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THERMOGRAPHIC ANALYSIS OF THE RICOMA 2 HEAD EMBROIDERY MACHINE

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Abstract: *The purpose of this paper is to quickly and accurately identify the points representing potential defects in 2 head embroidery machines by using infrared thermography. Thermography measurements were performed with the FLIR SC 640 thermal imaging camera, which is a portable thermographic scanning equipment. The Flir Reporter 9.1 software is used to create reports based on photos taken with the Flir Sc 640 thermal imaging camera. Measurements were taken on the Ricoma 2 head embroidery machine at different work patterns to track the way the needle temperature is transmitted on the fabric on which the embroidery patterns are made. The measurements were taken for several materials and the material chosen to be presented in the present paper is a synthetic and natural fiber compound, because of its large dimensional stability. In this paper the results of thermography measurements on the chosen material are presented at a minimum working regime of 300 sinkings/min, at the optimal working regime determined by the authors to be 790 sinkings/min and at the maximum working regime of 900 sinkings/min .*

Key words: *thermographic measurements, FLIR SC 640 thermal imager, needle, embroidered fabric.*

1. INTRODUCTION

In recent years, infrared thermography has shown applicability in more and more areas. A temperature-based image provided valuable information about the status of the analyzed item. Any failure of the equipment is preceded by an increase in temperature. Identifying the temperature that increases beyond normal operating limits allows the avoidance of malfunctions [1].

2. THE EXPERIMENTAL PART

Thermography measurements were made with the FLIR SC 640 [2], [3] thermographic camera on the RICOMA embroidery machine, which is a reliable industrial embroidery machine with two embroidery heads each with 12/15 colors. Ricoma machines incorporate state-of-the-art mechanical and electronic technology. It has its own operating system with an intuitive interface that allows the modification of the embroidery patterns on the spot and editing digits and letters directly on the machine software without having to be previously edited and processed on a computer.

Thermo Camera FLIR SC 640 is a portable thermographic device for scanning, without cooling. It is equipped with the most powerful existing IR detector with a resolution of 640x480pixels, which shows thermal sensitivity (NETD) found only in cameras with cooling (<0.04 ° C).

The termographic camera FLIR SC 640 disposes of new functions such as:

-Possibility to overlay the thermal image into visible image (Picture-in-Picture)

-Possibility to combine the thermal image with visible image (Thermal Fusion)

Figure 1 depicts the component elements of Flir SC 640 thermo camera.

Fig. 1. *The component elements for Thermo Camera Flir SC640 [2,3,4]*

According to Figure 1, the thermo camera is equipped with a laser pointer, germanium lens, SD card, USB and Video connector [2,3,4]

The thermographic view of the objects are realized in 2 modes

-Through a tilt-able viewfinder

-Through a large color LCD

Advantages of testing with thermo camera Flir Sc 640 are as follows:

Allows scanning objects at a distance without contact, the testing is non-destructive against measured objects, provide predictive maintenance for equipments in the early stages to reduce costs. Flir Reporter 9.1 software is used to create reports in infrared based on pictures realized with thermo camera Flir SC 640.

With the Flir Reporter 9.1 software we have the posibility to:

- Detailed analysis of the infrared image
- Modify the: level, span, color palette
- Modify object parameters
- Add or delete the: spot, line, area, delta T
- Modify the properties of measurement units
- Add arrows to image

During the stitching (embroidery) process it is very important to know the influence of the needle temperature on the material [5,6]. During the stitching (embroidery) process, the needle heats up, which result in stitching (embroidery) defects and implicitly decreases of the productivity[6].

Thermography measurements [7,8,9] were made on Ricoma 2 head embroidery machine (Figure 2). These measurements were taken on different materials and during different working regimes [10,11], from 300 sinkings/min until 900 sinkings/min, in order to track the way the needle temperature is transmitted to the material on which embroidery patterns are sewn. Measurements were taken on a 0,7 mm needle from Schmetz. The embroidery thread has a linear density of 135x2 dtex and is 100% polyester

In this paper we have chosen to present the results of thermography measurements on the chosen material at 300 sinkings/min, 790 sinkings/min and 900 sinkings/min. These working regimens were not chosen randomly. We chose to present measurements at a minimum working regime of 300 sinkings/min, a maximum working regime of 900 sinkings/min, and a 790 sinkings/min working regime that was determined by the authors to be an optimal working regime, established by the vibration measurement technique.

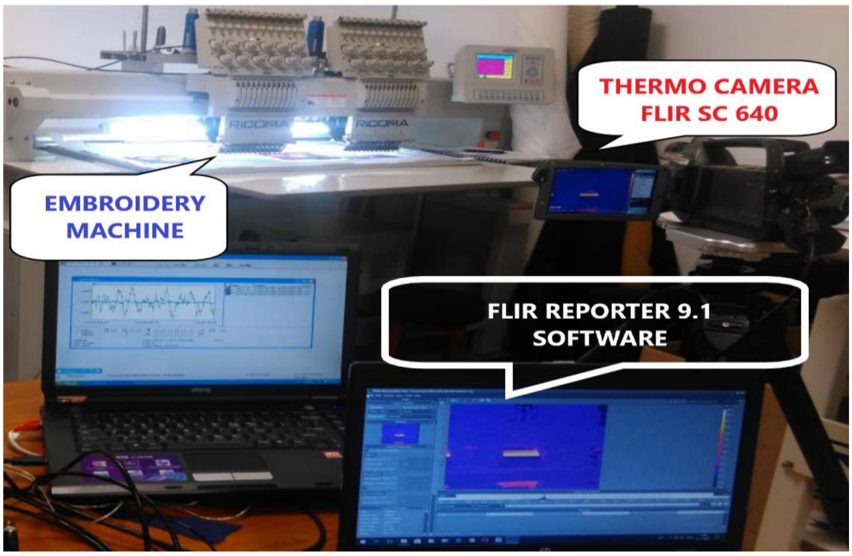

Fig. 2. *Thermography measurements on 2 head Ricoma embroidery machine*

For the first embroidery pattern, the thermography measurements were performed at a minimum working regime of 300 sinkings/min.

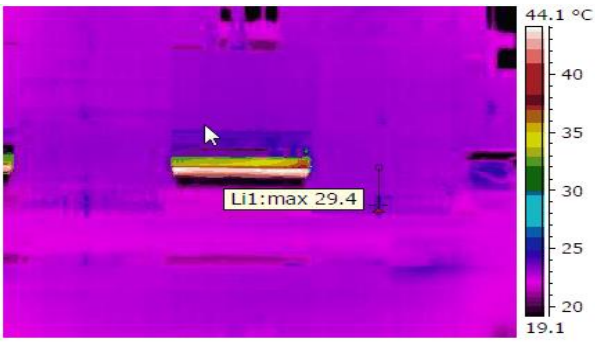

Fig. 3. *Image in the IR spectrum of the 2 head embroidery machine at 300 sinkings/min*

Date	24.11.2017
Image Time	11:06:32
Emissivity	0.95
Object Distance	1.0 m
Reflected Temperature	20.0 °C
Li1 Max. Temperature	29.4 °C
Li1 Min. Temperature	17.2 °C
Li1 Max - Min Temperature	12.1 °C
Li1 Emissivity	0.30
Li1 Object Distance	2.0 m
Li1 Reflected Temperature	25.0 °C

In (Figure 3) can be seen the graphic slider that is positioned on the needle and indicates a temperature of 29.4 ° C. The measurement distance was of 1m between the camara and the 2 head embroidery machine and the air temperature was 20 ° C. In (Figure 4), the needle temperature variations are displayed at 300 sinkings/min for the first embroidery pattern.

Fig. 4. *Variations of the needle temperature at 300 sinkings/min.*

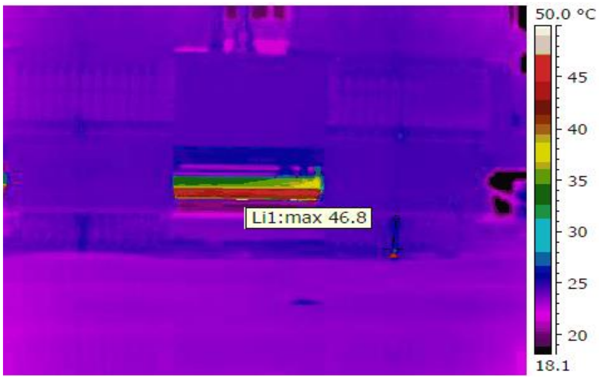

Fig. 5. *Image in the IR spectrum of the 2 head embroidery machine at 790 sinkings/min*

Date	24.11.2017
Image Time	11:37:44
Emissivity	0.95
Object Distance	1.0 m
Reflected Temperature	20.0 °C
Li1 Max. Temperature	46.8 °C
Li1 Min. Temperature	17.9 °C
Li1 Max - Min Temperature	28.9 °C
Li1 Emissivity	0.16
Li1 Object Distance	2.0 m
Li1 Reflected Temperature	25.0 °C

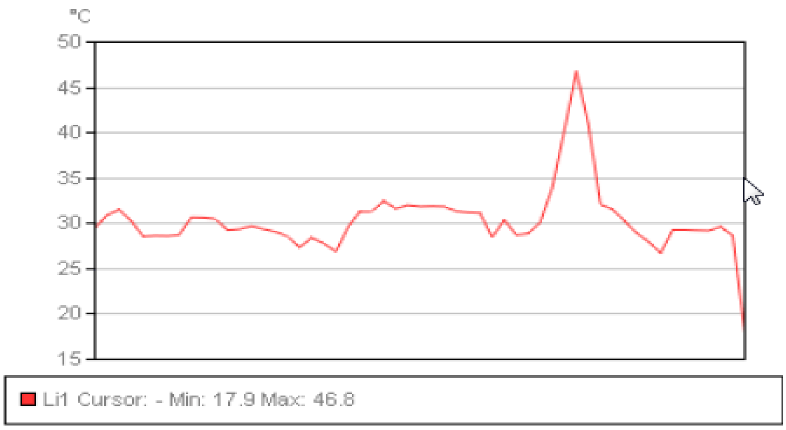

Fig. 6. *Variations of the needle temperature at 790 sinkings/min.*

In (Figure 5) can be seen the graphic slider on the needle indicating a temperature of 46.8 ° C. The measurement distance was of 1m between the camera and the 2 head embroidery machine and the air temperature is of 20 ° C. In (Figure 6) are shown the needle temperature variations at 790 sinkings/min for the second embroidery pattern.

Fig. 7. Image in the IR spectrum of the 2 head embroidery machine at 900 sinkings/min

Date	24.11.2017
Image Time	11:40:01
Emissivity	0.95
Object Distance	1.0 m
Reflected Temperature	20.0 °C
Li1 Max. Temperature	60.3 °C
Li1 Min. Temperature	12.3 °C
Li1 Max - Min Temperature	48.0 °C
Li1 Emissivity	0.13
Li1 Object Distance	2.0 m
Li1 Reflected Temperature	25.0 °C

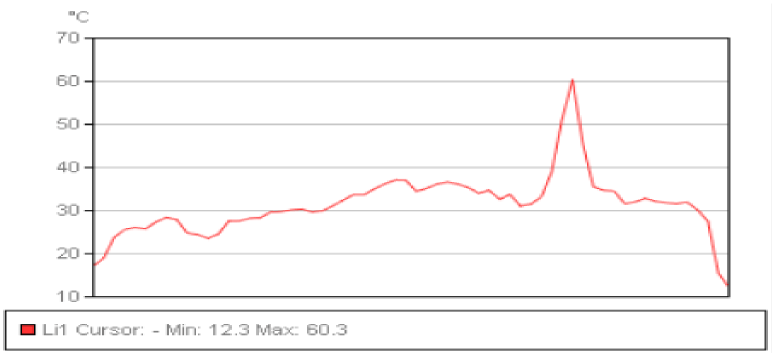

Fig. 8. *Variations of the needle temperature at 900sinkings/min.*

In Figure 7 can be seen the graphic slider on the needle indicating a temperature of 60,3 ° C. The measurement distance was of 1m between the camera and the 2 head embroidery machine and the air temperature was of 20 ° C. In (Figure 8) are shown the needle temperature variations at 900 sinkings/min for the third embroidery pattern.

3. INTERPRETATION OF RESULTS

Following the measurements of the RICOMA 2 head embroidery machine on the chosen material, at 300 sinkings/min the needle temperature was recorded as 29.4 ° C. At 790 sinkings/min, the needle temperature increases to 46.8 ° C and at 900 sinkings/min the temperature of the needle reaches a significant value of 60.3 ° C.

4. CONCLUSIONS

These measurements taken on the 2 head embroidery machine on the synthetic and natural fiber material lead to the conclusion that at the 300 sinkings/min working regime there are no high temperature increases of the sewing (embroidery) needle, even if the embroidery pattern is much more complex, which denotes an admissible needle behavior in relation to the embroidered material.

The authors have determined by means of the vibration measurement technique that the 790 sinkings/min working regime is an optimal working regime. At this 790 sinkings/min working regime, the needle temperature is of 46.8 ° C. Although no major changes to the needle occur during this working regime, the needle temperature increases with the complexity of the embroidery pattern. At 900 sinkings/min, the needle temperature rises to a significant 60.3 ° C, which leads to the conclusion that as the working regime of the embroidery machine the temperature of the needle significantly increases and a degradation of the thread may occur.

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