

# Temperature profiling systems support aluminium industry growth

In today's manufacturing market aluminium is increasingly becoming the material of choice being lighter, safer and more sustainable. With estimated growth in global aluminium demand in 2018 of 4-5% both primary and secondary processors of aluminium are rapidly looking to improve the efficiency of their operations.

Manufacturers looking to replace existing materials with aluminium are needing new methodology to prove that new thermal processing of aluminium parts and products is done to specification, efficiently and economically.

Helping with this need PhoenixTM offers a range of Temperature profiling solutions designed specifically for applications in the Aluminium manufacturing market. Whether reheating aluminium slabs/ingots or log homogenisation in a continuous pusher or walking beam furnace, solution reheating (T6) aluminium automotive parts, CQI-9 & AMS2750 TUS, CAB brazing radiators or powder coating aluminium extrusions a unique system solution is available. In many situations Phoenix™ has worked directly with key industry players to develop bespoke solutions for unique process challenges.

## PhoenixTM Temperature Profiling Solutions

The PhoenixTM temperature profiling

system is designed to travel through the thermal process measuring the product and or furnace environment. A safe, efficient alternative to traditional trailing thermocouples. A high accuracy, waterproof, multichannel datalogger records temperature from thermocouple inputs, located at points of interest on, in or around the product being thermally treated.

To protect the datalogger as it travels through the hostile furnace a thermal barrier 'Hot Box' is employed to keep the logger at a safe working temperature to prevent damage and ensure accuracy of measurement. The design and choice of barrier is strongly influenced by the demands of the process as illustrated later in the article (Aluminium Processing Solutions).

PhoenixTM prides itself on offering the most comprehensive, flexible and durable range of barriers to suit, even the highest of temperatures and longest soak times, hostile environments whether pressure, gases or quenches, and process challenges such space limitations, product rotation or automatic robotic handling systems.

Employing the PhoenixTM system a complete thermal record of the product throughout the entire process can be collected. A popular enhancement to the system is the use of 2-way RF telemetry providing real time process monitoring

direct from the furnace. The product temperature can be viewed live and downloaded at any point in the furnace. Raw temperature data collected from the process can be converted into useful information using one of the custom designed PhoenixTM Thermal View Software packages available. The thermal graph can be reviewed and analysed to give a traceable, certified record of the process performance. Such information is critical to satisfy CQI-9, AMS2750 and other regulatory demands. Fully TUS compliant reports can be produced in moments from the simple and intuitive software, making accurate TUS a simple and quick task. Information can be used to not only prove product quality but provide the means to confidently change process characteristics to improve productivity and process efficiency (Optimise Soak Temperatures & Times).

## PhoenixTM Datalogger Range

Dataloggers can be provided in a variety of configurations to suit the specific demands of the process being monitored. Models ranging from 6 to 20 channels can be provided with a variety of thermocouple options (types K, N, R, S, B) to suit measurement temperature and accuracy demands (AMS2750 & CQI-9). The loggers can be offered in either standard (<80°C/176°F) or high

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temperature operating temperatures (Barrier Core Temperature <110°C/230°F) variants to allow use of either standard thermal barrier designs (Dual Phase - Heat Sink) or high performance (Phased Evaporation - Water Tank).

Built to cope with hostile industrial environments the IP67 logger is capable of managing even the most demanding water quench process.

Provided with Bluetooth wireless connection for short range localised download and reset (direct from within the barrier) the logger memory of 3.8M data points allows even the longest processes to be measured with highest resolution to deliver the detail you need. An optional unique 2-way telemetry package offers live real time logger control and process monitoring with the benefits detailed in the following section.

## Live Radio Communication

The logger is available with a unique 2-way RF system option allowing live monitoring of temperatures as the system travels with the product through the furnace. Furthermore, if necessary using the RF system it is possible to communicate with the logger, installed in the barrier, to reset/download at any point pre, during and post-run.

Provided with a high performance 'Lwmesh' networking protocol the RF signal can be transmitted through a series of routers linked back to the main

coordinator connected to the monitoring PC. The routers being wirelessly connected are located at convenient points in the process to capture all live data without any inconvenience of routing communication cables as needed on other commercial RF systems.

The operator from the convenience and comfort of his control room/office can see what is happening in the process live. For an 11 hour process such live data gives the operator confidence that process is working without that nervous wait with a non-RF system to download from the logger at the end of the run.

In many processes there will be locations where it is physically impossible to get a RF signal out of the furnace. With conventional systems this results in process data gaps. For the PhoenixTM system this is prevented using a unique fully automatic 'catch up' feature. Any data that is missed will be sent when the RF signal is re-established guaranteeing in most applications 100% in-process data review.

## Aluminium Processing - Bespoke Thermal Barrier Solutions

### Preheat of Aluminium Slabs/Ingots prior to Hot Rolling (Pusher Furnace)

Thermal Barrier embedded into the slab (machined or milled out) to allow safe transit of the test slab through pusher furnace (Typically 550°C/1022°F).

Thermocouples set deep into the core of the slab/ingot. Water tank designed to give capacity (volume of water) to allow protection of logger running safely at 100°C/212°F as water boils and evaporates off. Filling mechanism designed so that even during slab rotation (180°) entering and exiting furnace water is not lost from the tank. Employing RF, the soak process can be monitored to guarantee that the correct rolling temperature is achieved to avoid excessive roll wear. From live monitoring halving of soak times have been achieved.

### Aluminium Log Homogenisation (Walking Beam Furnace)

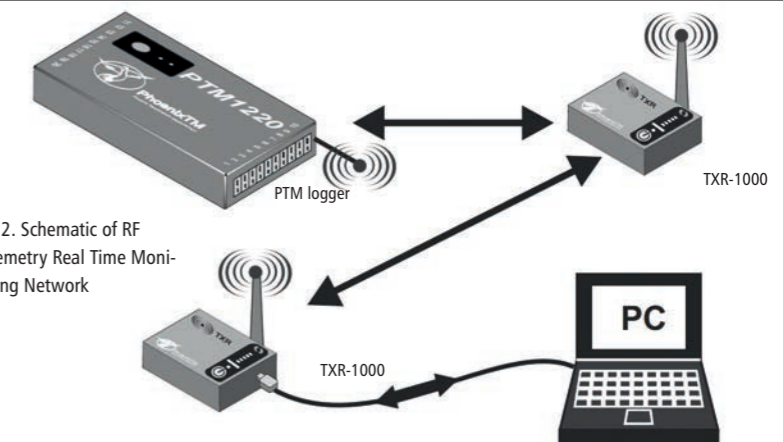
After casting aluminium logs are homogenised before being supplied to extrusion companies. The walking beam process is demanding not only due to the excessive durations (12 to 13 hours at 580°C/1076°C) but the fact that the profiling system has to rotate with the log and therefore needs to be the same form as the log with the same diameter or less.

The PhoenixTM rotating cylindrical barrier design meets the demands of the process perfectly. The barrier is attached to a shortened log and thermocouples are routed along the log in a machined channel to prevent problems during movement through the furnace. Design of the barrier water tank, providing thermal

Fig 1. PhoenixTM PTM1220 20 Channel IP67 Datalogger



Fig 2. Schematic of RF Telemetry Real Time Monitoring Network



\*Product Marketing Manager, PhoenixTM



Fig 3. PhoenixTM System embedded in aluminium slab/ Ingot - stainless steel cover to protect from high velocity air flow in furnace

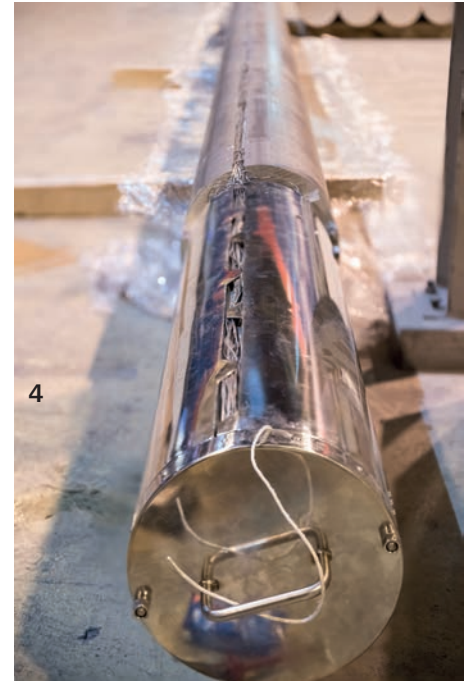


Fig 4. PhoenixTM Cylindrical Rotating Water barrier fixed to the aluminium log

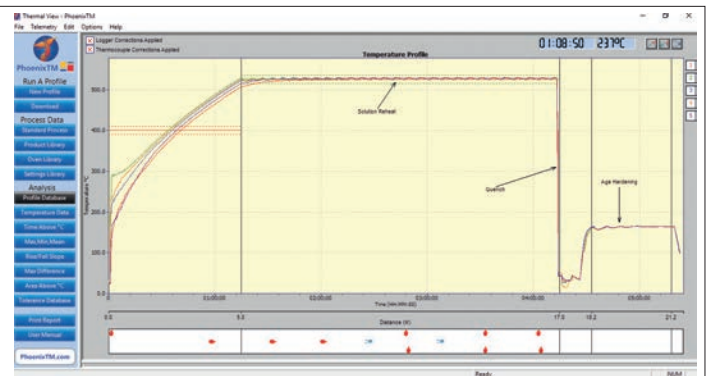


Fig 5. PhoenixTM HTS06 Solution Reheat System and Temperature Profile Trace collected from system

protection, guarantees that water capacity is maximised with no loss of water during continuous process rotation.

**T6 Solution Reheat of Aluminium Automotive Products (e.g.: Alloy Wheels, Cylinders)**

The solution reheat process (T6) comes with many technical challenges where temperature profiling is concerned. The need to monitor solution treatment, quench and then the age hardening process requires not only a system that will protect against heat over a long process duration but also withstand the rigors of being plunged into a water quench between the two heating phases.

The PhoenixTM HTS06 system has been designed specifically for the T6 process. The Datalogger is installed in the water tank cavity of the thermal barrier, with a water tight seal comprising of heavy duty

gaskets and compression glands, through which the thermocouples exit. This protection along with the loggers IP67 rating ensures that the logger is protected from water damage during the quench. Providing significant thermal protection, the outer cage containing the thermal insulation blanket wrapped water tank is capable of running through all three processes without interruption. In the quench the water tank is replenished and the blanket will absorb water providing further protection during the age hardening process. The TS06 can provide protection at 550°C/1022°F for up to 20 hours.

A key benefit of the TS06 system is the option to monitor with Real Time RF. Live process data can be viewed through the entire process. Although an RF signal cannot escape from the quench the unique 'Catch Up' feature allows this

data to be transmitted once the system enters the ageing furnace. Monitoring the quench rate and time after solution treatment and before quench is critical to ensure the correct material characteristics.

Increasingly with a move to robotic handling in rotary T6 basketless furnaces, where space is even more critical and automatic handling of barriers becomes essential further new barrier solutions have been needed.

The 'Humpback' barrier shown is an adaptation of the TS06 system. Utilising the water tank thermal protection principle, the cage containing thermal blanket is replaced by a microporous insulation skin and robust outer stainless-steel case. The resulting barrier can be shaped to allow the barrier to be picked up by robotic clamps as part of automatic transfer into either furnace or quench process.



Fig 6. Phoenix<sup>TM</sup> Humpback T6 barrier designed for robotic handling in automatic Rotary furnaces

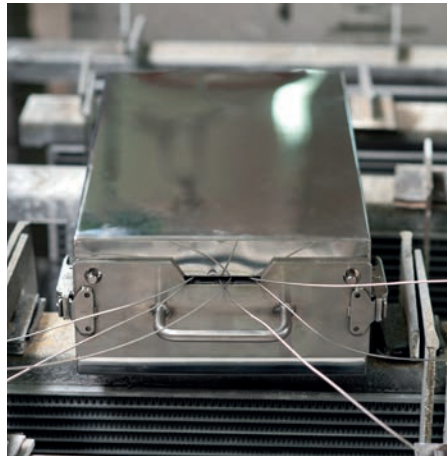


Fig 7. Unique Phoenix<sup>TM</sup> CAB Brazing System Design with contamination free profiling capability



### AMS2750/ CQI-9 Furnace Temperature Uniformity Surveys (TUS)

Complimenting the range of product profiling solutions Phoenix<sup>TM</sup> is able to offer fully AMS2750 and CQI-9 compliant Temperature Uniformity Survey (TUS) solutions. Combining the thermal barrier or external logger offerings the system can be used to validate that the furnace set-points defined in the TUS are within specified limits. The Thermal View Survey Software package provides full review, analysis and reporting to satisfy the strict requirements of regulatory standards.

### Aluminium Brazing (CAB & Vacuum)

Monitoring controlled atmosphere brazing (CAB) processes used in the manufacture of radiators and condensers although not a thermally demanding application, compared to others discussed, it does come with its own specific challenges. Mesh belt furnaces often have limited access requiring the use of low profile barrier designs. Chemicals in the flux used in the process create Hydrofluoric acid which can chemically attack the glass cloth used in most thermal barrier constructions. To overcome this issue the CAB barrier is designed with a front-loading draw as shown to minimise the amount of exposed cloth.

As its name suggests the CAB process can in some cases be compromised by the degassing of oxygen from the barrier. To eliminate such problem the barrier insulation is pre-treated with a vacuum heated/nitrogen purge procedure. A further option is available for use just prior to the profile run where a nitrogen purge can be performed to remove remaining air from internal insulation and logger cavity.

### Paint Cure on Aluminium Car Bodies

With the drive for fuel economy and tighter emissions controls automotive manufacturers are moving away from



Fig 8. Phoenix<sup>TM</sup> finishing system showing PTM1220 20 channel logger with traditional magnetic thermocouples used on steel body shells. New aluminium clamp probe used on car bodies with aluminium sections (door skin, roof or hood).



tradition steel to lighter aluminium. With this move there is ever more need to profile the paint process to ensure that the various coating chemistries

(E-coat, Primer Surfer, Top & Clear Coat) are cured correctly to give both physical protection and cosmetic appearance.

The Phoenix<sup>TM</sup> Finishing system allows the cure process(es) to be monitored accurately. To address the new challenges of aluminium door skins/roof panels and hoods an alternative thermocouple was needed to replace the traditional magnetic thermocouple. The unique aluminium clamp probe allows quick, efficient and accurate probe placement into the body shell.

### Age Hardening & Powder Coating of Aluminium Architectural Products

Aluminium plays a large part in the architectural market. Aluminium extrusions are commonly used in the manufacture of window, door and other architectural products. As part of the manufacturing process the extruded

aluminium profile needs to be artificially age hardened.

This process is essential to ensure ultimate tensile strength and yield strength and requires that the product is soaked at typically 185°C/365°F for 4-5 hours. Measurement of the load core in the ageing furnace is critical to ensure consistency of product ageing throughout the batch.

To monitor such processes the Phoenix TS01 system is perfect at allowing product temperature readings over the oven void without need for training thermocouples. The same system can be used to survey the oven (TUS) to validate temperature distribution without product.

The final manufacturing step for the extrusion is the powder coating to give protection against the elements and control surface cosmetic characteristics.

To protect against, coating life time guarantee warranty claims, applicators often are required to supply coating suppliers with evidence of product curing performance. Accredited applicator schemes will require that production runs

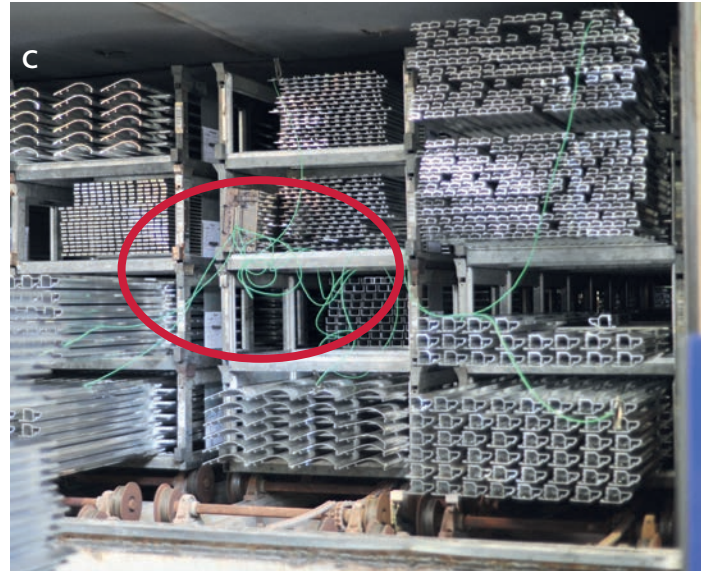
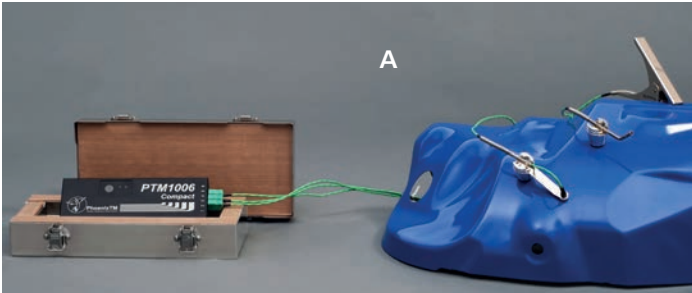


Fig 9: (A) PhoenixTM Compact Finishing System showing PTM1006 6 channel logger and (B) Clamp probe fixed to an aluminium extrusion (C) Phoenix TS01 system in Batch Age Hardening Oven

are certified with a profile trace showing that the powder coated product achieved the correct Time @ Temperature.

The PhoenixTM Compact finishing system is the perfect tool for monitoring such processes. Whether an applicator or coating supplier the system is portable, easy to use and provides the certified

traceable documentation needed for process validation and quality assurance.

**Conclusion**

PhoenixTM offers complete, reliable in process temperature profiling solutions, for use across the aluminium processing industry.

Offering unique solutions to meet the

specific application challenges PhoenixTM provides, tried and tested systems, used globally by key market players to understand, control and improve their manufacturing operations. ■

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