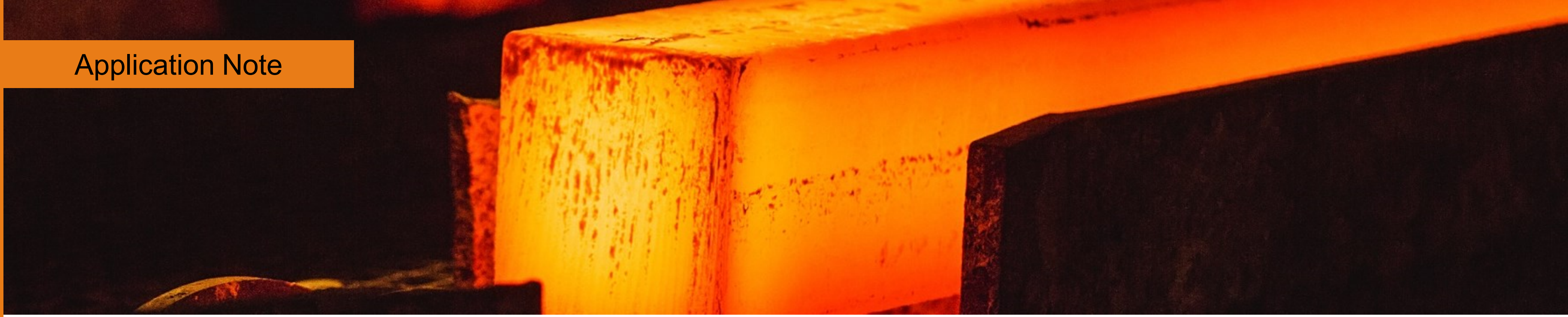


Application Note

Steel Casting Process Optimization

The Challenge

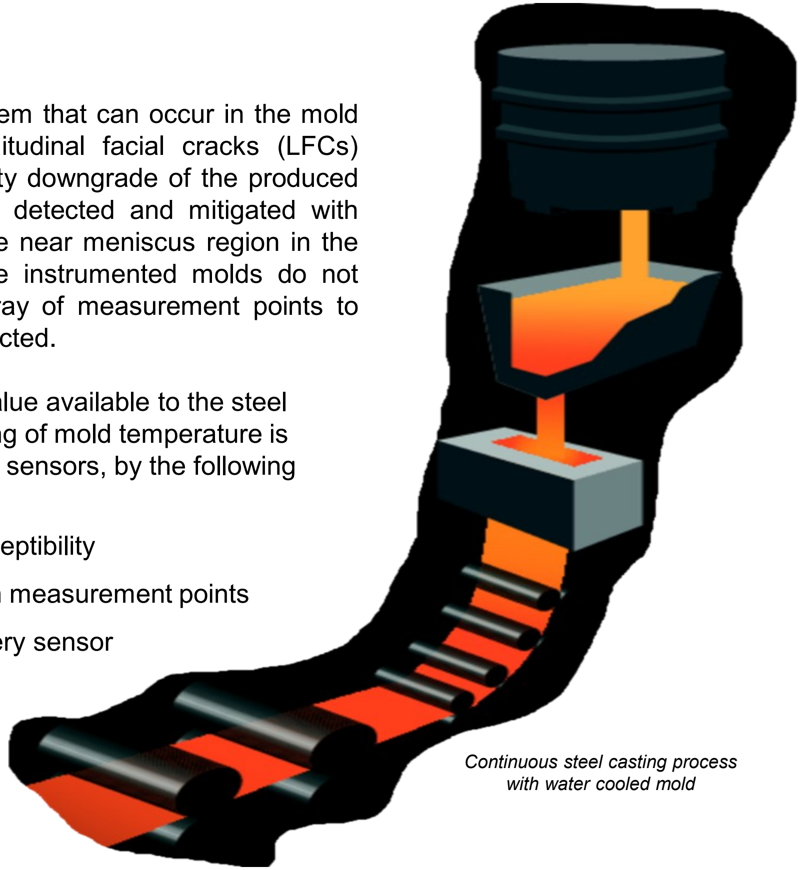
In steel continuous casting operations, one of the most serious and expensive issues is a breakout, where the molten steel is not contained by the thin outer shell of steel that solidifies when passing through the water-cooled copper mold. A common cause for breakout is a so-called sticker, where the shell of the material strand sticks to the mold wall. Monitoring temperature in the mold plates can help optimise process control to prevent stickers and subsequent breakouts, and molds are often instrumented with up to 80 thermocouples to this end.

It would be desirable to have many more than 80 thermocouples, firstly for closer spacing to avoid a sticker passing undetected between two thermocouples, and secondly for redundancy because thermocouples have a limited operating life in the harsh mold environment. However, since thermocouple cables need shielding from electromatic interference, handling of the large cables of more than 80 thermocouples becomes too cumbersome.

Another serious quality problem that can occur in the mold is the development of longitudinal facial cracks (LFCs) which result in a costly quality downgrade of the produced material. LFCs can also be detected and mitigated with temperature monitoring in the near meniscus region in the mold, although thermocouple instrumented molds do not offer a sufficiently dense array of measurement points to prevent LFCs passing undetected.

In summary, the significant value available to the steel industry of real-time monitoring of mold temperature is limited, when using electronic sensors, by the following challenges:

- High electromagnetic susceptibility
- Inability to achieve enough measurement points
- One shielded cable for every sensor
- Sensor failure in extreme harsh environment



Continuous steel casting process with water cooled mold

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Steel Casting Process Optimization

The Solution

Fiber optic sensors, in which measurements are made inside miniature (<=250µm) glass fibers, have a very small form-factor, support a large number of measurement points and are ideally suited to use in extreme harsh environments.

With fiber Bragg grating (FBGs) technology, many FBG sensors are written into a single fiber, with each sensor reflecting a wavelength that varies with temperature. Proximion has developed a unique process for writing as many as 100 FBGs in a single fiber at separations as low as 5mm.

Working with steel process industry experts, Proximion engineers have developed an instrumented a mold plate with 38 fibers, each containing 70 FBGs, so providing a grid of 2,660 temperature measurements with 0.1°C accuracy and 10 Hz update rate.

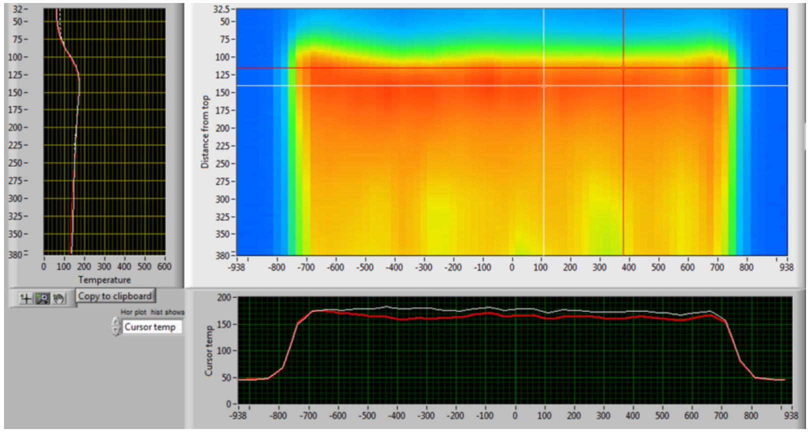
The system provides a temperature heat map of the mould, providing data which allows process optimization that avoids the occurrence of defects.

The system has been installed for many years in numerous foundries and has proven to be robust and reliable, providing highly valuable real-time data to process engineers.

In summary, the full value available to the steel industry of real-time monitoring of mold temperature can be achieved using a Proximion optical fiber sensing system, with the following benefits:

- No electromagnetic interference
- A dense temperature map giving real-time, actionable information
- Robust sensors able to operate for years in extreme harsh environment

Example instrumented mold plate, with robust optical cable connections



Example system output showing temperature heat map, horizontal and vertical temperature profiles and mold level (meniscus) shape.

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