

Monitoring log temperatures in furnace homogenisation

A reliable and safe method for optimising log homogenisation furnace systems is presented by Dr Steve Offley of Phoenix Temperature Measurement.

After casting, aluminium logs undergo a homogenising heat treatment process to ensure uniform distribution of the alloying elements within the structure of the log. This involves heating the log at a controlled rate, soaking at temperature for a specific period of time, and cooling at a specific rate.

Temperature measurement challenge

When setting furnace conditions for new production batches, monitoring the actual product temperature of the logs throughout the furnace is vital to maximise production throughput, while ensuring the correct metallurgical structure of the product. Measurement of the product temperature is generally not considered a problem when the operation is carried out in a batch furnace. In such cases, thermocouples can be run from the static logs, loaded in the furnace, to an external data logger without significant issues.

When homogenising is carried out in a continuous process such as a walking beam furnace, however, then monitoring the product temperature from a data logger external to the furnace is not possible because the logs generally travel in different directions as they enter, move through the hot zone, and exit the furnace. Also, the logs can slowly rotate due to the action of the walking beam. These factors make external monitoring with long thermocouples impractical and even if possible, and certainly do not comply with increasing safety requirements for technical plant operatives.

The solution is to use a 'thru-process' temperature monitoring system where a thermal barrier can be attached to the log, protecting a data logger as it gathers temperature data from thermocouples set within the test product. In this way the product temperature profile can be accurately monitored as the test system travels through the process.

Thru-process monitoring

The PhoenixTM 'thru-process' monitoring system to accommodate the size restrictions of the homogenising process, and its long duration (up to 10 hrs) and high temperature (600 °C/1,112 °F), employs a phased evaporation method of thermal protection.

The data logger is encased in a thermally insulated cylindrical water tank employing evaporating water as a phase change medium. As the water reaches its boiling point it changes from liquid to gas (steam) as it evaporates, but maintains the operating temperature of the logger at a safe 100 °C / 212 °F, so prolongs the period it can remain in the furnace. The barrier design must allow the steam to



Figure 2. PhoenixTM TS57 Rotating water barrier solution set-up - System is used to successfully routinely monitor in real time the homogenisation of cast aluminium logs in Service Center Metals (SCM) walking beam furnaces. Rotating cylindrical water barrier is attached to a 356 mm / 14" log with thermocouples positioned along its length at varying depths.

evaporate whilst not losing any water as the barrier rotates. For this type of system, it is also necessary for the data logger to be able to operate at 100°C as it is surrounded by boiling water (see Figure 1 - PhoenixTM TS57 Rotating water barrier).

Having established the diameter range of the logs and the process parameters, the size of the system (length and diameter) can be calculated and a piece of the log equal to the length of the thermal barrier can be cut off and discarded. The end of the log is then machined to accept the holder section of the thermal barrier where steel bolts secure it. A slot is machined longitudinally along the log to guide the thermocouples to holes drilled at right angles to the correct measuring depth. This ensures that both the thermocouples and the 'thru-process' system are kept within the boundaries of the product. When this is complete the thermocouples are positioned, the data logger reset and placed in the thermal barrier fixed to the test log, and the trial is ready to run.

Accurate process validation

Requiring a solution to allow process monitoring of their walking beam aluminium log homogenisation furnace, Service Center Metals (SCM) located in Prince George, VA (USA) approached PhoenixTM. The resulting 'thru-process' temperature monitoring system provided to SCM is shown in Figure 2.

Fitted with an RF telemetry module, the data logger allowed live 'real time' product temperature to be monitored through the whole furnace. With such information SCM were able to validate mathematical models used to control the furnace and so optimise the efficiency of the entire homogenisation process.

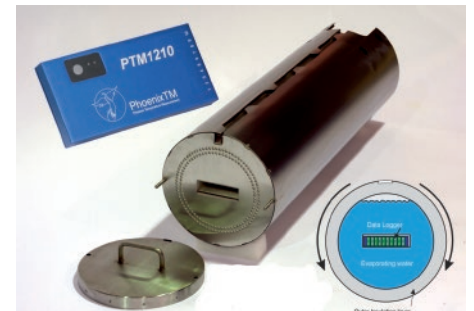


Figure 1. PhoenixTM TS57 Rotating Water Barrier solution - schematic showing the PTM1210 datalogger located in cylindrical water tank that rotates with the aluminium log during transfer through walking beam furnace.

As Mr Calvin Wiggins, Quality Director at SCM, observes "The ease of use of the PhoenixTM system allows us to do more surveys per year than compared to feeding thermocouple wires attached to a rigid log. Its single best-selling point is improved safety by keeping technicians away from the furnace entry door, where they would otherwise be feeding TC wires to the survey log as it advances through the furnace."

Employing the 'thru-process' temperature monitoring solution from PhoenixTM, major key casting plants have been able to measure the temperature profile of their aluminium log in all three stages of the homogenisation process. With such critical information it has been possible to minimise time in the soak zone to increase productivity and optimise fuel efficiency without compromising product quality.

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Author: Dr Steve Offley, Product Marketing Manager, Phoenix Temperature Measurement