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Application report: Temperature Measuring System for Molten Steel and Iron

Today's demand for product quality poses an ever increasing challenge to producers of iron and steel goods. To implement their claim for quality products, manufacturers must strictly comply with those production parameters so crucial to quality control.
In the course of quality assurance, industrial consumers of foundry products, i.e. the automotive industry, demand that the manufacturer supply documentation of production parameters upon delivery of the goods. The producer must be able to provide perfect evidence of the manufacturing process. This requires him to continuously monitor and document the measured values which are relevant to quality.

Temperature: an important factor

For the manufacture of iron and steel products, temperature is one of the most significant physical parameters being quantified by measurement. This is why it is so important to continuously measure and record the temperature of the material in process of production.

Up to now temperatures could only be measured by repeatedly and manually immersing a thermocouple into the melting furnace, melting vessel or transfer ladle. The disadvantages of this measuring method are:

- High operating expenses because thermocouples are not reusable.
- Temperatures are only measured sporadically and discontinuously; continuous monitoring and recording of temperatures is not possible.
- The accuracy of the readings will vary, depending on the precision with which the operator of the instrument takes the measurement, such as the position and depth of the immersion.
- Measurement with a thermocouple usually takes place prior to pouring the molten metal; the precise temperature at the very moment the stream of liquid metal is cast into the mould cannot be detected.
- Should a malfunction or disturbance ever occur at the moulding machines - depending on the duration of the disruption - it will not be possible to draw a conclusion about the pouring temperature because the time between the immersion measurement and the casting process will have varied.

New: Non-Wearing Alternative to Immersion Measurement

Due to the problems arising from the immersion method, KELLER HCW has developed an innovative system named „CellaCast" for non-contact temperature measurement using a pyrometer. The molten mass emits thermal and infrared radiation which is measured by the pyrometer and transformed into a signal which is proportional to temperature. Pyrometers do not have any wearing parts, thus no operating expenses are generated due to materials requiring frequent replacement. The acquisition cost pays for itself due to the greatly reduced consumption of thermocouples.

Continuous measurement at just the right spot

At automated casting lines, pyrometers measure the temperature of the molten metal exactly at that crucial point in time which will determine the quality of the finished product: just as the mould is being filled (Photo 1). Desired limit temperatures can be precisely maintained. Photo 2 shows how greatly the temperature can vary from one casting to the next,

Photo 1: Pour stream at an automated casting line

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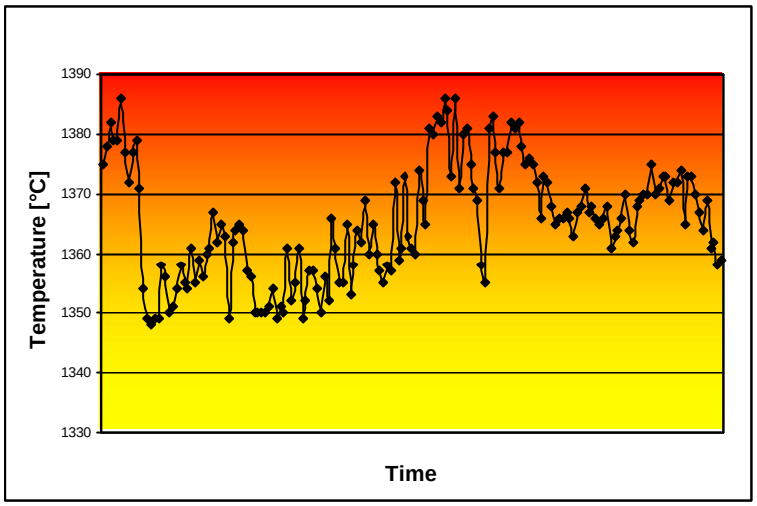

Photo 2: Typical temperature pattern of castings in one day

especially when interruptions occur during the casting process. The temperature of each casting is continuously monitored and precisely recorded, providing verification of compliance with correct casting temperatures. The stationary mounted pyrometers always measure at the exact same spot of the pour stream and at the same cycle time, thus offering a high level of repeatability. The readings are not dependent upon personnel.

Dependable readings even in harsh environments

CellaCast®, the self-sufficient measuring system for automated casting machines, consists of a two-colour pyrometer with precision optics for non-contact temperature measurement. One can rely on dependable readings even in extremely dusty conditions or when the surface characteristics of the molten mass constantly change. CellaCast® is non-sensitive to diverse alloys.

A connected digital display shows the temperature reading of the metal being cast into the mould. Algorithms in the display automatically recognise the moment the molten mass begins to pour and ascertain one temperature value per cast mould. The multifunction display automatically ignores disturbances to the measurement such as emerging flames or when the molten mass drips instead of pours. The readings can be viewed either at the digital display or in the control room and are transmitted via a serial interface to a centralised computer logging system for documentation.

Oftentimes pyrometers with focusable through-the-lens sighting are employed in order to keep a safe distance from the heat. In cramped environments, at high ambient temperatures and when measurement spots are hard to reach, it may be advantageous to use pyrometers in which the optical sensing head and the electronics are separately housed. With such a pyrometer the infrared radiation is transmitted by means of a fibre optic cable. (Photo 4)

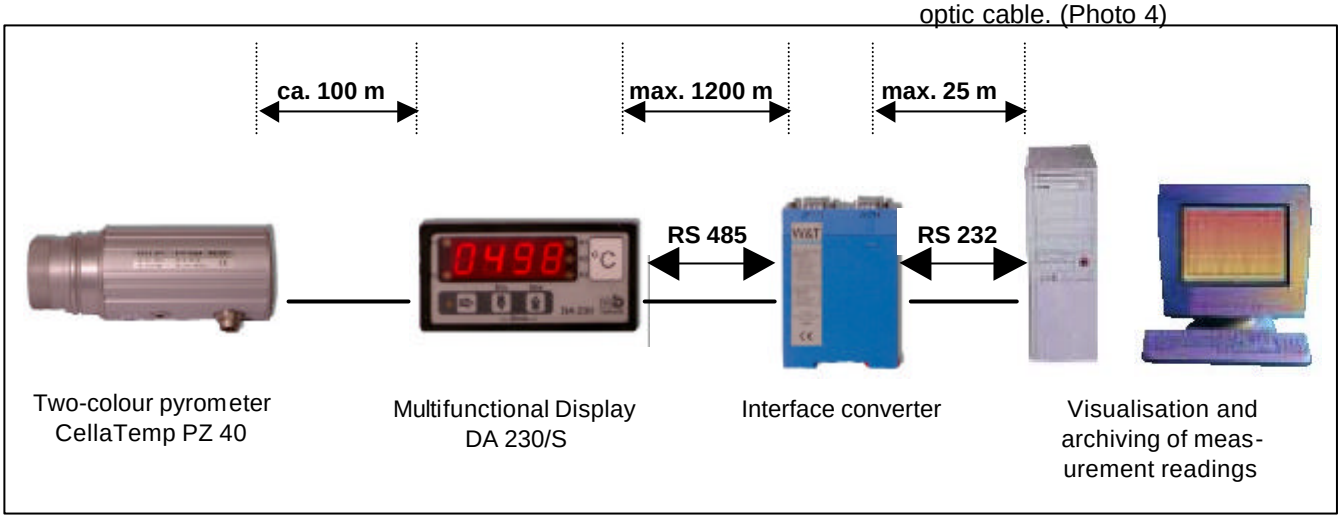

Photo 3: Components of the Measurement System

KELLER HCW GmbH • POB 2064 • 49470 Ibbenbüren • Germany • Tel. [+49] 5451 850 • Fax [+49] 5451 85412 • msr@keller.de • www.keller-msr.de

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Two-colour pyrometers - due to their extremely precise, high-resolution optics - are the best choice for continuous measurement of the molten metal within the transfer channel. There the ambient conditions often dictate that a pyrometer be installed at a considerable distance - sometimes up to 10 m away - from the molten stream. The system's algorithms ignore any surface slag and oxidation.

Optional integrated video camera

Appropriate protective accessories and mounting devices are crucial to the dependability of the temperature monitoring system. When the pyrometer is in continuous use, it must be protected by an axial air nozzle and components guarding against steam, dust and splatter of molten material. As an option, a video camera can be integrated into the CellaCast® temperature monitoring system. The video camera, mounted to the backside of the pyrometer, looks right through the pyrometer lens as would the foundry worker (Photo 5). At the monitor in the control room the foundry employee can view the exact measurement spot and the area surrounding it. A remote controlled swivelling/tilting device rounds out the monitoring system. If the position of the molten stream changes, the alignment of the pyrometer can be easily and quickly adjusted from the control room.

A KELLER HCW service team supports the foundry staff throughout installation, set-up and configuration. Nothing is worse than a cutting-edge monitoring system which yields unusable measurement data due to incorrect user adjustments.

Photo 4: Pyrometer with Fibre Optic Cable

In summary, CellaCast® provides producers of steel and iron products an absolutely modern, non-wearing temperature monitoring system, resulting in cost savings because expendable thermocouples are not needed. Because the temperature monitoring system is automated, it does not require personnel to be engaged in the task of measuring. Operator - caused measurement errors cannot occur. The temperature of the molten mass is continuously ascertained within the transfer ladle or at the molten stream to verify and document quality control of the process.

Photo 5: Temperature Measurement with Video Surveillance at the transfer channel of a blast furnace

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