# DYNAMIC TEST SPECIFICATIONS FOR DIAGNOSTIC AND CONTROL OF PARAMETERS IN TRIBO SYSTEMS

مواصفات الاختبار الديناميكي لتشخيص وضبط العوامل الداخلية في انظمة الاحتكاك

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**ملخص البحث**

تهتم هذه الدراسة بتقديم طرق التحكم في معايير الأمان وفي نفس الوقت طريقة التشخيص المعتدة لنظام الاحتكاك [illegible] وتحديد المعايير بواسطة وثائق إدارة فرع الولاية القياسي والحدود المسموح بها حيث تحدد نوعيتها ومدى الاعتماد [illegible] الخيار الأفضل لعناصر نظام الاحتكاك ويعتبر من غير المقنع بدون معلومات عن عوامل الاحتكاك وعملية [illegible] النظام في كل مرحله من إجراء التحليل و البحث في منطقة الاحتكاك. لهذا تم البدء لخلق نظام احتكاك مع معايير [illegible] نضديه مع البحث عن المعلومات ذات المصادر الموثوقه والتي تم فحصها.

**Abstract:**

In this study the control methods of the reliability parameters as well as a complex diagnostic device of tribo system will be intrudes. The parameters are regulated by the states and standards managing documents and standards of the enterprises. Its reliability and ability determine the optimum choice of tribo system elements. It is inconceivable without information about the processes of friction and wears proceeding (technical Tribo) in time at each stage for analyzing and investigating the processes of the friction zone. Therefore, creation of tribo system with test bench parameters begins with search for the information, which is the authentic source, are the tests.

**Keywords:** reliability parameters, Tribo system, friction, Wear processes, diagnostic.

## Introduction:

The modern theory allows choosing laboratory methods and the test bench for [illegible] Tribo-conjugate. Therefore, the physical model should provide similarity of [illegible] processes of the investigated [illegible] [1, 2]. The methods of transferring laboratory results are developed and the [illegible] of materials on friction joins [illegible].

However, there are little studies reported [illegible] the dynamic loaded conditions of [illegible] surfaces of the wear processes in [illegible] system. The character of loading influences in the contact zone is affected by the intensity and destruction mechanism.

For analyzing and investigating the processes of the friction zone, it is necessary to have the information about the technical Tribo (wear process and friction force) and Electra-physical (contact electrical resistance, Tribo electrical motive force, acoustic issue etc.) parameters. The time scale processes realization of the self-organizing and adaptive Tribo system can vary from seconds till hours [1, 3].

## Automatic dynamic loaded Tribo-System:

The automatic complex dynamic loaded [illegible] (ACDT) consists of the [illegible] friction machine, personal computer and interface which allow realizing the real time of multi-parameters of the control and program management by

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loading, speed and temperature[4,5]. Continuously and parallel measurement of parameters which inter in the friction moment,Tribo-emf, contact electro-resistance, temperature etc. are carried out. Methodical and program-algorithmic maintenance of ACDT contains standard methods of tests and also original methods of Tribo-diagnostic methods of stochastic processes and identification multisurface. ACDT provides:

1. Tests under the radial and load circuits face, automated by integration of sensors recording parameters of friction;
2. Primary data processing of the information with the help of electronic devices, which is further, processed on PC, in order to ease the formation and optimizing the distribution of files and the current parameters values;
3. Account for rating criteria of the status of researched friction;
4. Multi-parameters diagnostics and automotive definition of friction and deterioration critical points.

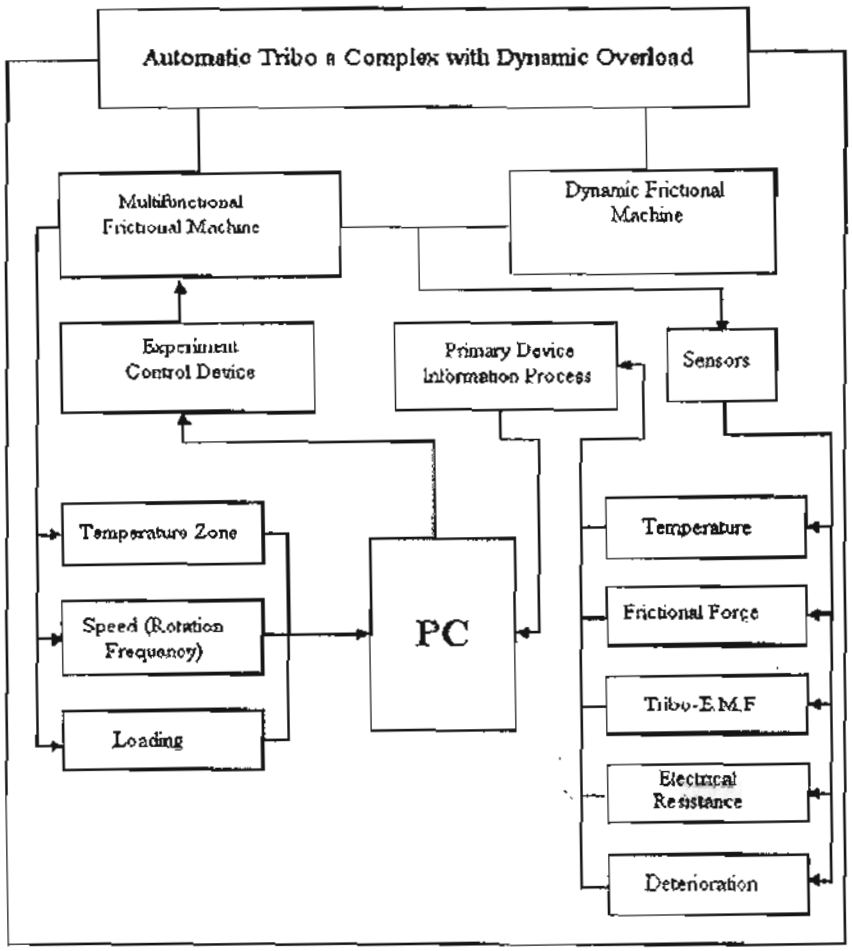


Fig 1: The block diagram of automatic complex Tribo- technical with dynamic loading.

searching a pair friction on ACDT is exposed to action of the load, the speed, the environment, the external source of heat; thus the measuring gauges of the friction moment, the deterioration and the temperature of samples, the electrical resistance of contact surfaces and tribo-emf. The software allows to estimate values of the tribo-dynamic characteristics, operated the speed, by loading and external heating of samples and includes low level programs, and also a complex of management both scientific programs of processing and performance of results. The low level programs carry out direct information interchange and management of the executive mechanisms. The management complex program allows

carrying out the experiment on the given mode with fixing of required parameters, statistical analysis of the received results with performance them in a graphic or tabulated kind [6]. The technical parameters ACDT and its complete set are given in the table 1.

Table 1: Technical parameters automatic complex Tribo-technical with dynamic loading.

| The name | The Technical characteristic | |
|---|---|---|
| ACDT | Power consumption, kw | 5 |
| | Weight or a complex, kg | 300 |
| Computer | IBM PC/AT | |
| Adjustable mobile sample drive | Relative speed of sliding of a mobile Sample, m/s | 0,013-5 |
| | Sample size, mm | < 100 |
| Loading : Pneumatic by cargoes | Load, H | 10-5000 |
| | Tolerance in loading, % | ±4 |
| Control System: Samples heating or tests Environment | Thermostat, °C | |
| | The furnace, °C | 30-200 |
| | Pressure of air in a highway | 30-600 |
| | Pneumatic drive, M Bas | < 0.4 |
| Pneumatic loading management rotating drive | Rotation frequency of a spindle, $min^{-1}$ | 3-2000 |
| Test device | The loading face circuit | |
| | The loading radial circuit | |
| | Reversal friction | |
| The measurement device: The friction moment | Friction moment, Nm. $10^{-3}$ | 25-5000± 5% |
| Linear deterioration | Total linear deterioration of samples, MKM | 2-500±10% |
| Electrical resistance of contacts | Electrical resistance of contacts, $O_M$ | 0.01-2. $10^5$ ±1% |
| Tribo-E.M.F | Tribo-E.M.F, mV | 0.01-1000±5% |
| Methodical and software algorithmic: | Standard tests methods. Processing methods of stochastic processes. Original methods Tribo-diagnostics. | |

The original method is realized by ACDT [3] researching the tribo processes in friction influence conditions and the normal loading modulation, concentrate formation and processes in the friction zone. The Kinetics of these processes is stimulated by the help of normal dynamic power (force) influence at constant values of other factors - temperature and speed of relative sliding [7, 8]. The dynamic influence is carried out by fluctuations modulating force of normal pressure.

The dynamic force component of normal pressure can be getting by dynamic vibrator - device, modulating a fluctuations load. The dynamic vibrator - device (fig. 2) consists of a motionless part I, coil 2 and mobile parts 3 electromagnets, spring 4, lock ring 5 and generator G. The electrical signal from the generator will be transformed by an electromagnet to mechanical fluctuations, which by means of a mobile part 3 are transferred in a zone of the contact 6 and the flat samples 7.

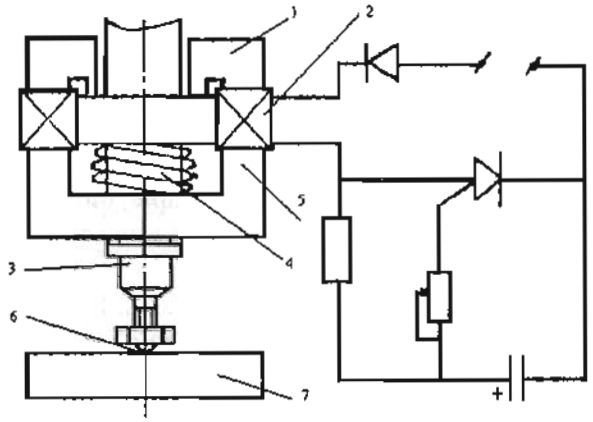


Fig 2: The dynamic vibrator-device

The size of dynamic loading ranges 0-30 % from quasi load. The quasi force component of the normal pressure in contact of researched pair samples set through a weight difference. The friction force measurement in contact (fig. 3) is located on a table of the test facility 1 and consists of the basis 2, little table for fastening a flat sample 7, two pairs bans 3 between them, inductive gauge 5, little table, recording moving, 7 under action of friction force arising at moving points 9 concerning flat samples 8. The gauge 5 is fixed in a clip 4, which allows carrying out its smooth moving for tuning and adjustment. The returning of a little table in an initial situation is carried out by a ring spring 6.

The friction force is registered on a deviation loop (ring), rigidly connected with a little table for fastening a sample. As ring used an elastic element dynamometer of a stretching such as DRY, having a straight-line characteristic "moving - force". For decrease (reduction) of force of friction between the basis and little table, last is established on spherical support. By maximum signal increase of the recording equipment variation factor for the received values of friction, force has made less than 6 %.

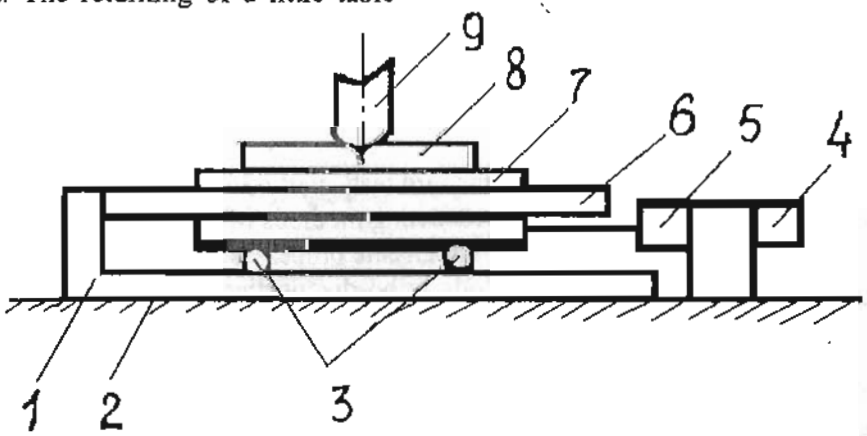


Fig 3: The site of measurement of friction force

The sliding speed of rood on a surface of a flat sample is in a range from 0.013 till 0.13 m/s and is set in steps by box of transfers' drive of the engine.

The definition of the geometrical characteristics of a track of friction is carried out with the help profilograph-roughness indicator by model B-201 which is in factory "Caliber". The tracks of friction received in identical conditions profilograph, also determined average value of deterioration. The error of registration of deterioration depends on size of vertical and horizontal increases profilograph and does not exceed 1 %. As criteria of a rating of the mechanism of destruction of a surface use the characteristics submitted in the table 2 [9, 10].

Table 2: Criterion of a rating of the mechanism of destruction of a surface of friction

| Criteria | Equation | The notes |
|---|---|---|
| $K_E$ Intensity relative parameter of wear dynamic process | $K_E = \frac{E_d - E_c}{E_c}$ | $E_d, E_c$, -deterioration parameters of a flat sample (track depth of friction h, fig.4) on sites, accordingly, quasi and dynamic loading modes. |
| $V_{Ec}$ $V_{Ed}$ Variation factor parameter of deterioration (characterizes material reliability) | $V_E = \frac{C_E}{E}$ | Disperse of a parameter of $C_E$ deterioration, E-Average value of deterioration parameter |
| $K^{PL}$ $K_d^{PL}$ Coefficients Layer Parameter | $K^{PL} = \frac{S^b}{S}$ | $S^b$ -The superseded material area, $S$ -The area of a track of friction (fig.4) |

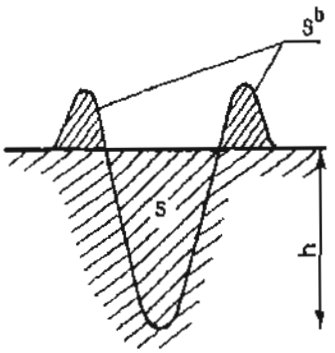


Fig. 4: Cross Section of a friction track

As a material of flat samples the metal and composite materials or coverings with hardness 10-65 HRC can be used [11]. Penetrator with a spherical working surface is made of steel, composite or ceramic materials with hardness not less than 1400 Mbas. Researched lubricant materials, the oils, dispersions of environment should have kinetics viscosity at 40 $C^{\circ}$ about within a range of 2-190 $mm/s^2$.

**3. Conclusions:**

The complex diagnostic equipment has most effective application in researches of complex tribo-system, when the multiparametrical control of a rating of reliability and quality of materials tribo-system such as gradient materials, coverings, super thin superficial layers of friction required, lubricant compositions with ultra dispersing additives and others. The methodology of the control of parameters tribo-system realized on ACDT allow realizing optimum choice strategy of covering for high load details and nodes of machines and equipment that has found a use on line of the machine construction. Thus, the complex, submitted in this paper, due to its high reliability and reliability data has been recommended for realization and certified tests for wide class of materials Tribo-technical purpose.

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