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## A NEW CONCEPT OF THE UNIVERSAL TRIBOMETER

Branko Ivkovic<sup>1</sup>, Nenad Marjanovic<sup>2</sup>, Miroslav Ravlic<sup>3</sup>

<sup>1</sup>Serbian Tribology Society, Serbia, ivkovic@kg.ac.rs

<sup>2</sup>Mechanical Engineering Faculty, Serbia, nesam@kg.ac.rs

<sup>3</sup>PRIZMA Kragujevac, Serbia, miroslav.ravlic@prizma.co

**Abstract:** *The development of new materials, coatings and lubricants is accompanied by all kinds of tribology tests. As it is known, tribology research is realized on tribometers Pin on Disk, Block on Disk (Ring), Disk on Disk and Linear reciprocating motion.*

*There are no many laboratories (University or Institute) equipped by all kinds of tribometers. In the last few years the universal tribometer is developed in collaboration of Serbian Tribology Society and company PRIZMA Kragujevac. In this paper are presented the basic information about the universal tribometer UT-07 together with a few experimental results.*

**Key words:** *Tribometer, Tribology, Lubricant*

### 1. INTRODUCTION

In the process of development of the new materials, coatings and lubricants, as well as in control of this type of products, it is necessary to conduct the tribological tests, from the aspects of friction and wear. For performing the tribological tests in laboratories are used tribometers of different kinds. There are several kinds of contemporary tribometers, but in laboratories in institutes, development sectors of larger factories and universities' laboratories, the most frequently present are tribometers Pin-on-Disc, Block-on-Disc, Disc-on-Disc and tribometer in which is realized linear reciprocating motion.

In tribological tests, which are conducted on tribometers of the Pin-on-Disc type the contact is, most frequently, realized at a point, though it is possible to realize contacts over the area or along the line.

On tribometers Block-on-Disc (Ring) the contact is usually realized along the line, but the other contact geometry is also possible (over the area or at a point).

The contact on tribometers for linear reciprocating motion is being realized by application of all the three types of contact geometries (point, line, area).

In tribometers of those three types, the sliding friction is realized in the contact zones during tests, with or without lubrication. As it is known, the lubricant is, as a rule, the third element of the tribomechanical systems of all kinds.

For tribological investigations in conditions where simultaneously in the contact zone appear both sliding and rolling friction, one applies the tribometers Disc-on-disc. The sliding and rolling frictions occur when the contact is realized between the two discs that have different diameters and rotate with the same number of rpm or they have the same diameters but they rotate with different numbers of rpm.

The tribological investigations in conditions in which in the contact zone appear both sliding and rolling friction are very important for development of materials and lubricants that are used for manufacturing the gears and lubricating the gear pairs.

Within collaboration of the Serbian Tribological Society and the PRIZMA company from Kragujevac in the last few years was designed a kind of a universal tribometer on which it is possible to perform the tribological investigations that are usually performed on all the four kinds of tribometers and that are most frequently used in practice.

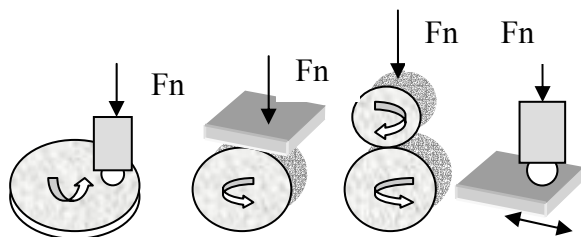
Considering the necessity for high loads (pressure) and large peripheral speeds in investigations in which the sliding and rolling frictions occur, the basis of the new tribometer is the Disc-on-Disc tribometer. By building-in additional couple of elements, the tribological tests can be performed on this tribometer, which are otherwise performed on the Pin-on-Disc and Block-on-Disc tribometers and others.

In this paper is shown the basic concept of the designed universal tribometer with several results of tribological investigations on configurations Disc-on-Disc and Block-on-Disc.

## 2. BASIC STRUCTURE OF THE UNIVERSAL TRIBOMETER UT-07

Design of the universal tribometers was done with intention to realize four kinds of contacts in conditions that are most frequently used in tribological investigations. The conditions under which the tribological investigations are determined by:

- the contact geometry (point, line, area)
- type of motion (rotation, linear reciprocating)
- maximal sliding speed
- maximal normal load.



**Figure 1.** Kinds of contact that are the most frequently used in tribological investigations

Depending on the shape of the pin or block it is possible to realize the contact over the area. This possibility is not so frequently used in tribological investigations.

On tribometer Disc-on-Disc it is possible to realize the contact where appear rolling, simultaneously sliding and rolling and rolling.

In other kinds of tribometers the contact is realized in conditions where only appears sliding.

Considering the contemporary possibilities (using the Dc and servomotors) sliding speeds and external loads can continuously be varied from zero to the selected maximum value.

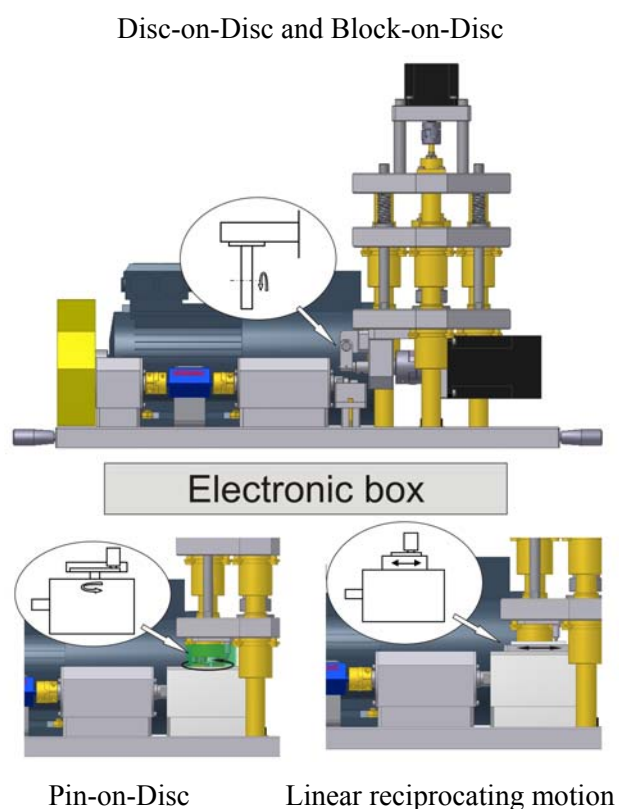
The maximum sliding speed usually is not larger than 5 m/s and maximal normal force does not ever have to be larger than 4000N.

In Figure 2 is shown the basic structure of the universal tribometer UT-07 modeled in the program AutoDesk Inventor CAD software.

## 3. TRIBOMETER UT-07ES

Depending on the planned programs of investigations the basic exploitation characteristics of the universal tribometer are determined, as well as its dimensions and the power of the motor.

The tribometer UT-07ES that was designed and manufactured in collaboration of the Serbian Tribological Society and the PRIZMA Company from Kragujevac, for the TEKHNIKER Institute, Spain, enables realization Disc-on-Disc and Block-on-Disc tests with or without lubrication



**Figure 2.** The structure of the universal tribometer UT-07

The UT-07ES tribometer consists of three motors (AC motor, Servomotor and Step motor) with the basic Disc-on-Disc configuration, module Block-on-Disc, Lubrication System, System for obtaining the normal load, Torque Rotary Transducer and Temperature Measurement System.

The UT-07ES tribometer has modern design, contemporary electronic devices and very useful Measurement Software for Windows application. The main elements of this tribology machine are made of steel and Al alloys.

The key features	
Speed Range for both Disks	0 – 4000 rpm
Sliding rate	0 – 100%
Torque Tmax	10 Nm
Load range	0 - 4000N
Contact pressure	0 – 3000
MPa	
Disks diameters	10 – 50 mm
Servo motor	1,5 kW
AC motor	3,0 kW
Step motor	3,0 Nm

Software (Windows applicable) gives the following possibilities:

- Selection of Lower and Upper Disk diameters in mm
- Contact width in mm
- Normal Load in N
- Selection of speeds (rpm) for both Disks
- Contact duration (in s)

During test the next variables are monitored on the screen:

- Normal load
- Friction force
- Friction coefficient
- Torque
- Contact pressure
- Wear (during the long test)
- Temperature of Contact zone
- Temperature of oil contact layer (Block-on-Disc test)
- Temperature of lubricant in the bath

The maximal pressure in the contact zone in realization of the Disc-on-Disc tests should not be higher than 3000 Mpa. Investigations with the intended pressure in the contact zone can be realized with the higher or lower normal loads by changing the width and diameters of Disks.

In Figure 3 and 4 are shown photographs of the UT-07ES tribometer and the PC screen where the conditions of tests are recorded as well as the measurements results are monitored.

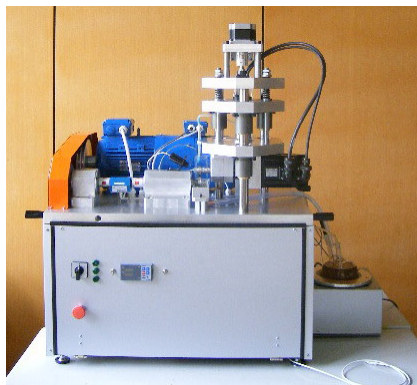


Figure 3. The UT-07ES tribometer



Figure 4. Appearance of the PC screen

All data on the screen can be printed except for the contact pressure, torque and wear.

In Figure 5 is shown the typical appearance of the investigation results obtained in the Disc-on-Disc tests.

Experimental results

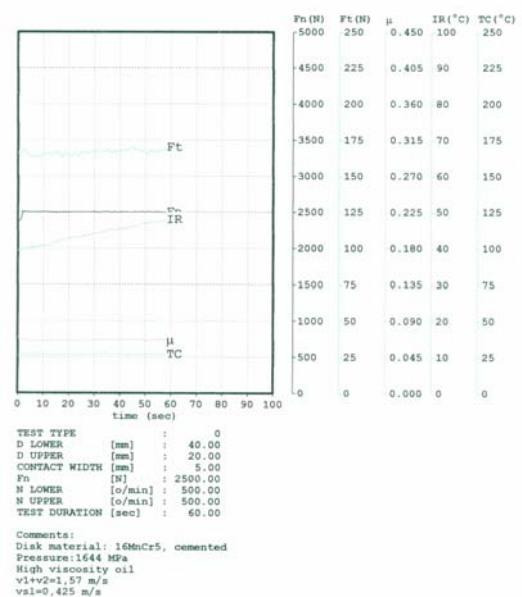


Figure 5. Example of results obtained in the Disc-on-Disc test.

UT-07ES - Experimental results

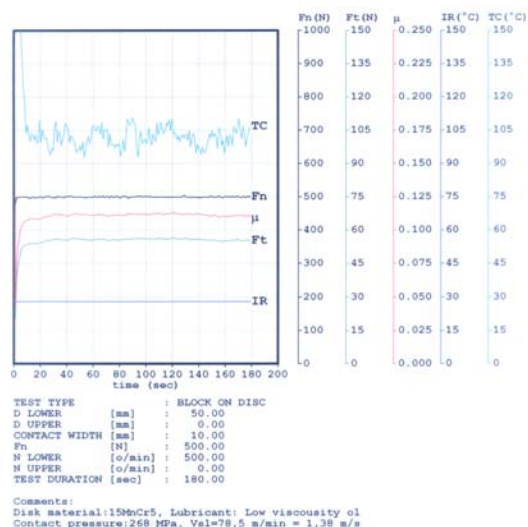


Figure 6. Example of results obtained in the Block-on-Disc test.

In Figure 6 is shown the example of the investigation results obtained in the Block-on-Disc tests.

#### 4. CONCLUSION

The universal UT-07 tribometer enables tribological investigations by performing the experiments in all the four kinds of contact and in conditions that are characterized by the wide ranges of variation of loads and sliding speeds.

The basic configuration was designed for realization of the Disc-on-Disc contact with possibility of continuous variation of the sliding to rolling friction ratio. For realization of other kinds of contacts, the additional elements are designed.

Investigations of tribological characteristics of materials, lubricants and coatings can be performed with or without lubricant. The lubrication system with oils enables circular lubrication or lubrication by dipping of the lower portion of the disc into the oil bath.

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