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IR CAMERA APPLICATION IN CONTROL OF THE CURRENT STATE OF AN INDUCTION FURNACE IN LABORATORY CONDITIONS

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ABSTRACT – This paper presents the application of a thermal imaging camera (IR camera) in laboratory conditions in order to obtain data for current state of induction furnace. Therefore thermal imaging measurements were done inside the furnace as well as outside, on different areas to check heating and possible overheating of furnace's inner wall. In this manner, these data can help solving some problems in work and maintenance the furnace itself.

Keywords: Thermography, IR camera, Furnace, Laboratory.

INTRODUCTION

Thermography is a non-destructive technique that uses an IR camera to identify temperature differences on objects: from buildings to devices, even spare parts in various fields. IR cameras are widely used in industry, medicine and home as well. The advantages of thermal imaging are, besides non-invasiveness, high precision and the fact that recording can be done in different weather conditions. The principle of technique itself is the same, only camera specifications differ.

Each object can emit infrared radiation (IR) related to it's temperature. Thermal imaging cameras (IR cameras) detect this radiation and display temperature differences on the screen. In that way, the camera creates a thermogram based on those temperature differences, an image that shows temperature changes. Therefore, the application of these cameras is multipurpose. IR cameras are successfully used in maintenance to detect early signs of malfunction, in process monitoring to detect heat losses as well as building inspection [1, 2, 3].

In metallurgy, thermography is used in determining a technical state of devices (furnaces, pipelines, etc.) and in the monitoring of processes (production – steel, copper…, plastic deformation, heat treatment). IR camera gives us the possibility to make fast analysis of the state of the devices during their normal work and plays an important role in the prevention of the deterioration of their technical condition [4, 5].

Consequently, the aim of this paper is to point out the application of IR camera in

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furnace control state in laboratory conditions. So, based on monitoring the thermogram of the tested furnace, it is possible to establish the cause and degree of possible malfunction and in this way prevent the complete failure of the equipment by taking preventive measures in a timely manner of maintenance

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EXPERIMENTAL

Flir E40 thermal imaging camera was used in laboratory investigations in order to check the temperature of the induction furnace, i.e. its existing state. Its main characteristics are given in Table 1:

Table 1 FLIR E40 camera characteristics [6, 7]

IR resolution (array size)	19,200 (160 x 120)
camera mass	825 g
thermal sensitivity	<0.07 °C (70mK)
field of view	25°H x 19°V
LCD touch screen	320 × 240 dots
temperature range	-20° C to +650° C (-4 to 1202°F)
accuracy	± 2° C or ± 2%
visual camera	3.1 MP
spectral range	7.5 to 13µm
thermal palettes	Arctic, Gray, Iron, Lava, Rainbow, Rainbow high contrast; plus all inverted

Measurements were done at room temperature (20 °C) at a distance of 1 m from furnace and with a camera emissivity of 0.95. The values of emissivity depend of material, because the emissivity means ability to emit electromagnetic radiation.

Tests were performed in laboratory conditions, on the induction furnace shown in Figure 1.

Figure 1 Induction furnace

RESULTS AND DISCUSSION

Thermal imaging measurements were carried out in the laboratory in order to determine the current state of the induction furnace. Therefore, measurements were done not only inside the furnace yet outside as well. The software FLIR Tools+ has been used for thermogram analysis. This is licensed software that includes all the features of the free FLIR Tools [6, 7], as well as some new capabilities. The results are shown in Figures 2 – 4, and it can be seen on thermograms which area (or spot) has maximum (minimum) temperature.

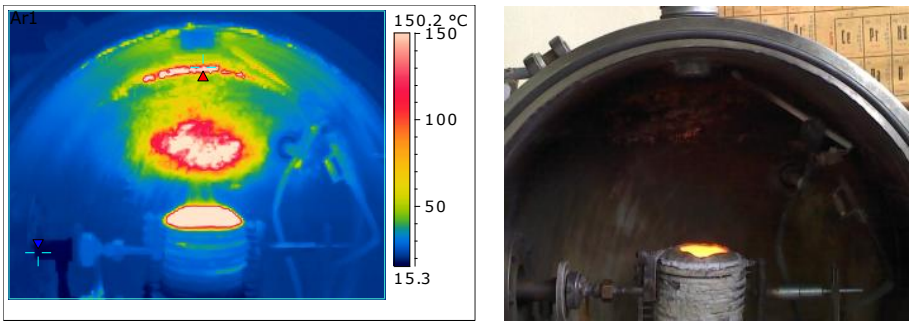

Figure 2 IR and digital photo of induction furnace (inside)

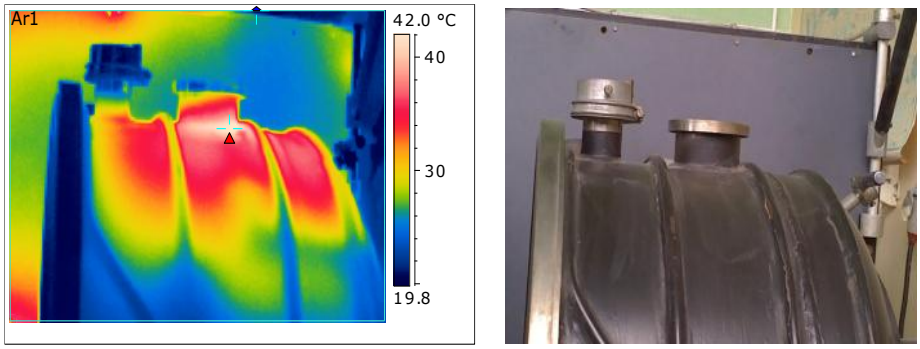

Figure 3 IR and digital photo of induction furnace (outside)

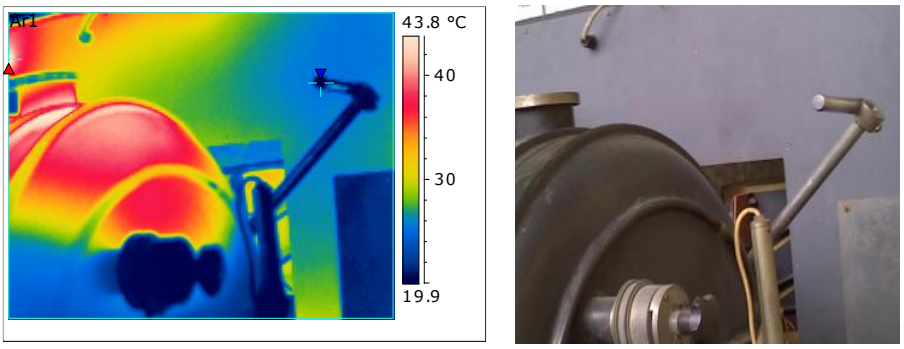

Figure 4 IR and digital photo of induction furnace (outside - different area)

It should be mentioned that the measurements at the same places were repeated in several series at different times, in order to control and monitor the operation of the furnace. Also, any major deviations of the series measured values were not observed.

In Table 2 the results of three series of measurements are given. The results are related to thermograms given in Figures 2 - 4: temperatures for Outside area 1 are related to Figure 3, while ones for Outside area 2 are related to Figure 4.

Table 2 Measured temperatures of induction furnace

	Series 1		Series 2		Series 3	
	Max t	Min t	Max t	Min t	Max t	Min t
Inside area	>150.2 °C	15.6 °C	>150.2 °C	15.3 °C	>150.2 °C	15.5 °C
Outside area 1	42.5 °C	18.6 °C	41.5 °C	19.6 °C	42.2 °C	18.9 °C
Outside area 2	50.7 °C	19.6 °C	50.5 °C	19.8 °C	50.5 °C	19.7 °C

CONCLUSION

Thermal imaging as a non-contact measurement method has a wide application in the control of processes as well as devices and equipment because it does not disturb their operation. The trend of technological development has enabled the application of thermal imaging in the fields of power engineering, mechanical engineering, metallurgy, construction, medicine, in thermal energy transmission systems, construction and implementation of computer systems for monitoring numerous systems, as well as in many other areas of work and detection of the state of plants and objects. Therefore, in this paper the results of temperature measurements recorded by an IR camera on an induction furnace in laboratory conditions are given.

Thermal imaging measurements were performed in laboratory conditions in order to control the current state of induction furnace. Measurements were done on different areas of the induction furnace – inside and outside. Obtained temperature values measured in several time series did not show significant deviations.

Based on the results of the experiment, it is possible to conclude that the thermal imaging (IR) camera is an excellent device for recording the current state of the equipment. In that manner, it is possible to diagnose the problem immediately and pointed out to a specific situation.

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