Journal of Young Scientist, Volume II, 2014
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

THERMOVISION APPLIED FOR STUDYING THE ELECTROMECHANICAL TRANSMISSIONS OPERATION

Monzer AL ISBER[1]

Scientific coordinator: Assoc. Prof. Adrian ROŞCA[2]

[1] University of Balamand, Technological University Institute - Issam Fares, Liban
[2] University of Craiova, Faculty of Agriculture and Horticulture,
19, Libertăţii Street, 200404, Craiova, Romania,
Phone: 0251.414.541, Fax : 0251.414.541, adrosca2003@yahoo.com

Corresponding author email: adrosca2003@yahoo.com

Abstract

The paper presents experimental reserch results during an industrial technological practice internship organized according to a pedagogical cooperation convention signed between the University of Balamand - Techological University Institute – Issam Fares, and University of Craiova. The paper presents relevant thermogrames obtained during experimental researches concerning both several new or old electromechanical products, and maintenance aspects, too. The thermogrames are in detailed explained considering the interdisciplinaries concepts concerning all the stages of electromechanicals produces making such as desinging, technological making process, assemling operations, quality control, maintenance aspects, and possible environmental impact aspects.

***Key words**: thermovision, electromechanical transmissions operation, environmental impact*

INTRODUCTION

Infrared thermography (IRT), thermal imaging, and thermal video are examples of infrared imaging science. Thermographic cameras detect radiation in the infrared range of the electro-magnetic spectrum (roughly 9–14µm) and produce images of that radiation, called thermograms. Since infrared radiation is emitted by all objects above absolute zero according to the black body radiation law, thermography makes it possible to see one's environment with or without visible illumination. The amount of radiation emitted by an object increases with temperature; therefore, thermography allows one to see variations in temperature. When viewed through a thermal imaging camera, warm objects stand out well against cooler backgrounds become easily visible against the environment, day or night. A thermal imaging camera is capable of performing algorithms to interpret that data and build an image. (https://en.wikipedia.org/wiki/Thermography).

Advantages of thermography**:** it is capable of catching moving targets in real time; it is able to find deteriorating, i.e., higher temperature components prior to their failure; it can be used to measure or observe in areas inaccessible or hazardous for other methods; it is a non-destructive test method; it can be used to find defects in shafts, pipes, and other metal or plastic parts (http://www.flirmedia.com/MMC /THG/Brochures/ T820264; www.micronix.ro).

Thermal imaging cameras are commonly used for inspections of high voltage and low voltage electrical systems and components in all sizes and shapes (www.micronix.ro; www.flirmedia. com/ MMC/THG/Brochures/T820264).

In many industries, mechanical systems serve as the backbone of operations. Thermal data co-llected with a thermal imaging camera can be an invaluable source of complimentary information to vibration studies in mechanical equipment monitoring. Mechanical systems will heat up if there is a misalignment at some point in the system. Conveyor belts are a good example: if a roller is worn out, it will clearly show in the thermal image so that it can be replaced. Typically, when mechanical components become worn and less efficient, the heat dissipated will increase. Conse-quently, the temperature of faulty equipment or systems will increase rapidly before failure. By periodically comparing readings from a thermal imaging camera with a machine's temperature signature under normal operating conditions, it can be detected a multitude of different failures (www.micronix.ro; www.flirmedia.com/MMC/ THG/Brochures/T8202640).

Infrared Thermography testing is one of many Nondestructive testing techniques designated by the American Society for Nondestructive Testing (ASNT): infrared Thermography is a nondestructive, remote sensing technique, has proved to be an effective, convenient, and economical method of testing concrete. It can detect internal voids, delaminations, and cracks in concrete structures such as bridge decks, highway pavements, floors and pavements, and building walls. As a testing technique, some of its most important qualities are that it is accurate; it is repeatable (www. flirmedia.com/MMC/THG/Brochures).

According ISO, in industrial electromechanical applications, infrared Thermography is reglamented by the standard ISO 18436-7, Condition monitoring and diagnostics of machines - Requirements for qualification and assessment of personnel - Part 7: Thermography (www.micronix.ro; www.flirmedia. com/MMC/THG/Brochures/T820264).

Infrared monitoring and analysis has the widest range in predictive and proactive maintenance application (from high - to low - speed equipment), and it can be effective for spotting both mechanical and electrical failures; some consider it to currently be the most cost - effective technology (www.flirmedia.com/MMC/THG/ Brochures/T820264; www.micronix.ro).

International standards for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing, and Handling of Combustible Particulate Solids (Eckhoff, 2003; Hatwig & Steen, 2004) contain comprehensive guidance on the control of dusts to prevent explosions. The vast majority of natural and synthetic organic materials, as well as some metals, can form combustible dust. International Industrial Fire Hazards standards (Hatwig & Steen, 2004) state that "any industrial process that reduces a combustible material and some normally noncombustible materials to a finely divided state present a potential for a serious fire or explosion." A combustible dust explosion hazard may exist in a variety of industries, including: food (dust cloud such as grain, flour, sugar, pollen, powdered milk), plastics, wood, rubber, furniture, textiles, pesticides, dyes, coal, metals (e.g., Al, Cr, Mg, Zn, iron), and fossil fuel power generation (Eckhoff, 2003; Hatwig & Steen, 2004).

There are four necessary conditions for a dust explosion or deflagration: a combustible dust; the dust is suspended in the air at high concentration; there is an oxidant (typically atmospheric oxygen); there is an ignition source. To support combustion, the dust must also consist of very small particles with a high surface area to volume ratio. In agriculture and food industry the dust can arise from activities such as transporting grain and indeed grain silos do regularly have explosions. Flour mills likewise have large amounts of flour dust as a result of milling. Some devastating and fatal explosions have occurred at flour mills (including an explosion) and a series of devastating grain dust explosions in grain elevators left many people dead and injured (Eckhoff, 2003).

According to international general standards for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, to prevent fire hazard in flour milling process, the operation temperature must not exceed 80^{o}C.

In University of Craiova previous experimental research were focused on thermovision applications' to prevent fire hazard in flour milling industry (Rosca & Rosca, 2011).

A thermal imaging analyze revealed an intense overheat of the sliding bearing of a rolling flour mill. During consecutive Thermovision monitoring a fast increase of the sliding bearing' temperature was observed: after 30 min from the starting of milling process the maximum temperature in thermal image was 139^{o}C (Figure 1), and then after just 30 min the maximum temperature increased up to 151^{o}C (Figure 2).

Due to these Thermovision monitoring results, the flour milling process was proposed to be stopped. During the mechanical evaluation it was observed a very high ware rate of the sliding bearing; therefore this machine element was replaced with a new one.

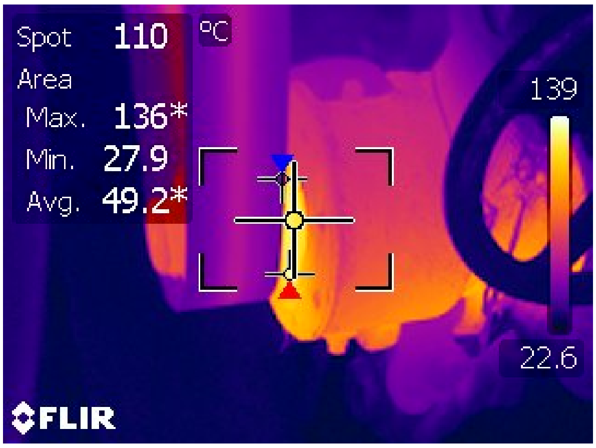


Figure 1. Sliding bearing overheated at 139°C

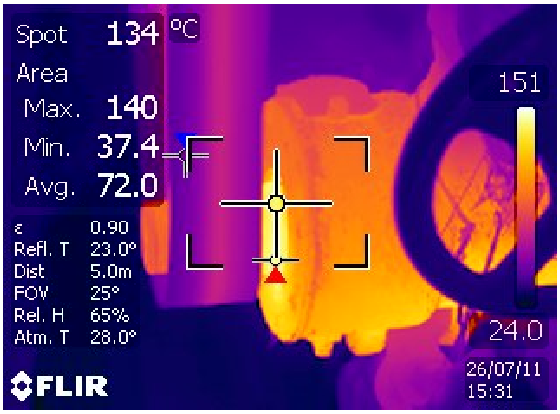


Figure 2. Sliding bearing overheated at 151°C

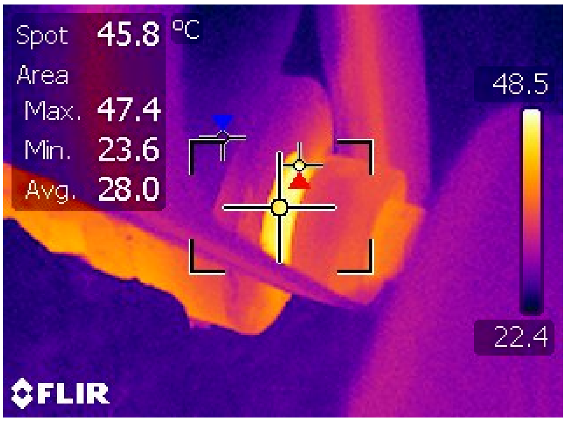


Figure 3. Sliding bearing in proper operation 48,5°C

After 30 min from the flour milling process start, the Thermovision monitoring revealed a proper temperature at about 48,5°C (Figure 3) in all thermal image (Rosca & Rosca, 2011).

MATERIALS AND METHODS

According to a Pedagogical Cooperation Convention signed between the Techological University Institute - Issam Fares within University of Balamand - Liban and University of Craiova - Romania, the University of Craiova organised a student industrial technological practice internship.

For this industrial technological practice internship, University of Craiova signed Collaboration Partnership Protocols with three representatives industrial companies in Craiova interested in hosting industrial practice of foreigner students, and to organise and monitorise all the student's industrial technological practice internship: SC Cummins Generator Technologies SA - Craiova; SC POPECI Heavy Equipment - Craiova; SC RELOC S.A. COMPANY - Craiova. According to the products making stages within these companies, the thermovision was used to study the electro-mechanical transmissions operation for the products making technologies.
During the experimental researches, FLIR T200 infrared camera (wave range 7,5 - 13µm) was used. The emisivity, the ambient tempe-rature, the reflected temperature, the humidity and the distance to the object surface were setted on the infrared camera each time when was necesary (www.micronix.ro).

RESULTS AND DICUSSIONS

In SC Cummins Generator Technologies SA - Craiova, the practice tutor established the practice program according to the products making stages in Impregnation Section.
During the experimental researches the heating oven components were evaluated. In Figure 4 is presented the thermograme that shows the correct operation of the oven's ventilation system (90,7°C maximum ventilator temperature) during the preheating process (100°C) for moisture elimination (Al Isber, 2013).

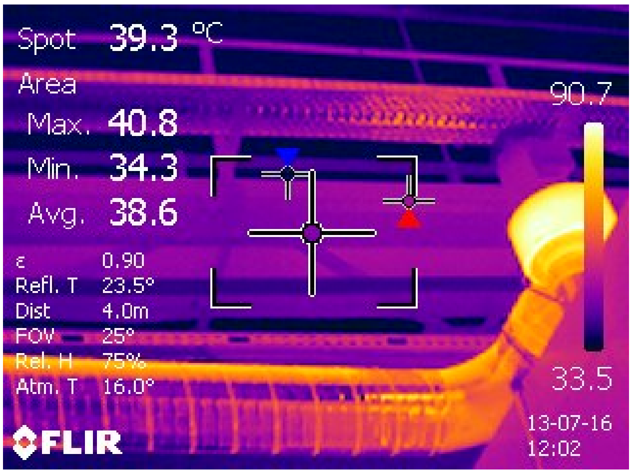


Figure 4. Correct operation of the oven's ventilation system (90,7°C maximum ventilator temperature) during the preheating process (100°C) for moisture elimination

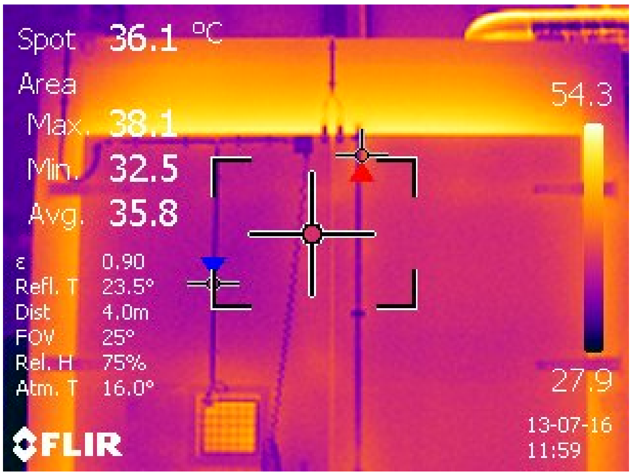
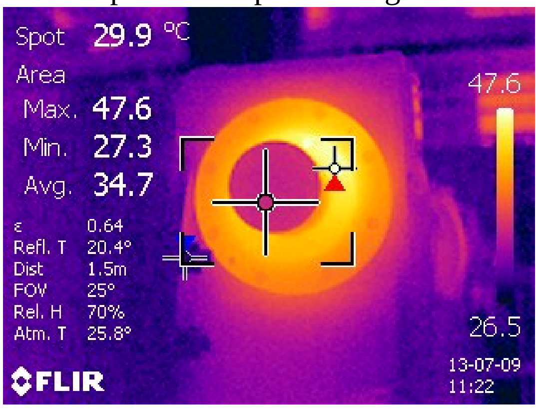


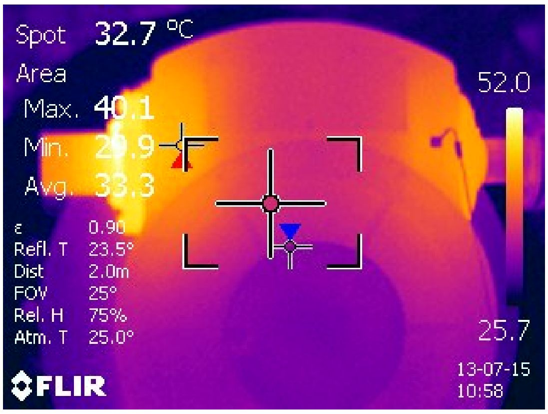
Figure 5. Low quality isolation between the oven's doors, and the oven's frontal side (54,3°C)

But in the same experiment the thermograme revealed (Figure 5) low quality isolation (54,3°C) between the oven's doors, and the oven's frontal side (Al Isber, 2013).
Therefore the practice internship supervising teacher addressed collegial recommendations to the Impregnation Station maintenance team.
In SC POPECI Heavy Equipment SA - Craiova, the practice tutor established the practice program according to the products making stages, and according the Simulation Test Bench and Gearing Systems Laboratory programme and Mobile Research Laboratory programme, too.
During the experimental research, the thermovision revealed no thermic problem in heavy equipments operation (due to maintenance or intensive mechanical cutting processes).
During the experimental research within Simulation Test Bench and Gearing Systems Laboratory, thermovision evalution of a special multiple orbital gear box was realised.
The special multiple orbital gear box is the main component of surface mining combine driven system.
The first stage of the special multiple orbital gear box consists in an arhi-medic warm gear with 135 transmission ratio.
In similitude with in mining process, the special multiple orbital gear box was actuated by an electrical motor at certain rotational speeds, and a high performance hydraulic system (used as brake system to realise constant or variable resistent torque moment).
In real mining process time the special multiple orbital gear box is charged in four constant or variable resistent torque moment.

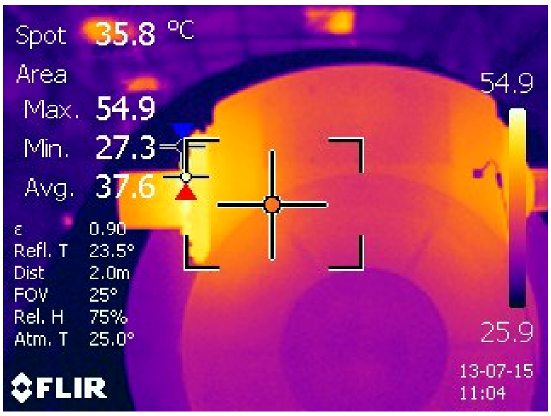
Thermovision revealed that one of the most loaded gear stage into the special multiple orbital gear box is the arhimedic warm gear, and for each loading stage, temperature increase of arhimedic warm gear was observed.
The thermogrames revealed that higher temperature occurs in the radial - axial bearing from oposite traction part of the arhimedic warm gear (Figure 6): in the first loading stage 47,6°C maximum temperature (a); in the second loading stage 52°C maximum temperature (b); in the third loading stage 54,9°C maximum temperature (c); in the fourth loading stage 56,9°C maximum temperature (d) (Al Isber, 2013).
These temperatures confirm the designing corectness of the special multiple orbital gear box.



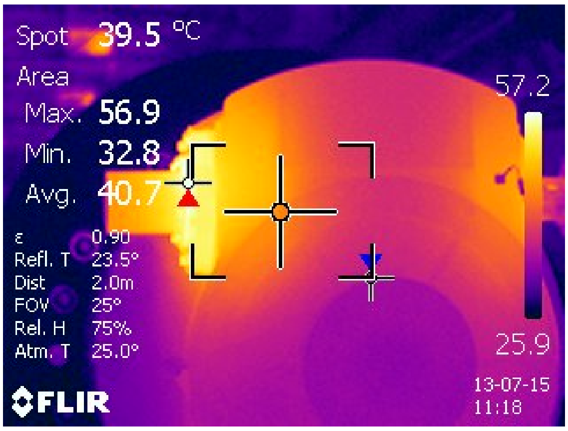
a) the first loading stage (47,6°C maximum temperature)



b) the second loading stage (52°C maximum temperature)



c) the third loading stage (54,9°C maximum temperature)



d) the fourth loading stage (56,9°C maximum temperature)

Figure 6. Higher temperature occurs in the radial - axial bearing from oposite traction part of the arhimedic warm gear

In these experimental researches an interesting temperature behavior in the frontal side of the radial-axial bearing (from oposite traction part of the arhimedic warm gear) was observed: the maximum temperature 47,6°C recorded in the same place / point (Figura 6,a).

These tempera-tures picks could be determined by screwing torsion moment uniformless that occured in radial-axial bearing mounting operation (Al Isber, 2013), therefore the practice intern-ship supervising teacher addressed collegial recommendations to the assembling technical team.

In SC RELOC S.A. Company - Craiova, the practice tutor established the practice program according to the electrical motors of diesel - electric locomotives making stages, and according the Electrical Motors Testing Laboratory programme, too.

In the preliminary electrical tests, two electrical motors are installed on a metallic rigid plate (3×6m), and then for each motor (unloaded) the electrical parameters are measured in certain rotation speeds operation.

It must be mentioned that the motors were made in 1997 by Electroputere - Craiova, and the diesel - electrical locomotive was for the second time in general reparation process.

During these tests a high frequency noise occurred (90 - 95dB), thus is not possible to detect which of the motors produce the higher noise level. In order to realize the thermovision evaluation, it was necessary to step near the electrical motors on the metallic rigid plate, and low vibrations were observed.

The two motors were successively connected to the energy supplying system, and it was determined which of the motors produce the metallic rigid plate's vibrations. This motor was separately scanned by using thermovision.

It was observed that even for low rotation speeds the opposite traction side bearing works in high temperatures range 82,9 - 87,3°C (Figura 7). Therefore the practice internship supervising teacher addressed to the technical team collegial recommendations to replace this bearing.

During the replacing operation high rate wear of the opposite traction side bearing was observed. After this bearing was replaced, by using thermovision it was observed normal temperature range 45,4 - 50,3°C (Figure 8) for low rotation speeds (Al Isber, 2013)

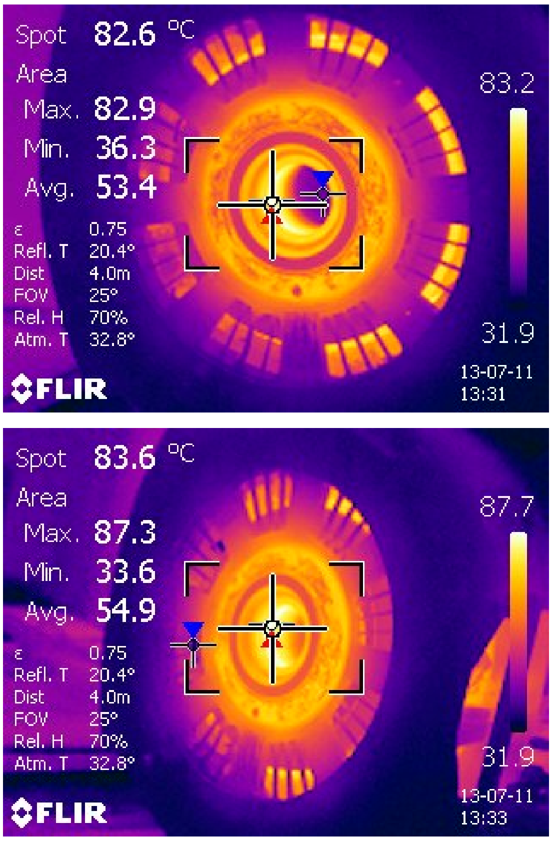
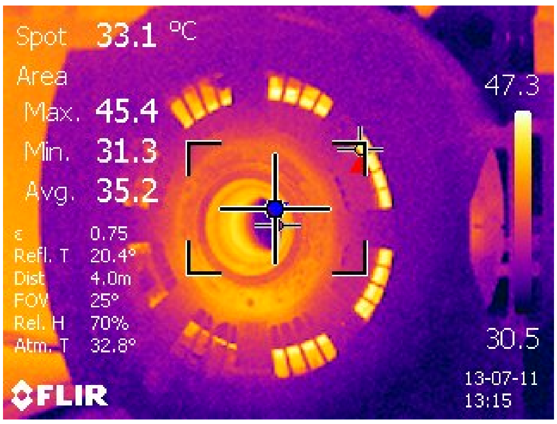


Figure 7. High temperature range 82,9 – 87,3°C of the opposite traction side bearing working in low rotation speeds



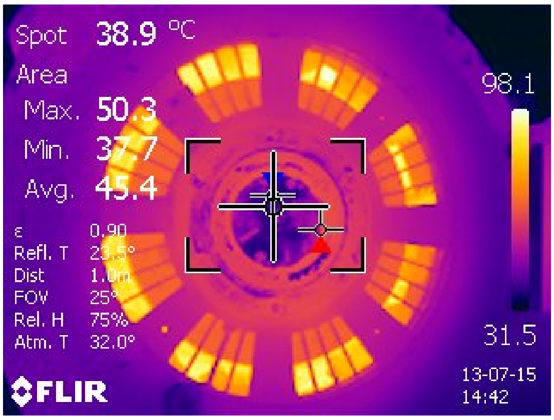


Figure 8. Normal temperature range 45,4 – 50,3°C of the opposite traction side bearing (new bearing) working in low rotation speeds

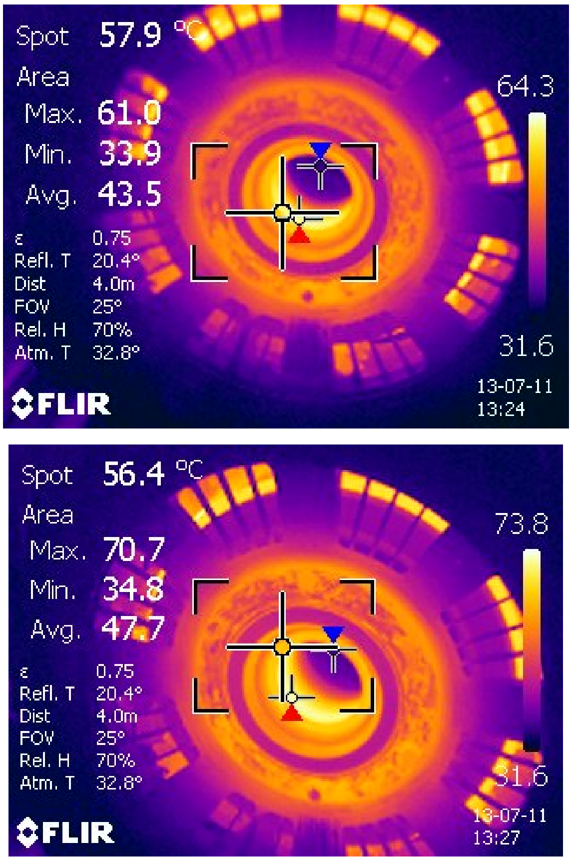


Figure 9. Normal temperature range 61 – 70,7°C of the opposite traction side bearing (new bearing) working in highest rotation speeds

After this bearing was replaced, by using thermovision it was observed normal temperature range 61-70,7°C (Figure 9) for highest rotation speeds, thus proper operation temperatures were observed (Al Isber, 2013).

CONCLUSIONS

In order to realize industrial technological practice internship and to elaborate the Industrial Technological Practice Internship Rapport concerning experimental research on Thermovision applied for studying the electromechanical transmissions operation, University of Craiova signed special Collaboration Partnership Protocols with three representative industrial companies in Craiova: SC Cummins Generator Technologies SA - Craiova; SC POPECI Heavy Equipment - Craiova; SC RELOC S.A. Company - Craiova.

The Industrial Technological Practice Intern-ship Rapport presents the most relevant thermo-grames obtained during experimental researches concerning both several new or old electro-mechanical products, and maintenance aspects, too.

The thermovision reserch was focused on interdisciplinaries concepts concerning all the stages of electromechanicals produces making: desinging, technological making process, assemling operations, quality control, preventive / proactive maintenance.

REFERENCES

Al Isber Monzer, 2013. Thermovision applied for studing the electromechanical transmissions operation, Industrial Technological Practice Internship Rapport.

Eckhoff Rolf. K., 2003. Dust Explosions in the Process Industries. 3rd Edition, Gulf Professional Publishing.

Hatwig M., Steen H., 2004. Handbook of Explosion Prevention and Protection, Wiley-VCH.

Roşca D., Roşca A., 2011. Thermovision - A Reliable Method To Prevent Fire Hazard in Flour Milling Industry. Annales of the University of Craiova, Biology, Horti-culture, Food produce processing technology, Environ-mental engineering Series, vol. XLI (LII), Universitaria Publishing House Craiova, pp. 368-373, ISSN 1453-1275.

Roşca D., Roşca A., 2011. Thermovision Predictive Main-tenance for Large Capacity Milling Process in Food Industry, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, Editor B[ranko] Katalinic, Published by DAAAM International, Vienna, Austria, pp. 1407-1408, ISBN 978-3- 901509-83-4.

http://www.flirmedia.com/MMC/THG/Brochures/T820264

www.micronix.ro

http://www.flir.com/thermography/

https://en.wikipedia.org/wiki/Thermograph