

## Thermography in Quality Assurance

Automated Infrared Thermography for Temperature Measurement in Industrial Processes



**Quality assurance and process enhancement is essential to complex industrial processes. Leading businesses rely on certified quality management, to allow for matters of quality and environmental sustainability even during the early stages of manufacturing development. In co-operation with Kirchhoff Automotive GmbH, InfraTec GmbH developed an automated thermography solution to inspect the product quality of press hardening with an accuracy of 100 %.**

Kirchhoff Automotive GmbH, located in Iserlohn, with its core technology in the metal structure sector of automobiles, demands high quality standards of its own products and follows a strict zero-defects-policy. "We are introducing procedures, which monitor and ensure the effectiveness of our quality- and environmental policies and their respective measures. We check for deviations of our quality- and environmental policies in internal audits and take the actions necessary to achieve our goals" is one of the official company slogans of Kirchhoff Automotive GmbH, regarding quality and environment.

Mainly, sheet metal parts are formed by cold pressing, which makes good rheological behaviour necessary. However, high stability is required as well. It can be obtained by several approaches. If the sheet metal does not have a sufficient diameter, it will be reinforced with stiffening structures during the pressing stage. It is also possible to harden thin sheet metal parts to obtain higher strength. The required structural change is effected by a defined cooling of the previously heated material. The reshaping of hardened sheet metal is complicated, since the now occurring spring effect results in high tolerances.

The combination of shaping and cooling during the pressing stage – called press hardening – can be an alternative. It combines both advantages: reshaping free from breakage and increase of strength. Parts which have been produced this way are lighter and show the same strength as those produced conventionally. Pressed goods, such as axle parts, beams and suspensions which come from hot forming and which are used in critical parts of a vehicle have to be checked particularly carefully. That is why Kirchhoff Automotive already uses thermography as a completely process-synchronic mechanism to measure temperature during the production stage, to ensure the required quality of every single part.

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## Application of thermography in non-destructive testing

Randomised and contacting thermometry with contact thermometers, as well as measurements with pyrometers parallel to the manufacturing process do not allow for complete monitoring of the cooling process of the entire component. According to the factory manager Timo Müller, the alternative of subsequent “destructive testing to determine the mechanical characteristics” is “linked with expenses and waiting time”, which do not guarantee an ideal manufacturing process.

Thermography offers a safe and efficient solution in the field of material testing. As an extensive, non-contact, and automated measuring procedure, it is capable of recording thermograms and evaluating them according to predefined thresholds and limits. To Kirchhoff Automotive, the most advantageous aspect of thermography is “receiving a quick qualification of thermal imperfections in less than a second – even during the running manufacturing process, without an impact on the press-hardened parts”, confirms factory manager Timo Müller. The very reliable evaluation of the collected data is reason for the following sorting of imperfect parts and the resulting necessary process optimisation. Post-hoc and large-scale analysis of collected thermograms is possible on every computer, using the IRBIS® 3 professional thermography assessment software, made by InfraTec.

## Specific customer requirements demand for individual solutions

The process of pressed parts manufacturing, in a case of application, generally consists of the following steps: before entering a press, the sheet metal parts will be heated in a continuous furnace. Inside the press, the parts will be cooled down again. The so-created mechanical characteristics are essential for the following application as chassis in automotive engineering. The redundant heat is detracted by a controllable liquid cooling. To monitor the temperature of the pressed goods on the output side, a thermography camera is used.

This customised automation solution was integrated into the existing production system by InfraTec, based on its long-term experiences in infrared thermography technology in various industrial branches. The planning of a metering project is always preceded by a full-scale analysis of the test circumstances. A modular system of thermographic automation, developed by InfraTec, is the starting point of every customised solution.

Consisting of thermography camera-, transmission-, gauge-, interface-, industrial computer-, and software-components, it allows for flexible tailoring to the exact requirement, based on well-tried modules.

Process heat-based thermography automation solutions mostly rely on compact and very robust, uncooled microbolometer camera technology.

To Kirchhoff Automotive, crucial buying criterion for InfraTec’s automation solution were the “flexible one-source solution” and the efficient “capability to create thermal images in real-time”, according to Timo Müller. At Kirchhoff Automotive, process thermometry happens without contact, which means it takes place outside the press, using an industrial computer to control a thermographic camera VarioCAM® hr head in long wave spectral range (7.5 ... 14) µm. An area of approximately (2 x 2) m can be captured at the current working distance. The geometrical resolution of (640 x 480) IR-pixels detects objects of a minimum size of 4 mm. In the hot forming process described above, the sheet metal part is picked up by a claw and then hovers above the camera until the metering is done. The repeating accuracy of the claw-mechanics is very high, therefore the sheet metal will be positioned with only minimal variation. This makes several tasks possible: ranging from an easy comparison with a previously saved reference image, to calculations of extensive dispersion of temperature differences. Utilisation of a software-based evaluation of the thermograms can ensure that process specific temperature limits will be observed. For instance, if an increased temperature is detected in an area on the preform, the pressed part will be sorted out, since it would not have the necessary structure and therefore lack strength. The thermometry sequence is controlled by an industrial computer, which is connected to the superior process guide-system of the press that feeds the computer information about the ongoing process. The specifically customised thermography software IRBIS® 3 organises the test sequence

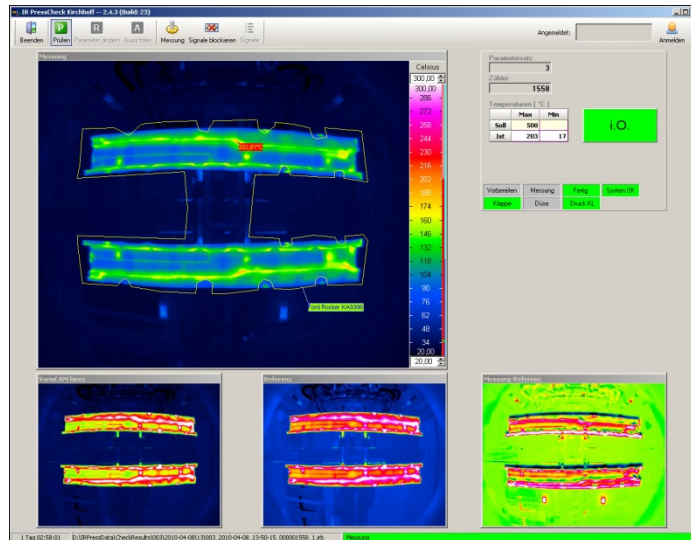
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and evaluates digital images delivered by the thermography camera. The results will be sent to the guide-system of the production process in accordance with the presses clock cycle. It is possible to manage different moulds and evaluate and record their respective data at once. This guarantees universal system operation for various orders which are being processed by the machine.



III. 1: Control- and evaluation unit, used to operate the press camera and to transmit evaluations to the press control



III. 2: Evaluation software IRBIS® 3 used for real-time display of thermograms from different sources (current measurement, live image, reference, difference) in automatic test mode

### Automated thermography measurement methods for high reliability

During the realisation of the thermographic quality assurance system, InfraTec focussed particularly on its reliability. Therefore, important components are equipped with monitoring- and self-reactivation mechanisms. Consistent production can only be ensured by a consequent realisation of measures that guarantee continuous operation. The amount of wearing parts is reduced to a minimum and every part can be exchanged quickly.

Air conditioning in the evaluation unit provides for a stable process environment, even in varying temperatures. The converter components and sensors inside the measuring head of the press have been covered with a housing made from stainless steel to protect the measuring instruments. The house also allows for adjustment of the optical axis and has a pneumatically powered hatch, which reduces soiling to a minimum. During the metering, an air curtain ensures that no tinder can reach the lens. Overpressure inside the camera housing keeps the components dust-free and prevents a congestion of hot air. Incorrect operation can be prevented with a user administration with password protection and adjustable access rights. Furthermore, the automated measuring process will not allow any changes of parameter settings in order to prevent unauthorised alterations. It is possible to start the analysis software in an automatic inspection mode to ensure unattended system operation. Settings which are relevant to the system's output quality, such as the introduction and change of reference mouldings, can only be controlled by authorised personnel. Every moulding can be assigned an individual set of parameters, which will be used by the press for their respective production order. Each set includes a number, a reference image that shows the tested area and the assessment criteria. Therefore, no manual change will be necessary to adjust the production. Reliable measurements are guaranteed from the very beginning, as well. To parametrise the press goods, they will be matched with a software-mask. To do that, a suitable press part will be analysed

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thermographically. The degree of emission of the product's surface can be determined beforehand to ensure accurate measurements.



*III. 3: Stainless steel housing with pneumatically power hatch to protect the measuring instruments, converter components and sensors*

### Thermal images for zero-defects-, quality- and environmental policies

Kirchhoff Automotive GmbH has introduced a method to guarantee and monitor its own quality policy with InfraTec's individual automation solution. The completely automatic quality assurance with outspoken reliability for press hardening is the basis for maximum occupancy operation. Factory manager Timo Müller confirms, that the system "has been running trouble-free for two years" and that Kirchhoff Automotive is "very happy with InfraTec's automation solution and the co-operation between both companies".

In addition, plannable short maintenance breaks allow a minimisation of idle time. High product requirements as well as safe handling under harsh conditions are standards that can be met with InfraTec's automated infrared measurement solution. Individual configuration of controllable data analysis and evaluation is made possible by the modular system INDU-SCAN. Additionally, comprehensive examination of thermograms can be done with the IRBIS<sup>®</sup> 3 software. Follow-up costs can be stopped by means of complete inspection, since no defective parts will be built-in any more. The effect of the measurement output at the press on the optimisation of the cooling process is essential to meet the customer's product requirements. Higher acceptance of high-quality parts in automotive engineering affirms investments in product- and process optimisation through higher long-term volume and certification of the quality management system.

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