction coefficient with the normal force, in the case rubber/PA46 and rubber/PTFE added PA46.

Figure 6 presents the variation of the friction coefficient with the normal force for different values of the speed. The friction coefficient decreases with the increasing of the normal force and has smaller values in the case of the contact between the rubber and the PTFE added PA44 polyamide than the contact between the rubber and the PA44 polyamide. At high normal forces, the value of the friction coefficient is stabilised and there are small differences between the rubber/PA46 and the rubber/PTFE added PA46 polyamides.

The variation of the friction coefficient at small speeds and small forces can be explained due to the adhesive and hysteresis friction which is characterising the friction in rubber. For small speeds, the adhesive friction has a big influence in the amount of the friction coefficient.

In conclusion, the friction coefficient decreases with the increasing of the speed and of the normal force. In all the cases the friction coefficient has smaller values in the case of the contact between the rubber and the PTFE added PA44 polyamide than the contact between the rubber and the PA44 polyamide; smaller differences are noticed at high speeds and normal forces (where the adhesive friction in the rubber has a smaller influence on the total amount of the friction coefficient). According to these, it is suitable to use PTFE added PA46 polyamides in contact with rubber elements instead of PA46 polyamide at small speeds and normal forces.

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