LAND

AMETEK®

LIQUID METAL TEMPERATURE MEASUREMENTS APPLICATION NOTE

The quality, exclusion of cavities and other properties of a cast part can be significantly affected by its temperature at the point of casting. For this reason, temperature monitoring of the liquid metal as it is poured into moulds, plays an essential role in the production process.

Delivering an accurate and reliable measurement of the metal – unaffected by the hot, dirty, and smoky environment, or by layers of slag or dross forming on the surface of the liquid metal pouring stream or liquid metal bath surface – is challenging.

AMETEK Land produces a range of expert solutions to ensure precise, continuous liquid metal measurements, using non-contact systems based around pyrometer and thermal imaging technology for the best fit to each application.

LIQUID METAL TAPPING AND POURING

Liquid metal tapping is an application that is used with nonferrous metals and alloys, steel, iron, aluminium, copper, and brass. Accurate measurements of the liquid metal temperature are required to ensure product and process quality.

Thermocouples are often used to make these measurements by dipping them into the liquid metal within a ladle. To get the final tapping temperature, a measurement needs to be taken when the liquid metal is poured into moulds. Whilst thermocouples cannot be used for direct pouring stream measurements, non-contact pyrometers and thermal imagers provide an accurate temperature reading of the metal at this point in the process.

Dipping the thermocouple into the metal at this point and depth delivers an average temperature for the liquid metal within a few seconds.

However, this measurement is typically performed manually and requires the operator to be very close to the hot, dirty, and smoky atmosphere, creating a safety hazard.

Additionally, the thermocouple readings are likely to be inconsistent – two or three different thermocouple measurements are likely to produce two or three different results – so accuracy will be an issue.

A further disadvantage of this technique is that the dipping tips for each thermocouple need to be replaced after at least one or two measurements, so there is a continual consumption of these tips and an ongoing cost.

NON-CONTACT MEASUREMENTS FOR LIQUID METALS

Non-contact measurement of the liquid metal can be taken with a hand-held portable pyrometer, a stationary pyrometer or a thermal imager. These measurements are taken on the surface of the metal or on the metal pouring/tapping stream.

However, since oxygen is present in the atmosphere, oxides, silicates and other impurities appear on the surface of the liquid metal forming a slag or dross layer. This affects the emissivity and the temperature of the metal, making it more difficult to achieve an accurate reading.

Additionally, the thicker the slag layer becomes, the lower the surface temperature in comparison to the liquid metal temperature.

So, it is important for non-contact temperature measurements to look for liquid metal applications where it is possible to view the metal surface where it is nearly or completely free of metal oxide.

Automated or manual tapping slag or dross processes, where the liquid metal is poured into moulds, provide one such application. The thermal imager or pyrometer is able to measure the temperature of the liquid tapping stream, which typically has a thin oxide layer – a "pouring skin" – on its surface.

This ensures the temperature being measured is that of the liquid metal, as it runs into the mould to create the final product. It is the latest and most exact point to measure the temperature of the liquid metal in the tapping/pouring foundry process, before it solidifies. This provides the best 24/7 assessment of the quality and metallurgical properties of the metal product with documented and trackable measurements being clearly assigned to each separate tapping and part.

AMETEK LAND MEASUREMENT SOLUTIONS

We offer the broadest range of solutions for liquid metal temperature measurements, offering portable and stationary pyrometer systems, and thermal imagers.

THE CYCLOPS C055L

This portable, hand-held pyrometer is specially designed for liquid temperature measurements between 1000 to 2000 °C (1832 to 3632 °F) and is both lightweight and rugged.

Easy to use – simply point and measure – it includes a Meltmaster mode which processes the data within milliseconds to deliver the real-time metal temperature. Temperature values are updated twice every second.

It can be operated one-handed, allowing the user to hold onto a safety rail while taking readings. Trigger-controlled data-logging stores up to 9,999 readings internally, for later analysis.

The Cyclops C055L also offers Bluetooth and USB connectivity, allowing data to be downloaded to a computer or live-streamed to a mobile device for analysis and trending. Completed by the Cyclops Logger software, available for Windows PC or Android mobile devices, it offers route management for application-related data storage and analysis.

THE AUTO POUR PYROMETER SYSTEM

A standard infrared pyrometer is not sufficient by itself to obtain a precise reading of the liquid metal stream temperature. Expert signal processing is also required to ensure a stable, accurate and reliable measurement.

This is provided by Auto Pour, a pyrometer-based stationary temperature measurement system for liquid metal and pouring streams, which reduces operating costs while improving processes.

The system's direct, non-contact continuous measurement does not interrupt the casting process, and provides the most accurate tapping temperature of the pouring stream as it runs into the moulds allowing for monitoring and documentation.

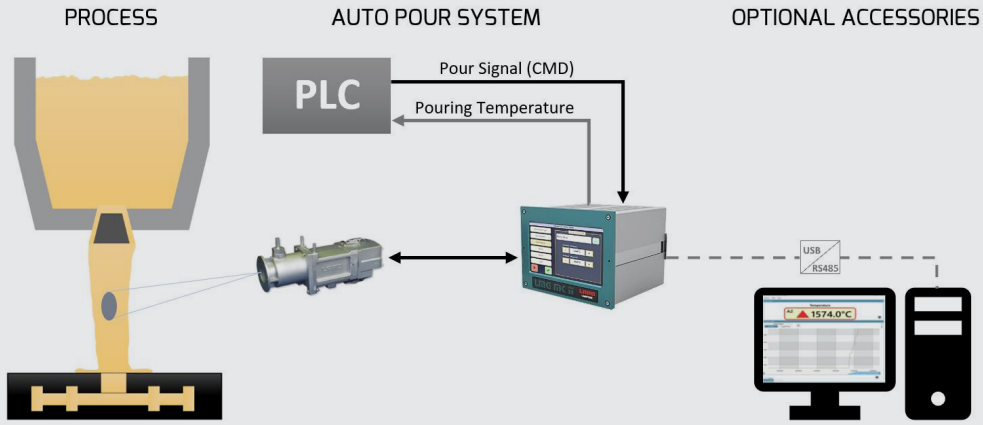
Its specially designed pyrometer improves the accuracy of the temperature reading created by variable emissivity and pouring stream movement, and offers simple alignment with adjustable focus and through-the-lens sighting.

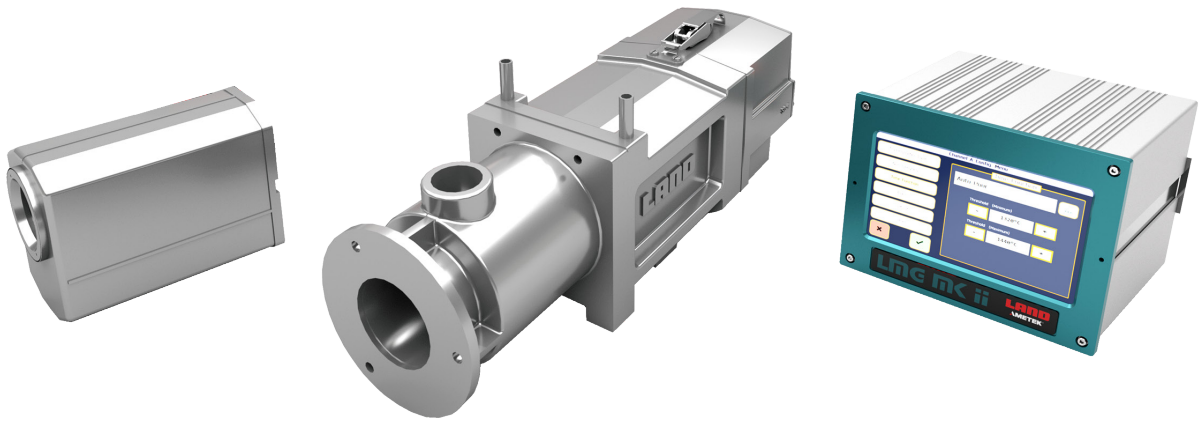
Analog, digital and alarm outputs provide process control and automated notification of out-of-range metal temperatures, while graphical and numerical displays allow temperatures to be monitored.

Built to withstand harsh foundry environments, Auto Pour provides accurate, continuous monitoring of molten metal 24/7.

How it works

One temperature per tap gives the output temperature, until the next tapping is finished.





BLAST FURNACE EXIT

It is important to measure liquid iron as it leaves the blast furnace prior to being transferred into torpedo cars or ladles and transported to the conversion process to steel. This can be performed by using pyrometers or thermal imaging solutions, as outlined above.

While pyrometers can be used at a portable or stationary installation, special thermal imagers provide a wider field of view.

Both are designed to be unaffected by existing hot, smoky and dirty environments and provide a continuous 24/7 temperature measurement.

SDS - SLAG DETECTION SYSTEM

High-quality metal and steel-making relies upon minimising the level of slag carry-over during tapping from ladles to further processing. Slag reduction also decreases the refractory wear in the vessels and significantly reduces the requirement to use costly additives to remove the slag.

Traditionally, operators monitored the tap visually, wearing a dark mask to prevent eye damage. However, this method depended on the operator's skill and experience in spotting the slag and reacting quickly, and using different operators would lead to different results. Even with the same operator, results could vary according to factors such as fatigue and the effect of fumes or smoke obscuring the operator's view.

A later solution involved an induction coil fitted around the tap hole. The induction field changed according to the composition of the flow, so as slag began to carry over, the coil signal was used to determine when reversal should start. While effective, the coil life was much shorter than the vessel campaign life, so coil failure meant extra downtime or a switch back to manual slag detection.

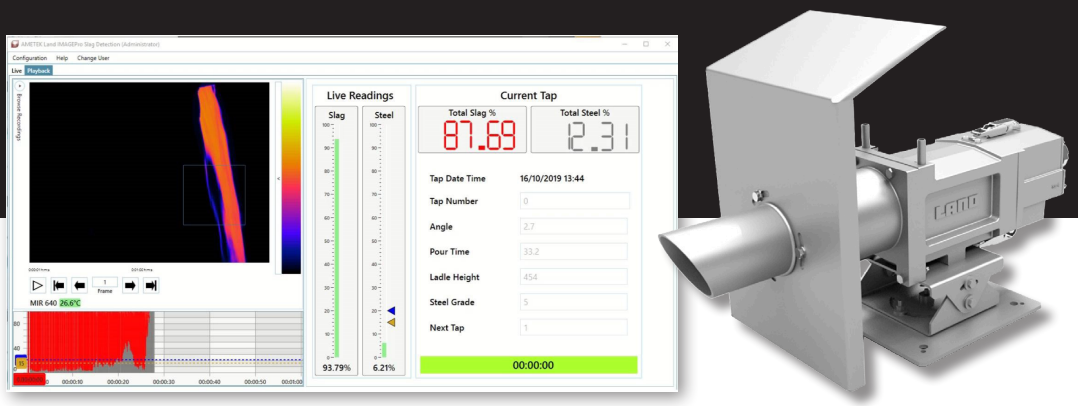
Modern coil designs are more modular, enabling easier, quicker replacement, but still create a period of time between coil failure and replacement, with the associated device and labour costs.

Visual or thermal imaging cameras provide a more reliable slag detection method. As these are non-contact, they do not wear out and have no consumable costs.

Optical and infrared detectors produce more reliable, repeatable results than an operator's eye, but optical detectors are still occasionally obscured by steam or smoke.

Advanced mid-wavelength infrared spectral filtering thermal imagers, however, offer significant advantages, with an imager an operator is able to view the vessel tapping stream through smoke and dust present in tapping processes.

The shorter waveband also allows for the use of extremely durable optical components, including sapphire protection windows.



SLAG DETECTION SYSTEM (SDS-640)

AMETEK Land's Slag Detection System (SDS-640) is a proven solution for accurate and timely detection of slag carry-over. It allows plants to improve product quality, reduce slag carry-over and improve operator safety.

Specifically designed to survive in challenging mill environments, it has a high-resolution thermal imaging camera to detect the transition between liquid metal and slag, using the 3.9 µm wavelength see through smoke, dust and fumes.

Quick termination of the tap after an alarm has been triggered is necessary to prevent excessive levels of slag in the ladle.

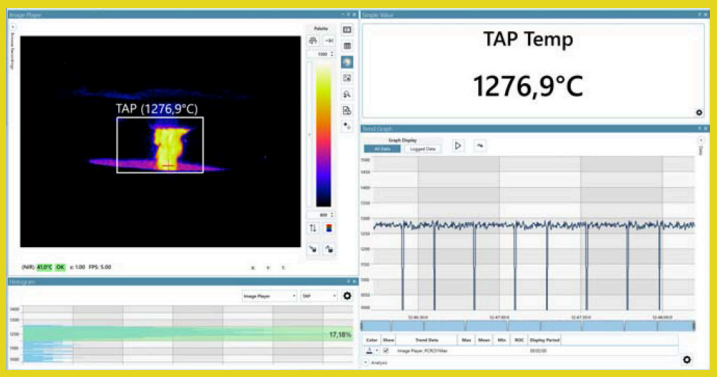
The IMAGEPro-SDS application software presents data to operators in real-time enabling them to make informed decisions about the tapping process and to automatically control the tapping process or stop it if a certain amount of slag starts to run out from the ladle.

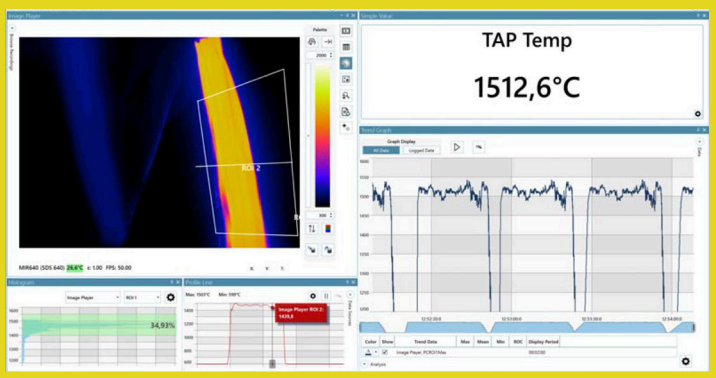
Use of the SDS-640 has been shown to improve operator response time and consistency at the end of each tap. This results in a typical reduction in slag depths of up to 25%, compared with traditional methods of stream monitoring.

As the tap commences, application-dedicated software IMAGEPro-SDS records it, using a stream identification algorithm, and produces a data log and graph for quality control. A stream tracking mechanism is included to ensure reliable operation in typical harsh environmental installation conditions.

When slag appears and exceeds an operator-defined amount, an alarm automatically triggers. The system is designed to ensure accurate detection of steel/slag that is independent of charge weight and without operator intervention.

POURING STREAM TEMPERATURE MEASUREMENT





A thermal imager – such as the NIR-656 or NIR-2K – provides a highly effective solution for measuring liquid metal.

Whereas pyrometers rely on peak-picking and data processing of the measurements to determine the true temperature, a thermal imager measures the pouring stream across a large number of pixels together with additional data processing time functions and algorithms.

A moving pouring stream may not be consistently in the same point to be measured by a stationary system, so in this case, a thermal imager is more effective.

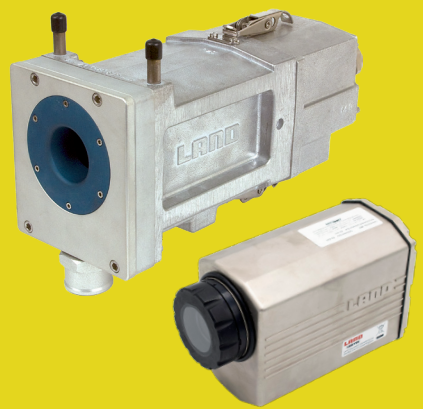
The NIR -656 and NIR-2K are high-resolution, full radiometric infrared imaging cameras, designed to produce continuous live, high-definition thermal images with a resolution of up to 3 million pixels at 1 µm wavelength.

They measure temperatures in the range of 600 to 1800 °C (1112 to 3272 °F), providing high-resolution images and temperature readings unaffected by the hot, smoky atmosphere.

The NIR-656 allows operators to measure from any of its 324,064 pixels, while the NIR-2K offers a 2,896,896-pixel image.

With 24/7 coverage via Gigabit Ethernet connection and automated alarm outputs, they provide effective continuous monitoring of liquid metal at the tapping point.

The advanced IMAGEPro software provides comprehensive process monitoring, continuous measurement, analysis and data capture. It enables bi-directional connection, analog and digital, to the process control system and plant network.



OUR SOLUTIONS FOR TEMPERATURE MEASUREMENT IN LIQUID METALS

AMECARE® PERFORMANCE SERVICES

Our global service centres provide after-sales services to ensure you get the best performance from your system. This includes technical support, certification, calibration, commissioning, repairs, servicing, preventative maintenance and training. Our highly trained technicians/engineers can also attend your site to cover planned maintenance schedules and repair emergency breakdowns.

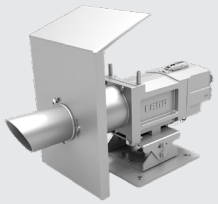
CYCLOPS L

PORTABLES

NIR-656 & NIR-2K

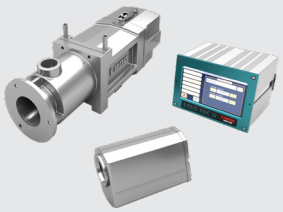
PROCESS IMAGING

SDS

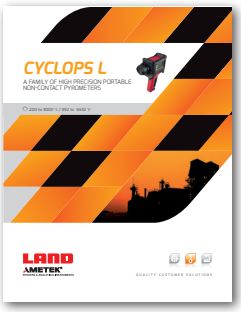


PROCESS IMAGING

AUTO POUR



FIXED SPOT THERMOMETERS



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