Two-colour measuring method for process reliable temperature control during tempering of rod material

by Albert Book

For tempering rod and tube material, induction technology has increasingly replaced conventional heat treatment. With inductive heating, the electrical energy is converted into heat directly in the material.

The great advantage are a faster heating time, a high thermal efficiency and a targeted local and time-dependent power input with precise temperature-controlled processes. The short heating and holding time at austenite temperature during inductive tempering minimizes scale formation and prevents decarburization.

Optimum functional properties with regard to hardness and durability on the one hand and ductility with the same high wear resistance on the other hand should be achieved by thermal heat treatment during hardening, quenching and tempering.

The aim of hardening is to completely convert the initial structure into austenite and to achieve a homogenous distribution of carbon. The more precisely the specific course of the conversion process is maintained during heating and cooling, the better the hardening result. The limit temperatures of austenite formation are significantly dependent on the heating speed and holding time as well as on the content of alloying elements. With increasing speed, the conversion temperature is increased.

After quenching, tempering takes place at temperatures between 400 – 600 °C. The short-term heating reduces the hardness or tensile strength in order to achieve better ductility. Here again, inductive heating compared to conventional heat treatment has great advantages, since the usual temper brittleness is avoided when the critical temperature is rapidly passed through.

Inductive heat treatment, however, requires a fast and accurate recording of the material temperature. Ideally suitable are pyrometers, which determine the temperature from the heat radiation emitted by the object according to Planck's formula. The passing rods are measured in milliseconds without contract from a safe distance.

When selecting infrared thermometers, you can choose between spectral pyrometers that detect radiation at one wavelength or two-colour pyrometers that detect radiation at two wavelengths. With a single-channel pyrometer, contamination of the optics or weakening of the radiation by steam and dust in the field of view leads directly to an incorrect measured value. In comparison, the two-colour measuring method has the advantage that it cannot be influenced by such distur-

Fig. 1 *A two-colour pyrometer with rectangular measuring field precisely measures the temperature even with an oscillating wire.*

bances. Even with a degree of weakening of 90 % a two-colour pyrometer still delivers safe and correct measured values. A special feature of non-contact temperature measurement is the influence of the surface, i.e. the emissivity of the workpiece. For example, if the emissivity changes between 70 % and 80 % with an object temperature of 900 °C, the measured value display of a spectral pyrometer varies by approx. 17 °C. A two-colour pyrometer reacts to this much less sensitive.

Especially with thinner wires and rods in the magnitude of the measuring surface of the pyrometer, the correct alignment and focusing of the instrument is necessary to avoid optical measuring errors. Two-colour pyrometers also offer considerably higher process reliability in this respect, since optical influences have less effect in the measuring process compared to a spectral pyrometer. At measuring positions where the wire oscillates, two-colour pyrometers with a rectangular measuring field are now available. The wire may move freely within the measuring field (**Fig. 1**).

Fig. 2 *Tempering of chassis springs requires precise temperature measurement to ensure reproducible production conditions.*

Reproducible production conditions are a decisive factor for good tempering results. The correct adherence to the specified heating up, holding and tempering temperature has a significant influence on the process. In order to achieve optimum measuring results, the two-colour measuring method is to be preferred. The devices should have an optical sighting device in the form of a pilot light or a through-the-lens sighting device. In recent years, more and more devices with integrated video camera have been used to keep an eye on the optical alignment and contamination on a monitor in the control room at all times.

A typical application is the production of chassis springs (**Fig. 2**). Only reproducible and precise process control can ensure that the springs really have the requested material properties. The analogue current output is often still used for the transmission of the measured values to the control system. In the meantime, however, with regard to the implementation of Industry 4.0 interference-free digital signal transmission is being used. With the introduction of the new IO-Link interface technology, a generational change takes place in the field of digital communication. With IO-Link a standardized, manufacturer-independent and fieldbus-independent communication concept was developed. Devices with IO-Link interface can be easily integrated into all common fieldbus controllers by using standardized IODD drivers. In addition to the measured value, diagnostic information or fault messages such as the indication of a dirty lens or the operation at inadmissible ambient temperatures are transmitted to the control system.

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