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THE ABRASIVE RESISTANCE OF A KIND SELF-LUBRICATED NYLONS MEASURED BY SCRATCH TESTER

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Abstract

The abrasive resistance of self-lubricated cast nylon like and other materials can be measured by scratch tester. On this instrument the simulation of linear moving of abrasive particles can be obtained by drawing a tungsten carbide or diamond stylus across the specimen surface under constant or increasing normal load.
The results of the experimental investigation of the abrasive resistance of a group self-lubricated cast nylon are presented in this paper

Key words: *Self lubricated cast nylon, scratch test, abrasive resistance*

1.INTRODUCTION

The various self-lubricating industrial plastics grades are available for unlubricated moving parts application include linear plain bearing, gears, pulleys, rollers, guides etc. This engineering plastics are a serious material for many engineering solution in which wear resistance and abrasive resistance of moving parts and low friction in contact zone are very important. Engineers are well informed about the traditional materials but they are often misinformed about the potential thermo plastics.
In order to compete in today's very competitive environment manufacturers must produce products with maintain good margins and low cost. For these reasons the use of thermoplastics to replace metal and other materials is becoming a key strategy in many industries.
Self lubricated nylon (extruded or cast) has excellent tensile and compressive strength, good wear properties and is excellent electrical insulator. It can be modified to improve any individual property as reduce coefficient of friction, operating temperature, impact strength and other.
For many machine elements abrasive resistance is very important because in the real contact condition abrasive wear is very often present.
The determination of abrasive wear resistance of a kind self lubricated cast nylon by scratch tester is shown in this paper.

2. TRIBOLOGICL PROPERTIES OF SELF LUBRICATED THERMOPLASTICS

There are many kind of self lubricated industrial thermoplastics on today's market. Their tribological properties are determinate by friction coefficient and wear intensity and depend of chemical composition, method of produce (extrude or cast for instance), applied modification (different type of additives and other) and contact condition.
The survey of prospects of a few bigger self lubricated thermoplastics producers show that friction coefficient can be from 0.05 to 0.3 usually in depend of kind of the base materials and applied modification.
For instance Nylacast company gives the next data about friction coefficient and wear intensity (Figure 1)

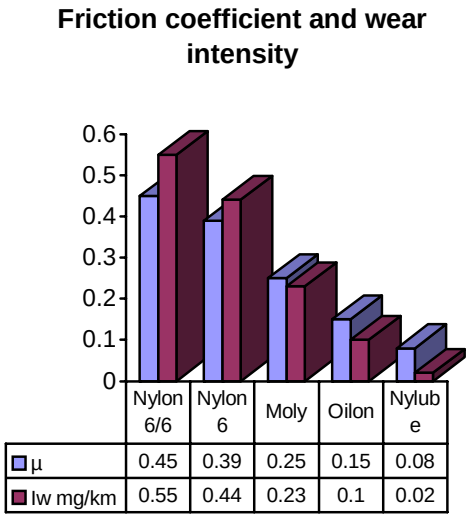


Figure.1: *The example of tribological performavce (2)*

The influence of manufacturing process (extruded nylon6/6) and (cast nylon 6) on tribology properties is about 20%

The influence of modified (different additives) can be much bigger (Nylon6/6 and Nylube). than influence of kind of manufacturing process.

Quadrant Engineering Plastic Products, one of leader in engineering plastics for machining gives in his prospects a lot of data about wear resistance and dynamic coefficient of friction which are got in their laboratories during tests of different kind of self lubricated plastics.

In Figure 2 is shown wear resistance of a group their industrial plastics which are self lubricated on temperature from 150 ^{o}C to 350^{o}C (continually service, 20 000 h)

Wear resistance and coefficient of friction are measured on a ”plastics pin on rotating steel disk” (pressure 3MPa, velocity 0,33 m/s, normal environment temperature 23^{o}C, unlubricated, total distance 28 km.)

In Figure 3 is shown dinamic coefficient of friction for the same group materials.

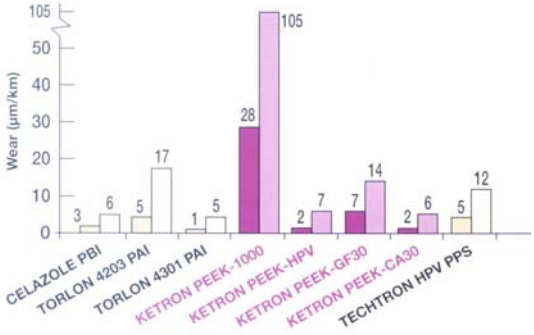


Figure 2: *Wear resistance (3)*

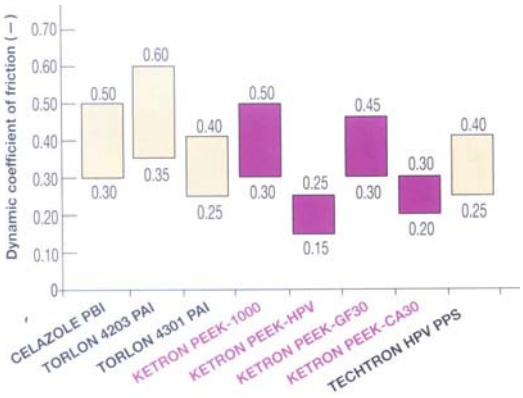


Figure 3: *Coefficient of friction (3)*

3. SCRATCH TEST AS A MEASURE OF ABRASIVE WEAR RESISTANCE OF SOLID MATERIALS

The Scratch Test basically consists of simulating the sliding (motion) of the tips of asperities of the hard body over the surface (through the contact layer) of the body of a lower hardness, in presence of variable external load, which varies from a certain minimum to a certain maximum values.

As it is known, surfaces of solid bodies (elements of the tribomechanical systems) are rough with asperities whose size, shape and mutual distances depend on type of machining which was used in their forming. The contact between the two solid bodies is always of a discrete nature (Figure 1. a). Radius of the asperities tips is, usually, very small, and it ranges, most frequently, around 0.1 to 0.3 mm. In Figure 1. b is presented a tip of a cone

made of the hard metal or diamond (used for measuring hardness according to the Rockwell method), which simulates the tip of a single asperity on the surface of the higher hardness body (Figure 4).

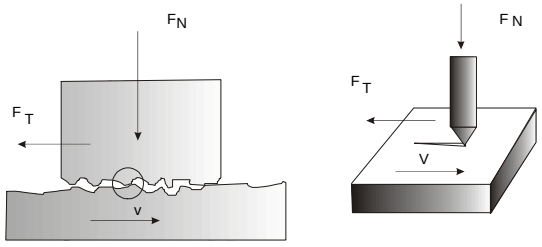


Figure 4: *Scratch test simulation of real contact of two solid bodies*

As it is known abrasive wear mechanism in contact zone of two solid elements participate with 60% in total wear mechanisms It means that it is very important to know magnitude of abrasive resistance for self lubricated materials not only wear resistance which we can get on Pin on Disk tribometer.

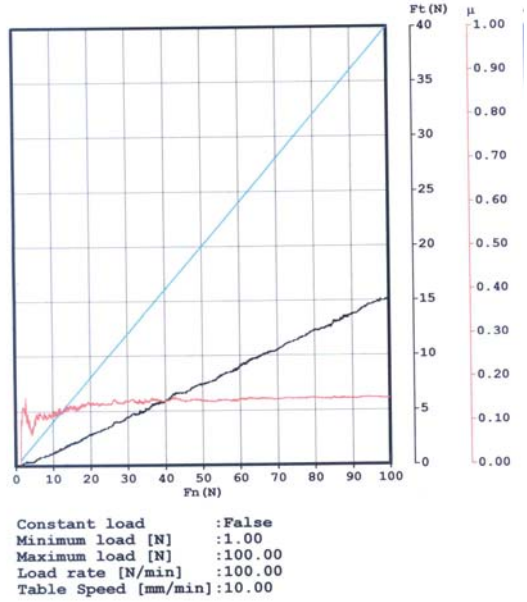
The results presented in Fig.5 show the typical experimental functions $F_T = f(F_N)$ and $\mu=f(F_N)$ which are got during scratch test of a group of self lubricated industrial plastics,

The friction force in this tests represented the deformation component of total friction force mainly. Scratch track on the sample contact surface has the same shape as the abrasive wear track on contact surface of machine elements in real condition.

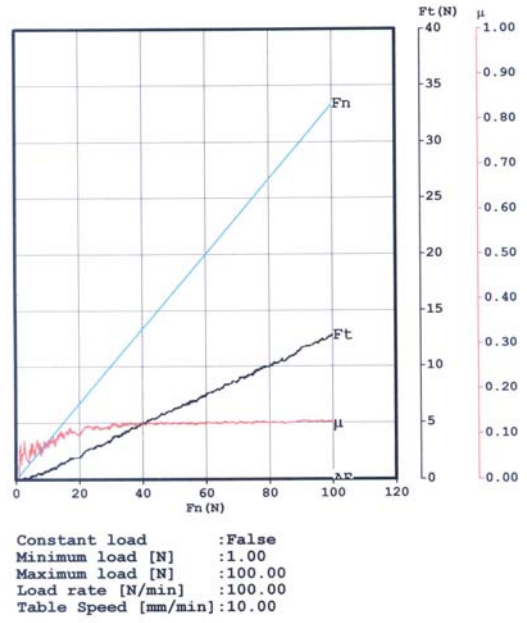
The analyse of friction force function show that there is constant relation between normal load and friction force during the most part of test. In the start only, friction coefficient grow with increase normal load until approximately 20 N. After that coefficient of friction is constant.

The magnitude of friction force and friction coefficient depend of self lubricated plastic composition and of the applied manufacturing process.

The very interesting observation was during tests of plastic's sample that there is no appearance of critical normal load as like in scratch tests of coatings and metal's samples. This may be means that there is no destroy contact layer during progressive scratch test of self lubricated samples but only its plastic deformation. For instance, the magnitude of critical normal load is about 50 -70 n for metals and coatings.



a. Self lubricated plastic E, Stylus TC r=0,2 mm



b. Self lubricated sample K, Stylus TC r=0,2 mm

Figure 5: *The examples of scratch tests*

The differences of magnitude of tangential forces (friction forces) and friction coefficients in scratch

testes with different self lubricated samples were between 5 to 20%.
The magnitude depth of scratch track (abrasive wear track) are measured on Talysurf instrument in Laboratory for metal cutting and tribology , Mechanical Engineering Faculty, Kragujevac.
The results presented in Fig 6 show typical form and magnitude depth of scratch track that are realized during test of a group self lubricated materials.

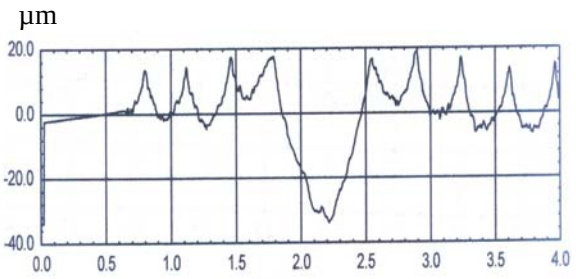


Figure 6: *Depth of scratch track on sample F*

In depend of self lubricated composition and kind of manufacturing process used for sample produced depths of scratch tracks were different. It is the second parameter which show abrasive resistance of samples.
The Figure 7 is shown experimental data of depth of scratch tracks for a group of self lubricated plastics

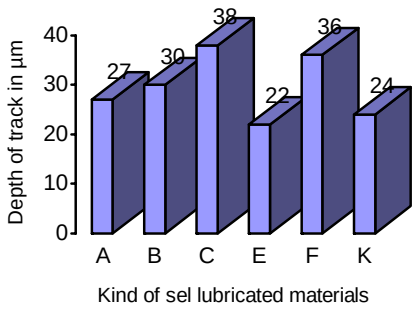


Figure 7: *Depths of scratch tracks*

Experimental tests were realized on Scratch tester ST-99 under the next condition:
Normal load: 1-100 N (progressive)
Load rate: 100 N/min
Table speed: 10 mm/min
Stylus: TC, r = 0,2mm
The differences of depth of tracks are bigger than differences of friction forces to refer to coefficient of friction.

4. CONCLUSION

The portfolio of engineering materials, particular of engineering plastics, for machining grew from performance over many years. It is consequence of industry's need for lighter materials that outlast metals in machined bearing and other tribological components
Today we have many kind of self lubricated industrial plastics with very high mechanical, thermal, electrical and tribological performances.
In depend of composition these materials can have very good stability, wear and chemical resistance at extrem contact condition as for instance at temperatures over 200^{o}C.
In standard test of self lubricated industrial plastics Pin on Disk tribometer is used. Through Scratch test made attempt to determinate abrasive resistance of a group these materials. The results of experimental tests are shown that analyze of friction force and scratch track can gives add information about tribological properties self lubricated plastics.

6. REFERECES

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