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Radim JANALÍK*, Tomáš VÝTISK**

UTILIZATION OF SURFACE TEMPERATURE MEASUREMENT IN INDUSTRY

VYUŽITÍ MĚŘENÍ POVRCHOVÝCH TEPLOT V PRŮMYSLU

Abstract

This article describes two examples of utilization of surface temperature measurement of solid substances. These surface temperature measurements are carried out through the use of spot-welded thermocouples, and the measurement itself, archiving and data processing were performed using SOLARTRON Schlumberger measuring system. The diagnostics measurements were carried out in order to detect the issue of uneven heating of door components and electromotor frames in the technological process of their production.

1 INTRODUCTION

The reason for the above described measurements was the suspicion of manufacturers regarding uneven temperature fields during heating of electromotor frames at the time of their assembly and the inside of stainless steel cover plates and aluminium door frames during the pressing process. In both cases, the uneven heating or the local high temperature causes their destruction. These are technological problems of various manufacturers and measuring surface temperatures makes it possible to solve these issues.

Measurement of surface temperatures by means of thermal camera is not possible in these cases. Electromotor frames are heated in a transformer box with minimum space between the heated electromotor frame and the heating transformer. When the doors are pressed, it is possible to measure the temperature only inside the doors, as the exterior surfaces are stressed by the press. Due to the above mentioned facts, the realization of temperature measurements of these surfaces is possible only by using spot-welded thermocouples. While this method is time consuming, it is the only feasible one in the above described examples.

2 MEASURING SYSTEM

The measured temperatures were taken and saved by SOLARTRON Schlumberger measuring system, which is a computer-controlled system suitable for thermal-technical measurements in power plants and industry. SOLARTRON Schlumberger measuring system, which is used for the above described measurements, consists of a computer I/O card "3595 4A" and external collecting cards "IMP 35951". This measuring system complies with ISO 2548 and ISO 9001 standards. Communication between the interface card (4A 3595) located in the PC computer and the external collecting cards (IMP 35951) is performed through an S-Net cable, whose length can be up to 1500 m. Communication and processing of measured data is performed using "PMS" software.

* Ing. Radim JANALÍK, CSc., VŠB – Technical University of Ostrava, Faculty of Mechanical Engineering, Department of Power Engineering, 17.listopadu 15, 708 33 Ostrava-Poruba, Czech Republic

** Ing. Tomáš VÝTISK, Ph.D., VŠB – Technical University of Ostrava, Faculty of Mechanical Engineering, Department of Power Engineering, 17.listopadu 15, 708 33 Ostrava-Poruba, Czech Republic

External collecting cards (IMP 35951) are 16-bit analog-digital converters, allowing accurate measurement of DC voltages, currents, temperatures (directly from thermocouples and resistance thermometers). During temperature measurements using thermocouples, these collecting cards allow compensation of the thermocouple cold end by means of built-in thermistors or by entering exact ambient temperature.

The temperature measurement error when using this system with thermocouple of "K" type is <0.3 °C in the range of -100 ÷ +450 °C, <1 °C in the range of -200 ÷ +1370 °C, which is in compliance with IEC 584 (BS 4937) standard.

SOLARTRON Schlumberger measuring system was used for all measured surface temperatures. These measured temperatures were taken, saved and processed with specified accuracy in selected interval. Further measured data processing was performed using PMS service software and Excel editor in spreadsheet or graphical form.

The SOLARTRON Schlumberger measuring system as a whole is calibrated in a calibration laboratory accredited by the state.

3 TEMPERATURE MEASURMENT METHODOLOGY AND DESCRIPTION OF MEASUREMENT POINTS

The measurement was performed using spot-welded thermocouple type "K" (thermocouple wires Ni and NiCr with a diameter of 0.3 mm) on the surface of the examined parts. They were a stainless steel plate and an aluminium door frame and an aluminium electromotor frame. The distance between the individual spot-welded wires in the measuring point was approx. 3 mm. The spot-welding was realized using a condenser welder (spot-welder). The individual thermocouples were attached by compensating wiring to the SOLARTRON Schlumberger measuring system.

The measurements were made simultaneously by 10 to 15 thermocouples. Thermocouples type "K" were spot-welded to selected points on the surface of the individual machine parts (door frame, electromotor frame) using condenser welder. Spot-welding of the thermocouples was carried out partly before the actual measurement directly in the production hall and partly, it was prepared before the arrival to the measuring site. The measuring points were agreed with the production department in such a way so that the surfaces of the examined parts were mounted in problematic areas where the overheating occurs.

Figure no.1 show examples of surface temperature measurement using spot-welded thermocouples in selected points and the interconnection of SOLARTRON Schlumberger measuring system with a computer using "IMP" collecting cards and the communication cable.

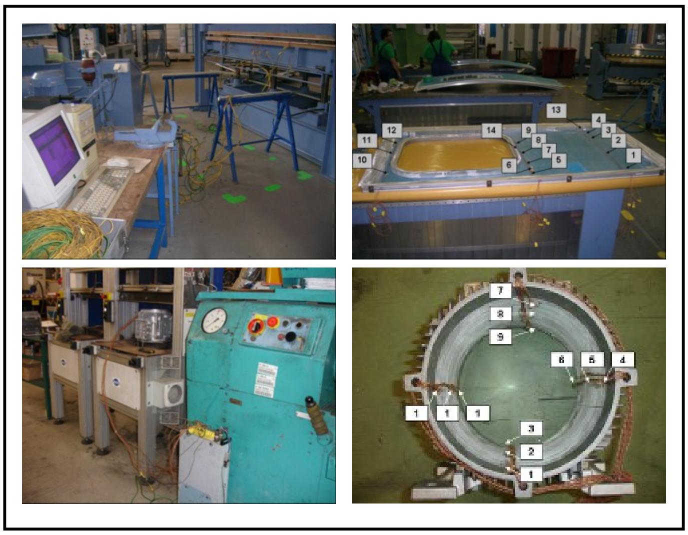

Fig. 1 Examples of surface temperature measurement.

The measured temperatures were taken and saved using this system in 1s intervals and, by means of the service software, they were visualized online on a PC monitor in use.

The representatives of manufacturers, who were always present at the tests, could optimize the heating according to the temperature curves on site, or they could change the position of the examined electromotor frames in the heating transformer.

4 MEASURED AND CALCULATED VALUES

The measured temperature curves of heating and cooling of the examined parts during the individual measurements were graphically processed and the charts provide clear-cut information.

For example, figures 2 and 3 describe data processing for heating and cooling of the electromotor frame in a heating transformer using its various heating powers, and figure no. 4 shows graphic data processing of measurements during heating and cooling of doors in press.

Figures 2 and 3 clearly show apparent differences in temperatures measured at the same measuring points when the same electromotor frame is heated. Figure 2 shows the development of temperatures at higher power of the heating transformer; figure no. 3 shows the development of temperatures at lower, optimized power of the transformer. The trend of increasing temperature at higher power is steeper, the heating time is shorter (about 30s), but on the other hand, the temperature distribution is uneven. The differences at the end of the heating were up to 150 °C, in this case. The maximum achieved temperatures were also up to 350 °C. In contrast, at lower power, the temperature distribution is even (temperature differences at the end of heating were about 50 °C), the maximum achieved temperatures were about 270 °C. The pictures illustrate the temperature curves for one type of electromotor frame. For other types of electromotor frames and other types of heating transformers, the measured temperatures even exceeded 400 °C.

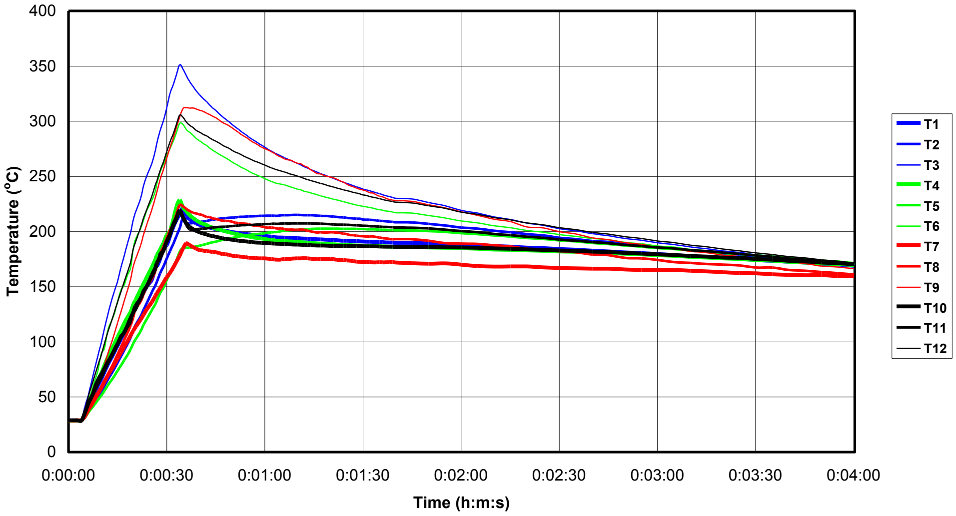

Fig. 2 Heating of the electromotor frame in a heating transformer using its higher power.

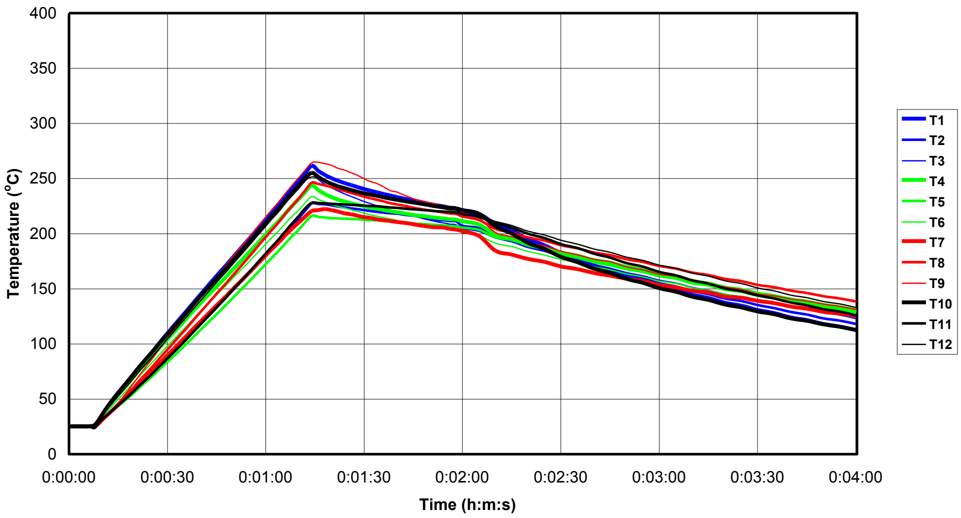

Fig. 3 Heating of the electromotor frame in a heating transformer using its lower power.

On the one hand, higher power of heating transformer leads to faster heating, to higher work efficiency and to increased number of mounted frames per shift, but on the other hand, higher achieved temperatures and their uneven character may cause technological problems during installation.

These measurements represent an ideal solution for manufacturers for optimizing the heating method, setting the optimum performance, or for adjusting heating transformers in order to increase production efficiency.

The individual components of sandwich safety doors use heat sealing production technology in time-standardized loads in the press. It is absolutely necessary to keep their required surface temperature for perfect bonding of the individual parts. In case of uneven distribution of temperatures during the pressing process, the required parameters of the electric heating can be set by means of a service intervention and adjustment of the individual resistance loops in the working press.

From the measured values of surface temperatures on the inside of the stainless steel cover plates and from their processing in graphical and tabular form, it can be proved that there are temperature differences in various points on the surface of the cover plates, which causes their uneven thermal load.

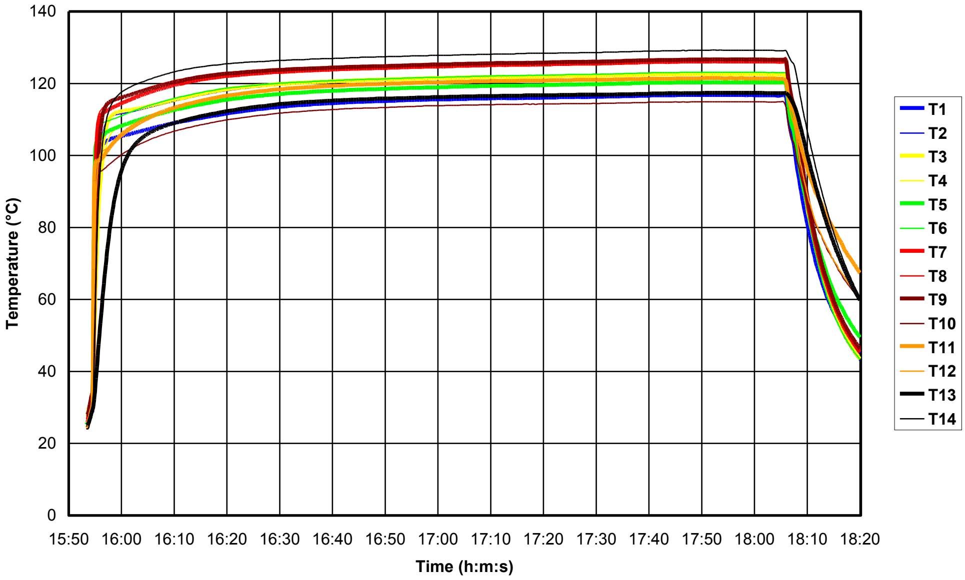

Fig. 4 The temperature curves during heating and cooling of doors in press.

Figure no. 4 makes it obvious that different temperatures were measured on the surface of the cover plate and the difference between the hottest and coldest place was up to 10 °C, while the highest temperature was, after 130 minutes in the press, measured at point no. 4 (127 °C) and the lowest one at point no. 1 (117 °C). In addition, according to graphic dependence, it is possible to state that all temperatures during the first two minutes will increase by approximately 80 °C, which is a trend of 40 °C / min. In the following 35 minutes, they rise in the trend of 0.43 °C / min, up to the values of 115 ÷ 124 °C. Aluminium frame had approximately the same temperature increasing trend at measuring point no. 14, where, however, the maximum temperature at the end of the heating was 129 °C.

5 CONCLUSION

From the measured values of surface temperatures at the individual measuring points, it was possible to prove that there was a difference in temperatures at the measuring points on the surface of the individual parts, which had caused their uneven thermal load. Manufacturers could use the acquired data to draw the necessary conclusions on the basis of which they modified the technological process of production.