

## Optimizing temperature control in fully automated induction systems

### Summary

The use of appropriate temperature sensors is a prerequisite for optimal temperature control in induction heating systems. Pyrometers, because they detect temperatures in milliseconds without contact, are ideally suited for such applications.

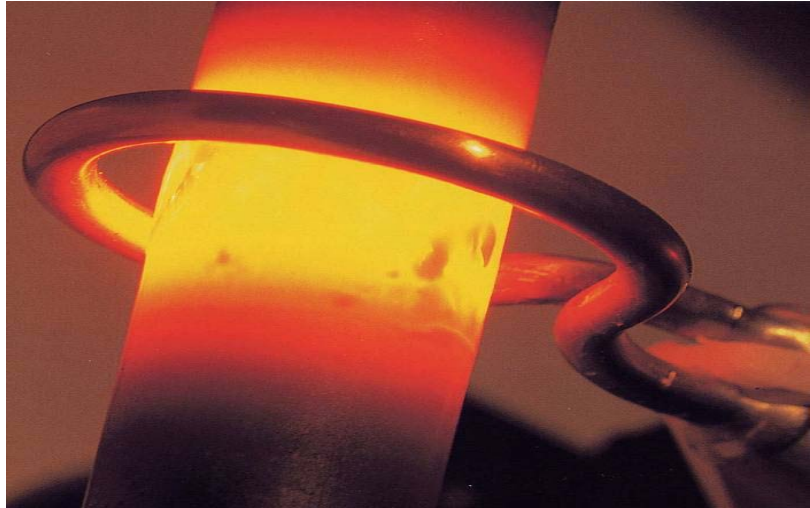
Aside from metrological characteristics, a pyrometer's optical imaging qualities will significantly influence the measurement reading.

A pyrometer's sighting device greatly facilitates the accurate alignment towards the heating zone. Innovative focusable optics with an integrated LED spot light not only show the position of the target spot but indicate the exact spot size as well. Because the measuring distance is adjustable, these instruments are extremely versatile and can easily adapt to the spatial conditions of the inductive equipment on-site.

### Introduction

The quality expectations of metal materials such as steel, aluminium, copper and various alloys used for modern machinery and motors are constantly on the rise. Material properties must be improved to satisfy the industries' exacting and ever-increasing requirements. Post-process heat treatment plays a most significant role in enhancing performance characteristics of a metal material. Furthermore, production facilities must comply with stringent environmental regulations while increasing production quantities and improving process reliability. What this means is that modern facilities must produce greater outputs and meet demanding quality standards in regard to process and material.

Heating by means of induction has gained significance in the last few decades. This heating method's ver-



A single induction coil heating a workpiece

satility and speed make it suitable for a multitude of applications. The application range covers various heat treatment processes, from hardening, annealing and tempering to melting, soldering, welding and shrink fitting up to powder coating systems and special-purpose machines.

Induction technology, when paired with state-of-the-art control systems, enables manufacturers to achieve the desired objectives. This, however, requires strict adherence to production parameters, especially with fully automatic and semiautomatic production lines. Industrial consumers such as the automotive industry as well as their suppliers have increasingly come to demand that crucial parameters be monitored and documented as a quality Principle of Induction Heating

The operating principle of high-frequency induction heating consists of placing an electrically conductive material in a fluctuating electromagnetic field. The induc-

tion heating power supply sends alternating current through a single or multiple induction coil, thus generating a magnetic field. When a workpiece is placed within the induction coil and enters the magnetic field, eddy currents are induced within the workpiece, generating precise and localised heat. An induction heater works according to the same principle as a transformer: the inductor functions as the primary winding and the workpiece as the secondary winding.

### Advantages of Induction Heating

In a conventional heat treatment furnace the entire workpiece is heated; this is a relatively slow process. In modern heat-treatment technology only a few millimeters of the peripheral surface of the workpiece are heated. Because the cross-section of the workpiece is unaffected and remains cold, shrinkage or expansion of the workpiece is much less likely to occur than with the conventional heat treatment method. The fact that the material is quickly and uniformly heated because the precisely controlled energy is spe-

cifically aimed at the workpiece presents a further advantage of this method.



Fully automatic brazing machine for circular saw blades

Pyrometers are perfect for fast, non-contact temperature measuring during partial heat treatment. Induction heating is also advantageous for soldering and brazing tasks. Due to the highly efficient heating process—virtually heating from the inside out—induction soldering and brazing provides more rapid and uniform heating than a soldering iron. An induction loop is virtually wear-free because it is a non-contact method.

### **Demands on today's production facilities**

Modern industrial plants aim to manufacture or treat components using sophisticated technology to produce uniform quality. The requirements, and thus the process parameters, are narrowly defined. Failure to comply with such variables and limits would result in destroyed or damaged components. One of the most significant variables relevant to the induction heating process is temperature. In applications involving partial heat treating, pyrometers are the temperature measuring instrument of choice as they provide extremely quick temperature readings

without contact to the component surface.

### **Pyrometers for induction heating equipment**

KELLER HCW GmbH's CellaTemp® PS and CellaTemp® PL Pyrometer Series were specially designed for induction heating applications. Because these instruments can measure temperatures between 0 °C and 1400 °C, they cover the entire temperature range of induction heating processes.

Since heating is only required at selected, localised points, it is all the more important that the instrument provide a high resolution and thus precise targeting to a very small spot. Due to the pyrometers' broad-band, antireflection-coated high-precision optical system, targets with a diameter as small as  $\varnothing 0,8$  mm can be achieved.



The pyrometer detects the temperature precisely at the target spot

For many applications, recognizing the precise measurement spot can be quite helpful and is sometimes even absolutely necessary. Lasers are often used for this purpose. Their disadvantage, however, is that they only show the centre of the spot. A laser cannot indicate the true spot size or correct focus.

Furthermore, the service life of lasers is limited, and they may pose a potential health hazard.

The instruments of the CellaTemp® PS 28 Series have an integrated LED spot sighting system to indicate the exact target spot. With its fixed focus optics, this pyrometer is especially suitable for close-up applications between 100 to 400 mm.

For its new CellaTemp® PL Pyrometer Series, KELLER HCW GmbH has developed an innovative optical system.



CellaTemp® PL 20 with focusable optics and integrated spot sighting system

This pyrometer, which also includes the integrated LED to indicate the true spot size, is distinct in that it can be focused. A sharply defined image of the spot is evidence of proper focussing. The focussing ability of the optics (measuring distance from 200 mm to  $\infty$ ) makes the CellaTemp® PL 20 extremely versatile, as it can be easily adjusted for the specific distance of the measurement task.

Both instruments make it easy for the commissioning engineer or machine operator to correctly align the pyrometer prior to initial operation. The continuously lit spot light acts as a function control or status indicator because the user can immediately identify any shift from the target position. In this way, greater process reliability can be achieved.

For precise temperature control of rapid heating process, a pyrometer must be able to instantly detect temperature changes. CellaTemp PS 28 and PL both offers a response time of 2 ms and are therefore ideally suited for immediate process control.

Because installation space at induction heating equipment is often limited, compact size is of utmost importance when choosing an instrument. With a diameter of 30 mm and a length of 190 to 230 mm, these pyrometers—thanks to the screw thread mounting—can easily be installed in cramped locations.

The CellaTemp PZ Pyrometer Series with fibre optics is ideal for measurements in especially difficult-to-reach places or when extremely powerful electromagnetic fields are expected.

These instruments have a separate sensor head which only contains the optical components. A fibre optic cable transmits the infrared radiation to the electronics, conveniently located out of the way. Two sensor head models are available ( $\varnothing$  30 x 72 mm und  $\varnothing$  16 x 27 mm), both of which are adjustable for the distance to the target. These instruments also feature the spot sighting system to indicate the exact spot size.

## Conclusion

Successful metal heat treatment processes demand not only an excellent heat source but a high-precision temperature monitoring system as well. The latest sensor technology combined with large priced infrared optics and filters meet the demands of the market for quality and value. No matter how good the individual components and materials used may be, ultimately, the quality of the final product is only as good as each step in the process that manufactured it.



Pyrometer CellaTemp<sup>®</sup> PZ with separate sensor head