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**USAGE OF THERMO-VISION IN RESEARCH CONCERNING KINEMATIC PAIR  
OF FRICTION IN MACHINES AND MECHANICAL DEVICES**

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*In this article the thermal effect that appears during operation of bearings and couplings is shown by using thermo-vision photographs. The analysis of the thermo-vision research results as well as the capability of this method in testing and diagnosis of bearings and couplings was made.*

**Key words:** *thermo-vision, bearings and couplings.*

The usage of thermo-vision photographs is becoming more and more popular thus is used in new fields. In many areas the thermo-vision research has become common and even necessary [1, 3-5].

The thermo-graphic techniques have become more common in the diagnostics of machines and devices.

High costs of equipment failure and the necessity of its repair bring about regular thermo-vision check which result in cost decrease.

The thermo-vision check allows to spot even small temperature deviation which indicate malfunction of the machines and devices that could lead to unexpected technical defects or big failures.

Thermo-vision allows to detect precisely all the faulty elements early enough to predict the repair plan without problems thus avoiding the costs of the production shut-down or unexpected failure.

***Formulation of the problem***

The scientific aim of this work is to present possibilities of using thermo-vision to thermal estimate of kinematic pair of friction in bearings and clutches and thermal changes which take place during examining forced-in joints.

***Objects and methods of investigation***

Research with the usage of thermo-vision was carried on selected laboratory stands In the laboratory of Faculty of Construction and Machine Exploitation of Academy of Mining and Metallurgy in Cracow.

The usage of thermo-vision in research also aims at sharing this knowledge with the students of mechanical courses so that they could use it in diagnostics of machines and mechanical devices.

### ***Results and discussion***

#### ***Therm-vision measurements***

Every object with temperature higher than absolute zero is the source of infrared radiation and its intensity depends on temperature and body surface qualities. Thermo-vision equipment is a kind of television sensitive to a part of infrared radiation range.

Creating the picture involves recording of the radiation, emitted by the observed object, by the camera and, then, transforming it into a coloured map of temperatures. Therefore, thermo-vision system is a kind of thermometer which allows to measure the temperature in many different places at the same time.

No matter what the use is the camera during taking measurements must be in a standstill position to the object.

The element used to put the camera in a precise position to the object is a tripod. It has a built-in laser indicator which makes cropping easier and shows precisely the point lying on the optical axis of the camera [2].

The researchers used the Flir T335 thermo-vision camera which is a modern measurement device used for measuring temperature without direct contact and from a distance.

The thermo-vision pictures are then analysed referring to the temperature layout on the object examined.

The analysis of the temperature was done with the help of FLIR QuickReport computer program linked to the Flir T335. camera.

It contains great possibilities of processing the thermo-vision photos including analyzing only selected parts of them or reading the temperature in every point of the thermogram.

#### ***Slide Bearing Investigating***

Laboratory investigating of radial slide bearings using thermo-vision was carried out on a stand presented in photo 1. Detailed description of the stand together with measurement equipment was presented in the work [6]; therefore this work presents only the possibility of using thermo-vision in investigation.

The investigation was conducted within a settled job condition of the slide bearing.

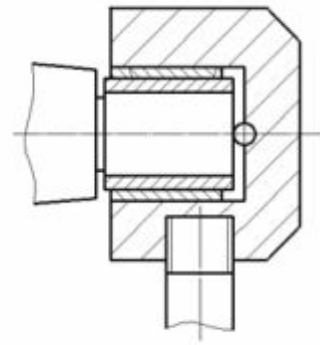


Photo 1. **Laboratory stand for investigating friction in slide bearings, diagram of slide bearing**

The examined slide bearing is on a final shaft neck (photo 1). During the rotation of the neck in a bearing shell the heat is emitted which defines the amount of heat produced in the bearing due to the load and the heat generated by the moment of friction. Emitted heat power increases the temperature in the joint: shaft neck-bearing shell compared to the temperature of the surrounding. The temperature increase is defined with the help of thermo-vision camera.

The temperature increase is determined by the Flir T335 thermo-vision camera. The camera used is equipped with micro-bolometric matrix with the definition of picture: 320x240 pixels and the speed N.E.T.D.0,05°C while the lens is 25° x 18,75°. The photograph below shows selected thermographs of the work of slide bearing, photo 2.

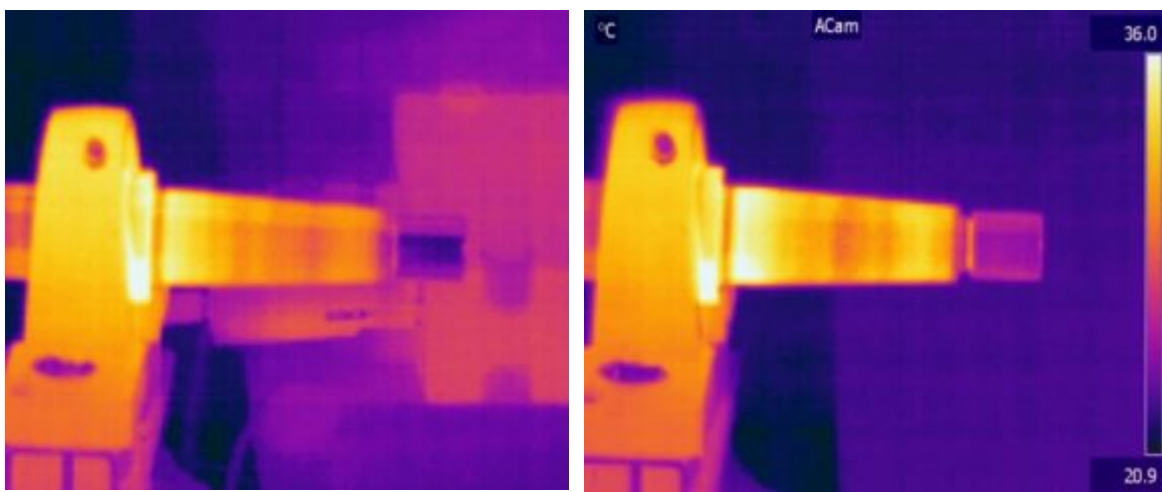


Photo 2. **Results of thermo-vision investigation of slide bearing**

Use of thermo-vision in clutch investigation

KKiEM laboratories carry out investigation concerning static and kinetic friction ratio in selected frictional contacts on the stand presented in photo 3.



*a*



*b*

Photo 3. **Laboratory stand for investigation of friction characteristics:**  
*a* – view with the monitoring and measuring equipment, *b* – friction pair

The structure of the stand allows one to use it for scientific and teaching purposes. It can be used during laboratory classes in order to investigate and visualize processes which occur during the work of clutches and brakes [7]. The stand presented was patented in the Polish Office of Patents [8].

During laboratory investigation conducted on joint frictional surfaces of rotating discs one defines a moment of friction which causes the heat emission. The heat emitted results in temperature increase in the joint of rotating frictional discs which can be measured using a thermo-vision camera. Examples of selected thermograms are presented on photo 4.

Use of thermo-vision in the investigation of forced-in joints

Teaching classes for the students of mechanical courses include laboratory investigation, in KKiEM labs, of forced –in joints on a stand shown on photo 5.

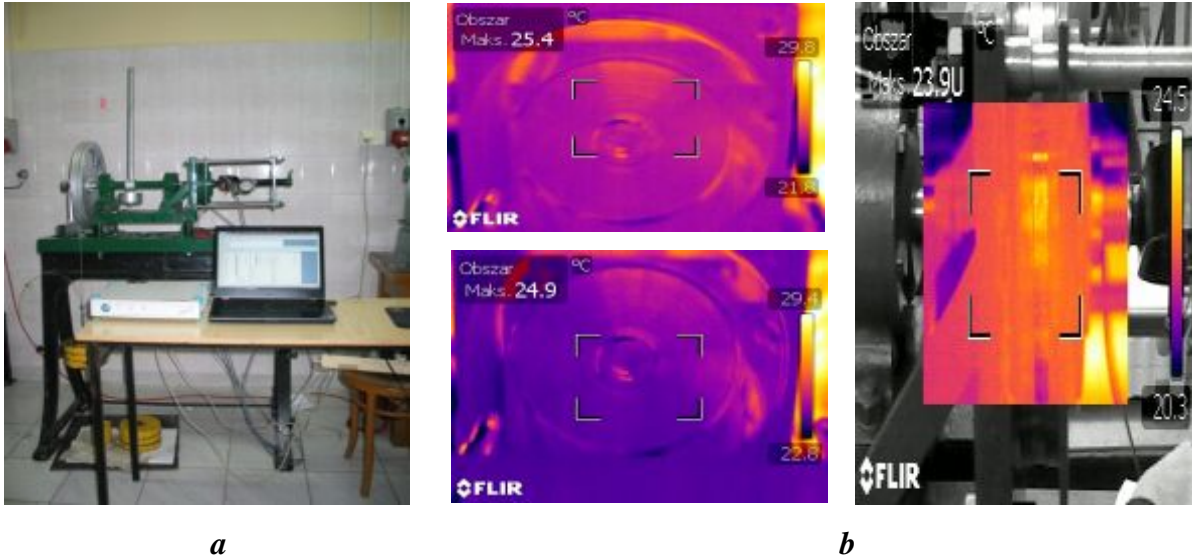


Photo 4. **Results of thermo-vision investigation of frictional characteristics:**  
*a* – laboratory stand with a thermogram of frictional surfaces put on,  
*b* – thermograms of frictional discs



Photo 5. **Stand for resistance investigation**

The investigation is carried out AT the Hungta TYP HT- 2402 resistance machine, which is In accordance with international norms: ISO 7500/1, EN 1002-2 and has a rating certificate issued by Regional Weight and Measures Office in Krakow.

During the investigation students determine the value of extrusion and forcing strengths and use the thermo-vision camera to analyse the changes of temperature which occur during extrusion and injection of pins with rings. Examples of selected thermo-grams are presented in photo 6.

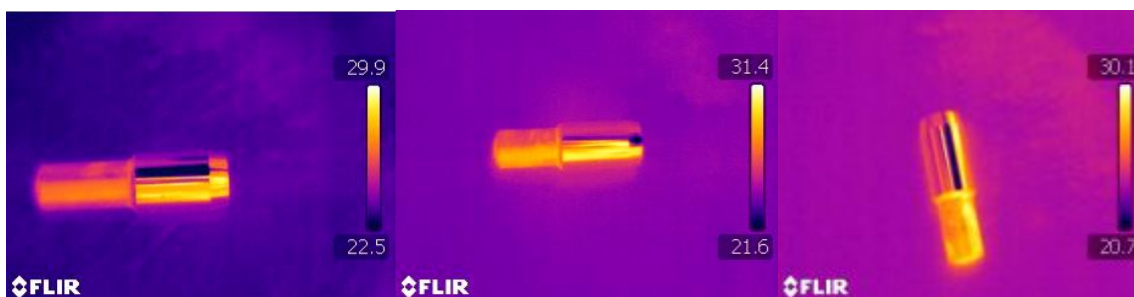


Photo 6. Thermograms of bolts used in the investigation

### *Conclusions*

Constant development of thermographic systems enables one to use this measuring technique in different industrial areas. It is due to the fact that measuring systems based on thermal analysis have many advantages. One of them is contact-free measurement of temperature which, in many cases, is a basic criterion of using thermographic techniques.

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***Д. Лепіарчук, Е. Тарновски, А. Угрински, В. Гаведски***

***Использование термовидения в исследованиях кинематической пары трения машин и механизмов.***

*В работе авторы на основе использования термовизорной камеры показывают термические явления, возникающие во время работы подшипников и муфт. Проведен анализ полученных результатов термовизорных исследований, а также оценка возможностей применения этого метода в испытаниях и диагностике подшипников и муфт.*

***Ключевые слова:*** термовидение, подшипники и муфты.

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***Використання термобачення у дослідженнях кінематичної пари тертя машин і механізмів.***

*У роботі автори з використанням термовізорної камери показують термічні явища, що виникають під час роботи підшипників і муфт. Проведено аналіз отриманих результатів термовізорних досліджень, а також оцінка можливостей застосування цього методу у випробуваннях і діагностиці підшипників і муфт.*

***Ключові слова:*** термобачення, підшипники та муфти.