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THERMOVISION PREDICTIVE MAINTENANCE FOR LARGE CAPACITY MILLING PROCESS IN FOOD INDUSTRY

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Abstract: *Thermovision is available two decades ago as one of the fastest method of identifying potential defects in machines' elements operation. Therefore, the relatively high costs of the infrared (IR) cameras and their operational complexity have resulted in the situation where the cameras have remained only in the thermograph certified specialists' hands. The latest news in IR technology have determined lower cost of implementing thermovision program and cheaper cameras have put these smart tools at the hands of IR trained and certified engineers. This paper presents IR techniques available to measure the condition of assets and provides various examples of the defects that can be identified for predictive maintenance of the large capacity milling process in food industry.*

Key words: *thermovision, predictive maintenance, machines elements, food industry milling*

1. INTRODUCTION

Predictive maintenance made necessary to drawn various technologies to identify the electrical and mechanical components that are in the early stages of failure or under stress due to normal or accidental operation: tribology (specific applications for machines' mechanical elements), acoustic level (specific applications for mechanical elements and electrical parts), vibration analyses (specific applications for bearings and rotating machines), thermovision or thermal imaging (wide and general applications method throughout the industrial activities).

Thermovision method has been used in predictive maintenance applications for at least two decades. The approach is to detect temperature rises that are indicative of problems before hazard failure of the machines' mechanical elements and electrical component (http://www.yellotec.com, 2011).

In principle, *electrical failures* are caused by electrical load and electrical resistance. Any electrical component, which is not 100% efficient, will exhibit a thermal rise with increases in current or power dissipation.

It is therefore possible to detect increased loads on individual components as diverse as individual conductors or whole motors (http://www.flir.com, 2011).

In main, *mechanical failures* are caused by friction. In any machine where two wear surfaces are in contact, any poor lubrication, poor alignment or bearing failure determines increased friction and therefore temperature rise.

Thermovision systems tend to be the most expensive technologies employed in the predictive maintenance programmes, but the benefits offered by this method will justify the high initial investment in the technology.

By contrast Thermovision has a wide range of applications including, but not limited to, the ability to detect the following defects: electric motor loads, bearing temperature (poor shaft alignment), bearing wear (lubrication failure or pitted damaged), imbalanced load of the machine elements during operation.

One of the great benefits of Thermovision over most other predictive maintenance technologies is that it is easy to both operate the system and to interpret the results with a normal training and experience to make a diagnosis of the fault.

2. MATERIAL AND METHOD

The food industry must maintain tight control of food temperatures during the transportation of perishable food materials, during preparation and processing, and all the way through storage in wholesale and retail environments (Vadivambal & Jayas, 2011).

Infrared thermography can instantly reveal the condition of electrical and mechanical systems in the factory: retail refrigerator stores, vacuum or cooking vessels, ovens, heat exchangers, compressors, motors and electrical connections (Rosca & Rosca, 2009; Meola & Carlomagno, 2004). In order to perform the interdisciplinary studies concerning the influence of low vacuum processing on non – thermic preservation of orange fruit, in the Unconventional Technologies and Equipment for Agro-Food Industry Laboratory within Faculty of Horticulture in Craiova, a FLIR infrared thermovision camera that can detect temperature differences as small as 0,1^{o}C was used (Rosca & Rosca, 2010).

In order to apply thermovision predictive maintenance for large capacity milling process in food industry, T200 FLIR infrared thermovision camera was used.

3. RESULTS AND DISCUSIONS

3.1 Thermovision predictive maintenance for electrical systems

The use of proper electrical equipment in hazardous locations is crucial to eliminating a common ignition source. The classify-cation of areas requiring special electrical equipment is discussed in the *Facility Dust Hazard Assessment* section in international and national standards. Once these areas have been identified, special Class II wiring methods and equipment (dust hazards such as "dust ignition-proof" and "dust-tight") must be used.

In milling process in food industry all the international norms recommend to operate with explosion proof enclosure electric motors special designed to withstand an explosion of a specified air/fine dust combination that may occur within it and to prevent the ignition surrounding the enclosure. It must operate at a temperature that prevents the surrounding flammable atmosphere from being ignited. Due to the specific operation conditions in milling process in food industry, the international norms recommend totally enclosed fan-cooled electric motor, insulation class F (allowable temperature rise up to 105^{o}C for motors' insulation).

In grains milling are used centrifugal cyclones, each one being provided with a proportioning discharge dozing device that are rotated by an electro-mechanical equipment composed in a single stage gear box direct connected to an electric motor. In figure 1 is presented the thermal image of 2 a.c. motors with *proper thermal operation*: 43,8^{o}C in the spot, and maximum temperature 48,1^{o}C in the entire thermal image.

In figure 3 is presented the thermal image of a motor in 90,2^{o}C *thermal operation*. To prevent the excessive motor heating up to hazard duty, the electro-mechanical equipment was necessary to be stopped. Due to this experimentally research approach was observed that two cable connections were hotter than normal caused by incorrect screws tithing; this improper operation caused consequently the overheat of motor' stator that determined the excessive temperature in bearing case in torque end shaft.

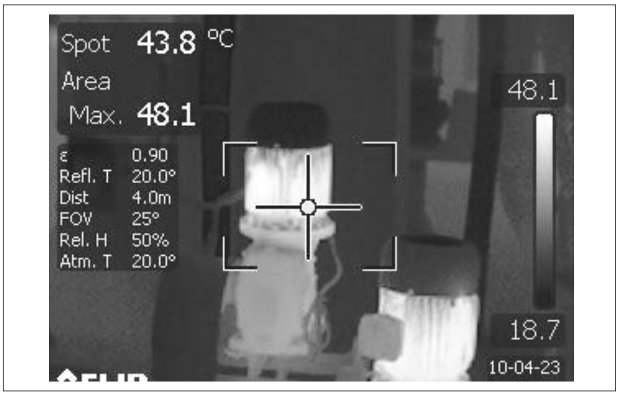

Fig. 1. Motors with proper thermal operation: 43,8°C / 48,1°C

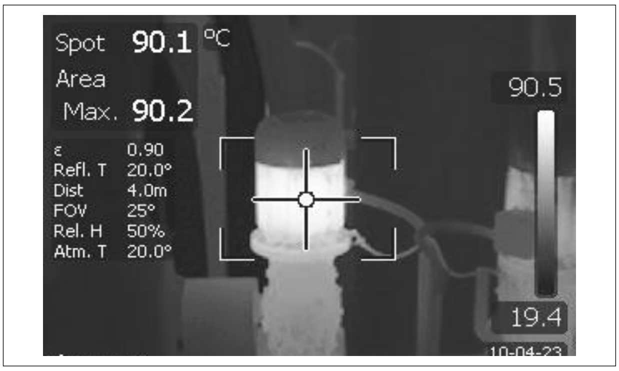

Fig. 2. Motor with abnormal thermal operation: 90,1°C

This excessive temperature in the bearing caused the grease loosing that realized the bearing and the shaft overheating. In this experimentally research approach was observed that due to the excessive temperature, irreversible damage of simmering seal system of the gear box (that determined the overheating of all internal mechanical elements of the gear box: gear teeth, bearings) occurred. This operation behavior is very difficult / or impossible to be correct estimated by any simulation programme.

3.2 Thermovision predictive maintenance for mechanical system

Flour milling is a mechanical manufacturing process which produces flour from wheat through comprehensive stages of grinding and separation. Gluten is the natural protein material which gives wheaten flour ability to make leavened bread and baked products, but during milling process must prevent water absorption in gluten. Therefore during the grinding, the operation temperature in all the milling process must not exceed 45°C.

The quality of the roller mill is of decisive importance to the efficiency of the mill and must create the optimal conditions for excellent product quality and yield in the field of grain milling. Poor roller mills distance alignment requires static and dynamic balance measurements using a specialist shaft alignment system.

During grinding, as a result of breaking grains between the rollers mill, the milling process develops heat which generally adversely affect the process.

To prevent the overheating during the grinding process there are made rollers mill equipped with internal water cooling system consisting in a cold water that enters through a pipe, then passes through the rolling / antifriction bearing cases, and passing through several nozzles, finally sprays the inner wall of the roller mill (http://www.buhlergroup.com., 2011).

In figure 3 is presented a roller mill with low quality maintenance of the internal water cooling system that cause fast increasing of the temperature more than 45°C during operation. In this figure is observed the fast increase of milling temperature with up to 51,3°C average (in the spot of thermal image), and maximum temperature up to 70,6°C in the squared image (maximum temperature during the operation up to 73,1°C in the entire thermal image).

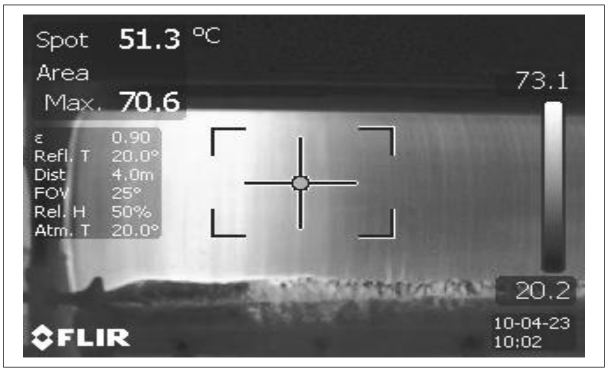

Fig. 3. Roller mill with abnormal operation temperature: 73,1°C

Due to the Thermovision predictive maintenance proposed by this experimentally research approach, the milling process was proposed to be stopped. During this maintenance activity it was observed that water supply system filter and the manual valve were severe clogged, and the water flow in the pipe of cooling system was blocked; therefore, with no water flow in the inner of the roller mill, the milling process temperature was very fast increased more than 45°C. In figure 3, the left side is hotter than the right side with more than 30°C. It was proposed roller mills distance alignment measurements, and after static balance it was observed more than 0,5mm parallelism misalignment in the roller mill system.

4. CONCLUSIONS

Due to experimentally research approach the future best results in Thermovision predictive maintenance will be obtained through a structured use of the system. In particular, the research described in this paper will lead to the adoption of condition monitoring programmes, with certain results in less unnecessary repair and more accurate fault severity assessment.

In the future, the operation condition monitoring programmes data must be recorded on regular bases that permit to establish trends and normal operating conditions and to identify the components with serious fault.

The best way to ensure that the predictive maintenance surveying is carried out at regular intervals and is not compromised by the production demands in food industry is to dedicate long term contracts to independent experts in Thermovision which offer services to various facilities within food industry plants.

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