

The range of applications of modernised Amsler machine in tribological examination

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Properties

ABSTRACT

Purpose: The purpose of the study is to reveal the manner of improvement, extension of possibilities and increase of effectiveness in conducting research with the use of Amsler machine.

Design/methodology/approach: In order to reach the goals further actions were provided:

- The replacement of mechanical measuring unit with electronic meter circuit with the $X - Y$ and $Y - t$ microprocessor recorder,
- Design and realization of new construction of research head,
- Introduction of computer for data processing and analyzing.

Findings: Applied modernization enables expansion, increase of precision and effectiveness of conducted research. As an example the further tasks of limiting of maximum temperature of lubricant in the conditions of friction pair determined load was presented.

Research limitations/implications: Analyzed modernization of the machine refers to pin on disk unit sliding friction processes.

Practical implications: Broadening of range of possibilities of data processing in tribological research conduction.

Originality/value: This publication can be used by centers conducting research on tribological processes, especially on friction pairs systems, sliding friction models, in extend given:

- Selection of materials for friction pair elements,
- Analysis of research on friction and attrition processes,
- Lubricant selection for specified tribological system.

Keywords: Mechanical properties; Effectiveness increase; Amsler machine; Modernised tribotester; Friction conditions

1. Introduction

One of the principal streams of tribological research concerns actions involving the selection of material for the elements of high attrition, evaluation of usefulness and selection of lubricants etc. Conducted examination on tribotesters is to include:

- Variation of friction pairs functioning nature
- Requirements defined by kinematics characteristics or load rates
- High requirements concerning the quality of obtained results on standard tribotesters.

It indicates necessity to run actions consisting on improvement of research stations.

In this study the range of modernization and examples of possible researches to be conducted on modernized Amsler machine were given. [1-2, 9-15].

As a crucial part of designed changes, those were introduced in particular [1]:

- The replacement of mechanical measuring unit with electronic meter circuit with the $X - Y$ and $Y - t$ microprocessor recorder,
- Design and realization of new construction of research head,
- Introduction of computer for data processing and analyzing.

2. Construction and research abilities of modernized tribotester

General view of modernized Amsler machine is provided in Fig. 1.

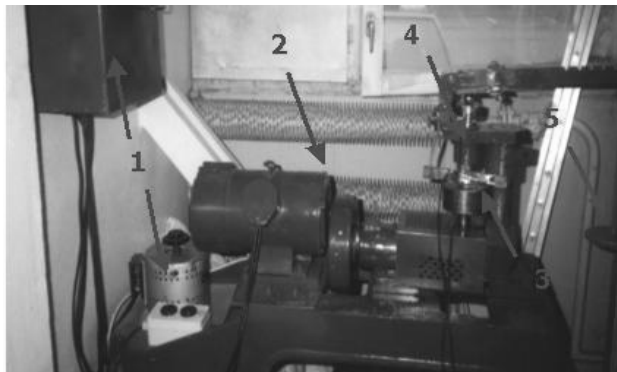


Fig. 1. General view of modernized Amsler machine 1) control and power supply system, 2) drive unit, 3) research head, 4) metering circuit, 5) load

Approved main assumption concerning parameters characterizing friction closed pair after modernization were as presented [3-9]:

- Contact: slack, flat (equipment has to be adjusted to examination of slide friction in pin-on disc unit),
- Modeled association of friction pair (pin on disk) has been achieved by rotating the disc and press down samples to it (sample diameter: 10mm, disc diameter : 90 mm),
- Applied research head at the research station enables installation of min. 3 up to 6 samples and conduction of tests with or without lubricant,
- Type of motion: slide friction of the speed range 0,5-1,5 m/s,
- Contact load moderates friction pair cooperation consisting on contact pressure rate 0,8-5,7N/mm²

Fig. 2 presents research unit for examination with 3 samples where dry friction conditions present. There is possibility of change of research unit to the one adjust to liquid lubricant environment test. Lower working element then is equipped with adequate clamping ring allowing hold required volume of such lubricant.

Designed measuring-recording unit records predetermined parameters variation in the friction process utilizes dial extensometers and thermo-elements for temperature measurement. Drive is provided by direct-current motor with drive-shaft rotation speed control. The complete research station includes also an universal recorder unit supported by computer with application software Tribol 1.

The analog data are converted to proportional electric signal of 4-20 mA. Fig. 3, presents circuits diagram of A/C transducers and universal recorder unit. Digital signal from the recorder is transmitted to the computer visualization unit (PC class unit).



Fig. 2. Research unit pin on disk

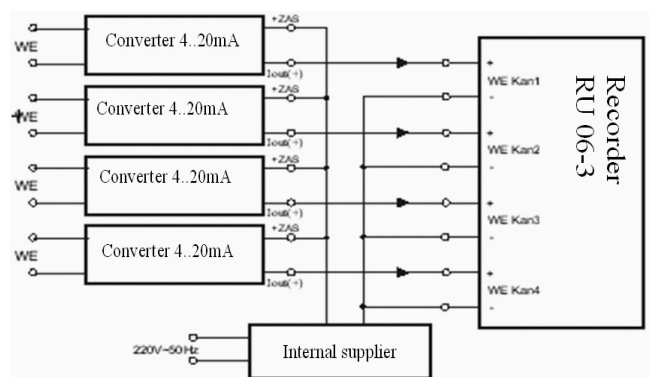


Fig. 3. Connection diagram of the A/C transducers with double wire terminals and the universal recorder unit

In order to data processing and visualization process, special application software Triol 1 has been designed. Equipped with computer system research station enables actions as:

- Data visualization,
- Data processing,
- Data logging and management.

Introduced improvements allowed the realization of modernization assumption, therefore observation and recording of changes that are to take place, in following parameters:

- Friction surface temperature and the temperature of lubricating media,
- The rate of attrition of sample surface,
- Moment of friction,
- Relative speed of disc according to pin,
- Friction path.

Exemplary record of alternation of temperature during the friction process with the use of lubricant is presented in Fig. 4.

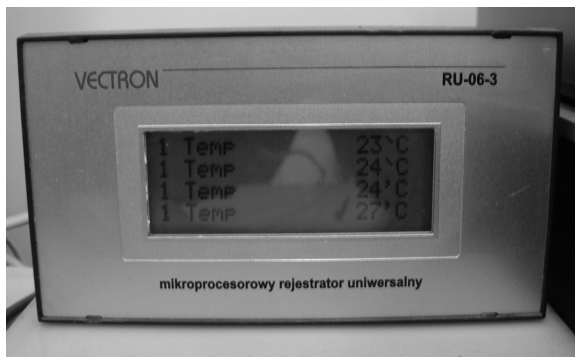


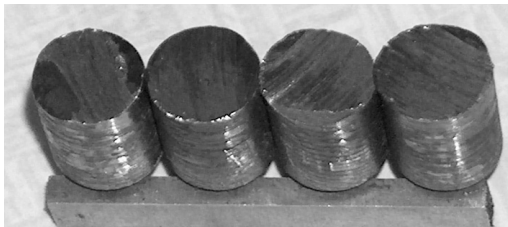
Fig. 4. Record of temperature alternation during friction process in lubricating environment (universal recorder Vectron)

3. Examples of possible ways of utilizing of modernized friction and attrition processes research station

One of the aims of conducted research was evaluation of possibilities of collaboration of sample – counter-sample units, made of steel 45 after heat treatment. Research concerned selection of lubricant with determined friction pair load. Usefulness of lubricant was connected with estimation of unit work temperature in defined liquid lubricant environment.

The problem consist on maintaining the stability of features of chosen lubricant in determined temperature. Fig.5. reveals samples and disk after (330 min.) attrition test.

a)



b)



Fig. 5. View on samples and counter-samples after measurement of the rate of attrition a) samples b) counter-sample

Introduced improvements and modernization of slide friction research station (based on Amsler machine) enable constant measurement and recording of temperature alteration on the contact surface of friction elements (sample and counter-sample). Sampling time and recording of measurements of temperature can be completed even each 1 second. For the measurement of temperature on modernized Amsler machine thermo-electrical sensors are used. Those sensors dependently on research program and needs are installed inside the sample via two methods: on the side surface and on axis of sample. Arranged and prepared in such a way samples are placed in especially designed research head [3, 4].

Measuring sensors placed on the side surface can be put on selected height dependently on the needs. It allows take a measurement and record of dispersal of temperatures when arranged in different distances from the sample working surface. The way of installing of thermo-electrical sensors on the side surface of sample has been presented On Fig. 6 and 7 respectively.

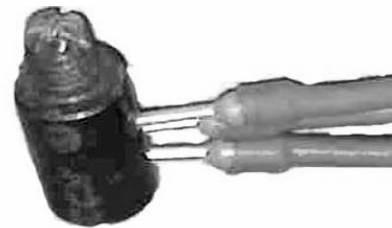


Fig. 6. Thermo-electrical sensors on the side surface of sample

The most accurate and verified method of measuring the alternation of temperatures of contact surface of friction pair is method based on use of thermo-elements placed in sample axis. Due to that fact the measurement of adequate temperature on sample and disc contact surface as well as lubricant can be provided.

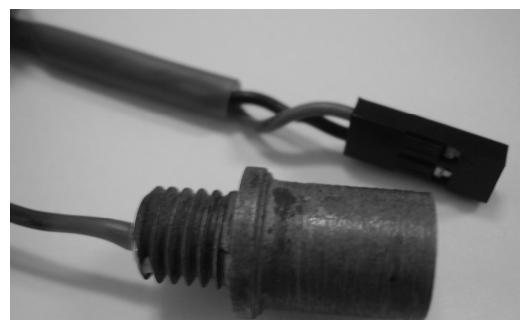


Fig. 7. Thermo-elements placed in sample axis

Location of pin on disc research unit in closed system enables conduction of researches of friction processes in lubricating environment and measurement of temperature of lubricant. Research on Amsler modernized machine can be run, when friction pair is constantly submerged in lubricating media or otherwise lubricant can be provided in corresponding time intervals.

Recorded temperature alterations from thermo-elements placed on sample axis are presented in Fig. 8.

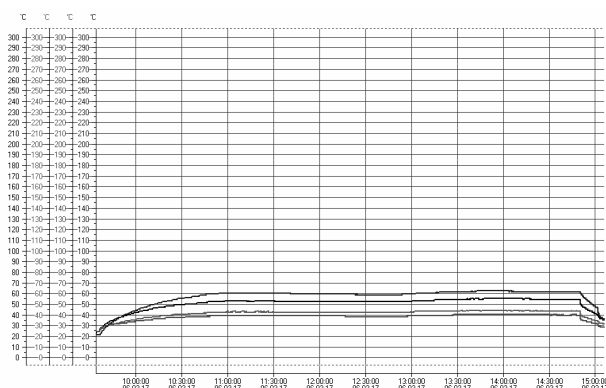


Fig. 8. Temperature changes graph with 2,45Mpa load from thermo-elements placed on sample axis

4. Conclusions

Leaded modernization of Amsler machine comprehensively resulted accurate during research completed in Technology Fundamentals Dept. Lublin University of Technology. The part of results reveals effects of those steps taken when research was conducted for realization of determined tasks. Presented study concerned providing the limitation of acceptable maximal temperature of lubricant at the determined friction pair load. The characteristic of selected lubricant allows it work to max. 70°C. When research was conducted temperature was estimate to have 60°C.

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