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THERMOGRAPHIC STUDY ON TEXTILE TREATMENT EQUIPMENT

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Abstract: *The thermal analysis of the equipment in this work paper, has an important role (for planning maintenance activities), because this machine ensures optimal loading with different material treatment solutions, intended for mattresses, according to customer requirements. In the present paper the authors conducted a research on the whole technological flow in order to plan predictive maintenance activities using online monitoring methods. The monitoring of machine conditions is very important from the viewpoints of productivity, economic benefits, and maintenance. With one motor not functioning, the ventilation system may not be able to circulate enough air to properly cool the treated material. This can lead to overheating and potential damage to the material. Without all motors working together, the airflow and temperature within the treatment equipment may become uneven. The increased heat caused by a lack of proper ventilation can also harm the equipment itself, potentially causing mechanical failures or other issues. The failure of one ventilation motor can have significant negative impacts on the overall performance and effectiveness of the treatment process. It is important to promptly address and repair any malfunctioning motors to ensure the continued operation of the equipment and maintain the quality of the treated material. This paper presents only a part of the research carried out and in a future paper the rest of the analyses performed on the Squeezing Pader Machine will be presented.*

Key words: *thermal imaging, FLIR SC 640, FLIR RESEARCH IR MAX 4.40 software.*

1. INTRODUCTION

Early detection and diagnosis of incipient faults is desirable for online condition assessment, product quality assurance, and improved operational efficiency of induction motors [1].

Motors are critical for many industrial processes because they are cost effective and robust in the sense of performance [1]. They are also critical components in many commercially available equipment and industrial processes. Because of the potential savings offered by fault diagnosis systems, a lot of research has been carried out for the study and development of fault detection and diagnosis [2] methods for electric machines. Research on monitoring the condition of industrial machinery is a very important area aimed at avoiding unexpected situations such as: malfunctions, breakdowns, failures, shutdowns and not least economic losses [1], [2]. The state of the textile machines can be evaluated by monitoring different parameters, such as vibration and temperature [3, 4, 5, 6], so their maintenance can be performed a short time before the failure [7].

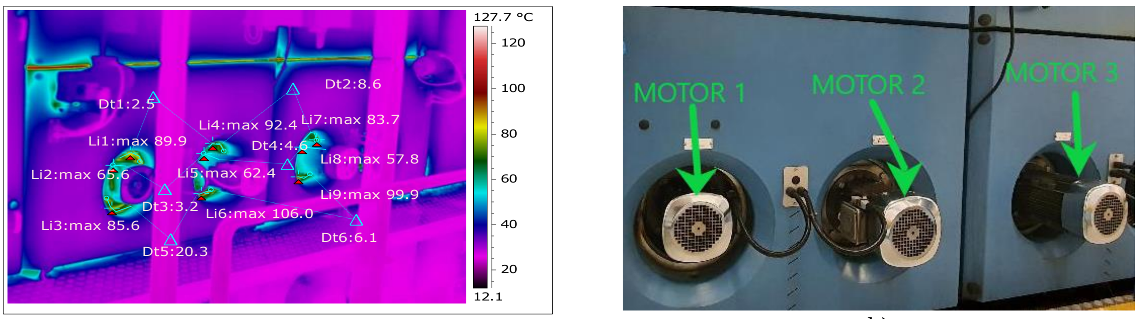
Thermography measurements were performed at the Lava Knitting in Oradea [8]. The Flir SC 640 thermal imaging camera was used, which is a portable thermographic scanning equipment, ”without cooling”, which has the strongest existing IR detector, with a resolution of 640 × 480 pixels and with a thermal sensitivity encountered so far only by cameras with cooling systems (<0.04°C) [5].

2. MATERIALS AND METHODS

Thermographic measurements were performed on the Squeezing Pader Machine, which is a machine for treating textile materials (mattress covers), as shown in Fig. 1. As it can be seen from Fig. 3 the maximum temperature along line Li1, which is positioned on motor 1, is 89.9°C, and the minimum temperature is 77.6°C. The temperature variation along line Li1 is 12.3°C, and the emissivity is 0.85 along line Li1, positioned on motor 1. The maximum temperature along line Li2, which is positioned on motor 1, is of 65.6°C, and the minimum temperature is 59.0°C. The temperature variation along the Li2 line is 6.5°C, and the emissivity is 0.85 along the Li2 line, positioned on motor 1. The maximum temperature along line Li3, which is positioned on motor 1, is 85.6°C and the minimum temperature is 65.1°C. The temperature variation along line Li3 is 20.5°C, and the emissivity is 0.85 along line Li3, positioned on motor 1.

Fig. 1*: Equipment for the treatment of textile materials [8]*

Fig. 2*: FLIR SC 640 thermal imaging camera components [9]*



a) b)

Image Camera Type	FLIR SC640
Li1 Max. Temperature	89.9 °C
Li1 Min. Temperature	77.6 °C
Li1 Max - Min Temperature	12.3 °C
Li1 Emissivity	0.85
Li1 Object Distance	2.0 m
Li1 Reflected Temperature	22.5 °C
Li2 Max. Temperature	65.6 °C
Li2 Min. Temperature	59.0 °C
Li2 Max - Min Temperature	6.5 °C
Li2 Object Distance	2.0 m
Li2 Emissivity	0.85
Li2 Reflected Temperature	22.5 °C
Li3 Max. Temperature	85.6 °C
Li3 Min. Temperature	65.1 °C
Li3 Max - Min Temperature	20.5 °C
Li3 Emissivity	0.85
Li3 Object Distance	2.0 m
Li3 Reflected Temperature	22.5 °C
Li4 Max. Temperature	92.4 °C
Li4 Min. Temperature	66.3 °C
Li4 Max - Min Temperature	26.1 °C
Li4 Emissivity	0.85
Li4 Object Distance	2.0 m
Li4 Reflected Temperature	22.5 °C
Li5 Max. Temperature	62.4 °C
Li5 Min. Temperature	50.6 °C
Li5 Max - Min Temperature	11.8 °C

Li5 Emissivity	0.85
Li5 Object Distance	2.0 m
Li5 Reflected Temperature	22.5 °C
Li6 Max. Temperature	106.0 °C
Li6 Min. Temperature	67.3 °C
Li6 Max - Min Temperature	38.7 °C
Li6 Emissivity	0.85
Li6 Object Distance	2.0 m
Li6 Reflected Temperature	22.5 °C
Li7 Max. Temperature	83.7 °C
Li7 Min. Temperature	58.3 °C
Li7 Max - Min Temperature	25.4 °C
Li7 Emissivity	0.85
Li7 Object Distance	2.0 m
Li7 Reflected Temperature	22.5 °C
Li8 Max. Temperature	57.8 °C
Li8 Min. Temperature	43.4 °C
Li8 Max - Min Temperature	14.5 °C
Li8 Emissivity	0.85
Li8 Object Distance	2.0 m
Li8 Reflected Temperature	22.5 °C
Li9 Max. Temperature	99.9 °C
Li9 Min. Temperature	71.2 °C
Li9 Max - Min Temperature	28.7 °C
Li9 Emissivity	0.85
Li9 Object Distance	2.0 m
Li9 Reflected Temperature	22.5 °C

Fig. 3*:IR and real spectrum image of motor 1, motor 2, motor 3 and temperatures along the measured lines: (a) infrared image, (b) real image.*

As can be seen from Fig. 3 the maximum temperature along line Li4, which is positioned on motor 2, is 92.4°C, and the minimum temperature is 66.3°C. The temperature variation along the Li4 line is 26.1°C, and the emissivity is 0.85 along the Li4 line, positioned on motor 2. The maximum temperature along line Li5, which is positioned on motor 2, is 62.4°C and the minimum temperature is 50.4°C. The temperature variation along line Li5 is 11.8°C, and the emissivity is 0.85 along line Li5, positioned on motor 2. The maximum temperature along line Li6, which is positioned on motor 2, is of 106.0°C, and the minimum temperature is 67.3°C. The temperature variation along line Li6 is 38.7°C, and the emissivity is 0.85 along line Li6, positioned on motor 2. As can be seen from Fig. 3 the maximum temperature along line Li7, which is positioned on motor 3, is 83.7°C, and the minimum temperature is 58.3°C.

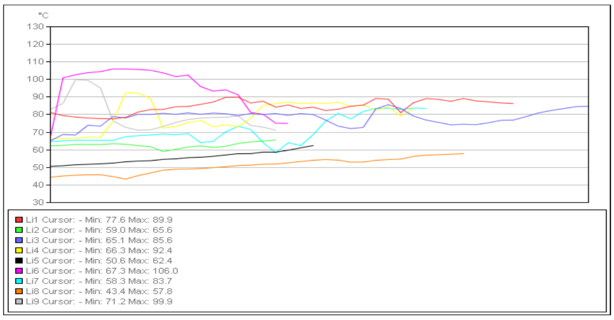
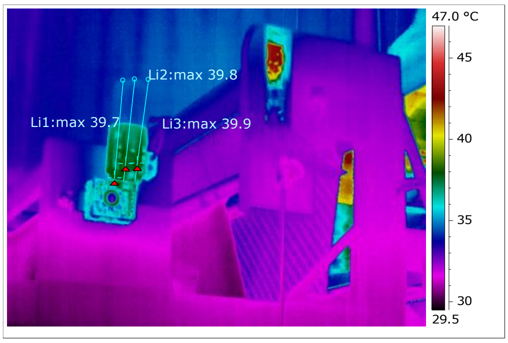


Fig. 4*: Temperature variation along the lines positioned on motor 1, motor 2 and motor 3*

The temperature variation along the Li7 line is 25.4°C, and the emissivity is 0.85 along the Li7 line, positioned on motor 3. The maximum temperature along line Li8, which is positioned on motor 3, is 57.8°C and the minimum temperature is 43.4°C. The temperature variation along line Li8 is 14.5°C, and the emissivity is 0.85 along line Li8, positioned on motor 3. The maximum temperature along line Li9, which is positioned on motor 3, is of 99.9°C, and the minimum temperature is 71.2°C. The temperature variation along line Li9 is 28.7°C, and the emissivity is 0.85 along line Li9, positioned on motor 3.

Fig. 4 shows the temperature variation along the lines positioned on motor 1, motor 2 and motor 3.



a)

b)

Image Camera Type	FLIR SC640
Li1 Max. Temperature	39.7 °C
Li1 Min. Temperature	35.5 °C
Li1 Max - Min Temperature	4.2 °C
Li1 Emissivity	0.85
Li1 Object Distance	2.0 m
Li1 Reflected Temperature	22.5 °C
Li2 Max. Temperature	39.8 °C
Li2 Min. Temperature	35.3 °C
Li2 Max - Min Temperature	4.5 °C

Li2 Emissivity	0.85
Li2 Object Distance	2.0 m
Li2 Reflected Temperature	22.5 °C
Li3 Max. Temperature	39.9 °C
Li3 Min. Temperature	35.5 °C
Li3 Max - Min Temperature	4.4 °C
Li3 Emissivity	0.85
Li3 Object Distance	2.0 m
Li3 Reflected Temperature	22.5 °C

Fig. 5*:IR and real spectrum image of motor 4 and temperatures along the measured lines: (a) infrared image, (b) real image.*

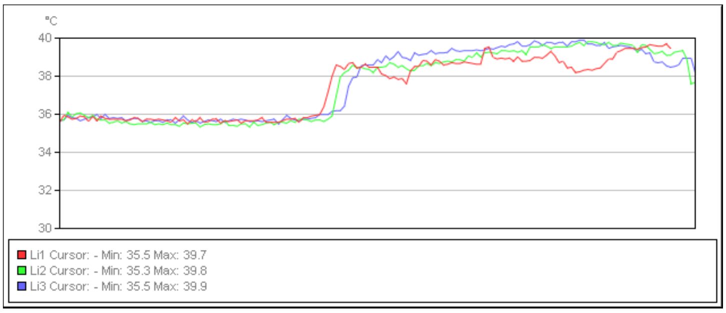
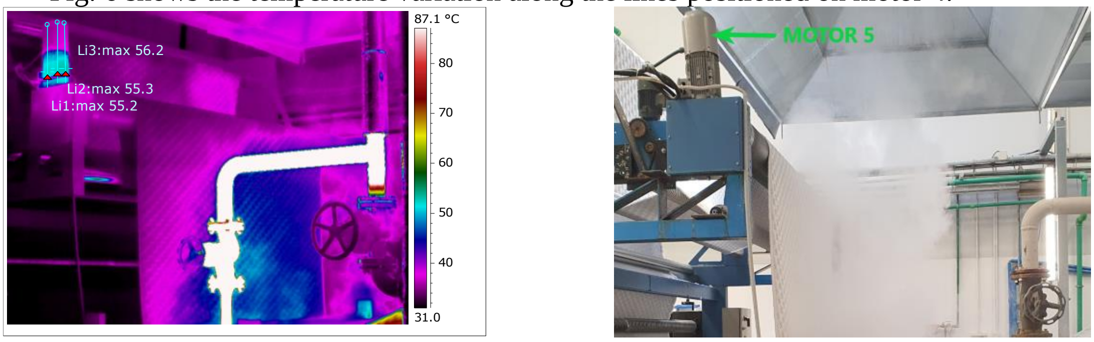


Fig. 6*: Temperature variation along the lines positioned on motor 4*

As it can be seen from Fig. 5 the maximum temperature along line Li1, which is positioned on motor 4, is 39.7°C, and the minimum temperature is 35.5°C. The temperature variation along line Li1 is 4.2°C, and the emissivity is 0.85 along line Li1, positioned on motor 4. The maximum temperature along line Li2, which is positioned on motor 4, is of 39.8°C, and the minimum temperature is 35.3°C. The temperature variation along the Li2 line is 4.5°C, and the emissivity is 0.85 along the Li2 line, positioned on motor 4. The maximum temperature along line Li3, which is positioned on motor 4, is 39.9°C and the minimum temperature is 35.5°C. The temperature variation along line Li3 is 4.4°C, and the emissivity is 0.85 along line Li3, positioned on motor 4.

Fig. 6 shows the temperature variation along the lines positioned on motor 4.



a) b)

Image Camera Type	FLIR SC640
Li1 Max. Temperature	55.2 °C
Li1 Min. Temperature	36.5 °C
Li1 Max - Min Temperature	18.7 °C
Li1 Emissivity	0.85
Li1 Object Distance	2.0 m
Li1 Reflected Temperature	22.5 °C
Li2 Max. Temperature	55.3 °C
Li2 Min. Temperature	37.6 °C
Li2 Max - Min Temperature	17.8 °C

Li2 Emissivity	0.85
Li2 Object Distance	2.0 m
Li2 Reflected Temperature	22.5 °C
Li3 Max. Temperature	56.2 °C
Li3 Min. Temperature	37.8 °C
Li3 Emissivity	0.85
Li3 Max - Min Temperature	18.4 °C
Li3 Object Distance	2.0 m
Li3 Reflected Temperature	22.5 °C

Fig. 7*:IR and real spectrum image of motor 5 and temperatures along the measured lines: (a) infrared image, (b) real image.*

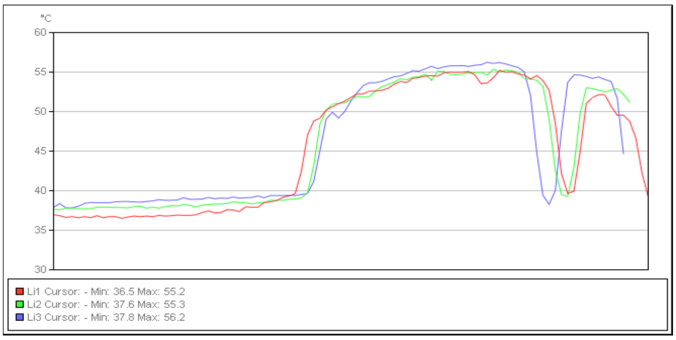


Fig. 8*: Temperature variation along the lines positioned on motor 5*

As it can be seen from Fig. 7 the maximum temperature along line Li1, which is positioned on motor 5, is 55.2°C, and the minimum temperature is 36.5°C. The temperature variation along line Li1 is 18.7°C, and the emissivity is 0.85 along line Li1, positioned on motor 5. The maximum temperature along line Li2, which is positioned on motor 5, is of 55.3°C, and the minimum temperature is 37.6°C. The temperature variation along the Li2 line is 17.8°C, and the emissivity is 0.85 along the Li2 line, positioned on motor 5. The maximum temperature along line Li3, which is positioned on motor 5, is 56.2°C and the minimum temperature is 37.8°C. The temperature variation along line Li3 is 18.4°C, and the emissivity is 0.85 along line Li3, positioned on motor 5.

Fig. 8 shows the temperature variation along the lines positioned on motor 5.

5. CONCLUSIONS

The failure of one ventilation motor can have significant negative impacts on the overall performance and effectiveness of the treatment process. It is important to promptly address and repair any malfunctioning motors to ensure the continued operation of the equipment and maintain the quality of the treated material.

Overall, by implementing a predictive maintenance strategy and regularly monitoring key parameters, textile manufacturers can prolong the lifespan of their machines, improve operational efficiency, and reduce maintenance costs.

A malfunctioning motor can decrease the overall efficiency of the ventilation system, potentially leading to longer processing times and higher energy consumption.

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