



PhoenixTM
Phoenix Temperature Measurement

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New choice in Temperature Profiling solutions to meet the demands of the Modern Industrial Paint Cure Market.....Who say's watching paint dry can't be made exciting?



Dr Steve Offley

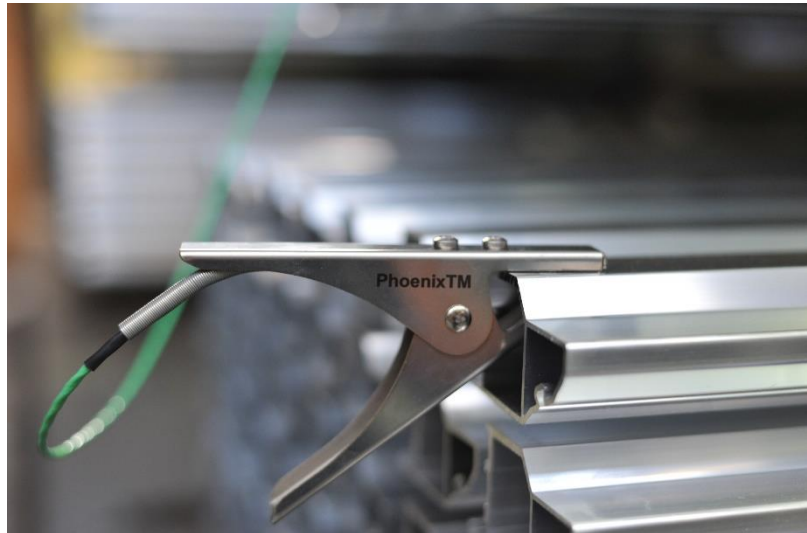
Product Marketing Manager PhoenixTM



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Benefits of 'Thru-process' Temperature Profiling – the value speaks for itself

The use of 'Thru-process' temperature profiling in the Industrial paint and powder market has long been established as the preferred default method for proving quality assurance of the paint cure process. Whether a painted automotive body shell or powder coated aluminium extrusion, it is critical to prove that the part has been heated correctly



in the oven to achieve the desired physical and cosmetic properties of the coating. At the coating stage, significant investment into the product has already been made, so it is even more critical to get the coating process correct, to avoid rework or at worst product scrappage. Getting the cure wrong is a costly mistake to make and the implications from a business perspective are often far more severe than many realise. (Refer to Figure 1: Incorrect Paint Cure - the Business Pain Points)

Obviously paint cure can be determined by many different laboratory tests (DSC, Solvent Rub, Impact etc) but these physical tests only provide a positive or negative result and will not give any evidence to the potential cause of the problem. The part may be under cured but why? Was the oven set at the wrong temperature or the line speed? Has a burner or fan failed, if so which and where? Frustration

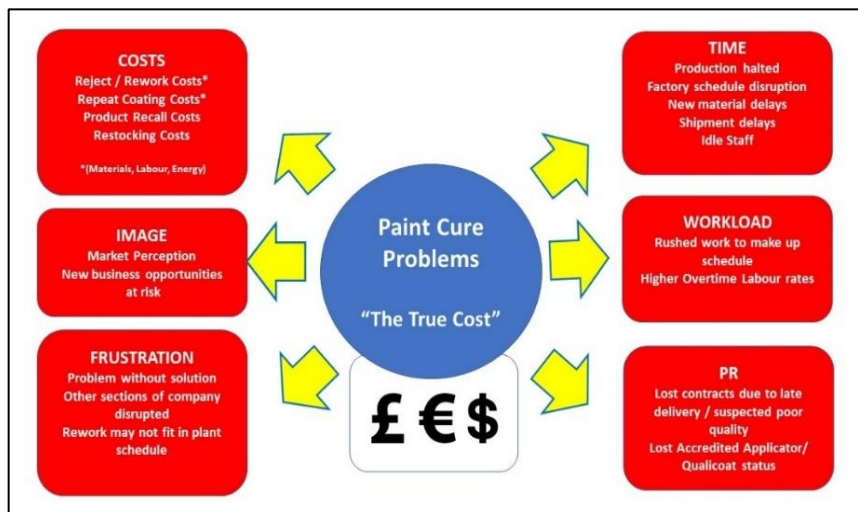


Figure 1: Pain Point Schematic - Business implication of getting the Paint Cure wrong.



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Despite the fact that modern ovens now are supplied with sophisticated control systems they are still not capable of truly giving an accurate picture of the coating cure process.

To certify that the coated product achieves the coating suppliers cure specification (Time @ Temperature) it is necessary to know the true product temperature through the entire oven process. Temperature sensors positioned along the oven give only a snap shot of what the oven environmental temperature is at that specific point in the oven. IR pyrometers can provide surface temperature measurement but require line of site so limit the areas of the product that can be measured. As with air sensors being fixed IR sensors only give information at that specific oven location. Referring to the product this may, as with an Automotive car body shell, be made up of many different materials with differing thermal conductivities (steel, aluminium, composites) and sections of very different thickness so thermal mass. This being the case the product temperature being measured may need to be from many unique locations to fully understand the cure process for the complete product. For simpler or a mix of products possibly, the location of the product within the oven may be critical requiring multiple products to be measured at different positions (Product Hanging Rack Top, Middle, Bottom) to highlight possible variations in oven temperature.

PhoenixTM Finishing systemcustomized to coating process

The PhoenixTM Finishing system has been developed to specifically provide the complete product temperature history of the product in the paint cure oven. The system travels directly through the oven with the product being monitored measuring continuously product and or oven environmental temperature from start to finish. Temperature data collected is later converted into a temperature time graph (Temperature profile) which is a historic record of what temperatures the product experienced and for how long in the oven. This profile graph will not only provide evidence of whether the coating is cured correctly, as part of a standard QA protocol, but provide invaluable process data that can be used to further control, improve and validate the operation as detailed in Table 1 and further in the following sections.

Figure 2: PhoenixTM Compact System travelling through a Powder Coating Oven with Aluminium Extrusion Products. (Insert Data logger Installed in thermal barrier shown in main image)





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Value Statement	Benefit
Product Quality	Confirm accurately that the coating cure meets supplier specifications (Time @ Temp) to give physical and cosmetic properties. Prevent costly rejects or rework.
Problem Solving	Identify the cause of Oven problems quickly. Suggest and prove corrective action with process data. Reduce production downtime to a minimum.
Process Optimization	Maximize the productivity and efficiency of your process with confidence. Optimize settings to improve throughput, fuel economy with no risk to cure quality. Optimize new product processes with ease and efficiency eliminating delays to production launches.
Regulatory Compliance	Generate the process validation certification necessary to prove process control for CQI-12, Qualicoat or other quality standards.

Table 1: Top level Benefits of Temperature Profiling

PhoenixTM Logger Range..... robust choice

At the heart of PhoenixTM finishing system is the temperature data logger designed for specific use in a hostile industrial process to measure temperature either directly from the product or environment within the oven from multiple thermocouple inputs. A range of loggers are available to both suit the needs of coating application and the budget. For standard powder coating applications, the Compact system (PTM1006) gives an easy to use 6 channel system. As its name suggests the system is designed to be easy to handle, and ideal for any travelling powder/paint rep needing a system to visit customers with as part of process set-up, validation and troubleshooting actions. Supplied with customer replaceable commercially available alkaline batteries the logger can be used efficiently hassle free. No battery recharging delays or unavailability during battery replacement at a service centre as with other commercially available product offerings.



Figure 3: Examples of PhoenixTM loggers – PTM1006 Compact and PTM1220 20 Channel Loggers.



For more sophisticated profiling requirements, the PTM1220 20 channel system is available ideal for use in top end automotive paint cure applications. With 20 measurement points the complete car shell can be monitored with a single system (One barrier) in great detail and accuracy (Logger accuracy ± 0.3 °C). Areas of high thermal mass such as the door sill and structural pillars (A, B & C) can be checked for risk of under cure whilst other areas of thinner metal the hood, roof and door skins can be monitored for possible over cure. For validation of new car processes (NPI Launches) where up to 40 channels or more may be needed multiple systems can be used together in the same run which is far more convenient and cost effective than using the equivalent of 5 x 8 channel systems.

Provided with a memory of 3.8M datapoints the logger allows even the longest processes to be monitored in fine resolution ensuring that you capture even the quickest transient events “Cold spots” (20 Channel, 0.2s Sample Rate = >10 hours run).

Offering Blue tooth communications and a Wireless 2-way RF option the PTM1220 logger can be employed to provide live profiling wireless capability. Direct from the oven you can review the product temperature in real time (See section - *Remote Monitoring*).



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Thermal Protectionfit for purpose in the paint shop

Protecting the logger as it travels through the cure oven a thermal barrier maintains the logger temperature < 80 °C/ 176 °F to guarantee measurement accuracy and obviously prevent thermal damage.

Offering a dual protection approach the barriers provide high protection without becoming too large or heavy (Aluminium case) for efficient handling and transportation. Combining high performance microporous insulation with a backup phase change heat sink logger protection is guaranteed even for the longest cure run or in the event of line stoppages.

With a wide range of barriers even the most demanding of processes can be handled. Designed for the paint market specifically all PhoenixTM finishing barriers (Even the Compact barrier) are manufactured from completely Silicone free materials eliminating any risk of silicone contamination in the paint shop and risk paint defects/craters. Making equipment handling easier particularly when moving around the automotive paint shop the thermal barrier is offered with a top magplate on which magnetic thermocouples can be safely secured. A 20-channel system can be carried in one hand allowing safe passage even up ladders and over gantries. With thermal protection of up to 5 hours @ 200 °C/ 392 °F it is possible to either monitor individual coating ovens separately or potentially monitor in a single run (Permanently rigged Test Car) sequential ovens (Ecoat/Primer/Top Coat/Clear coat).

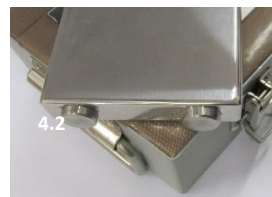


Figure 4: Aluminium, Silicone Free Finishing Thermal Barrier – (4.1) Mag Plate (4.2) Heatsink Thermal Protection @ 200 °C/392 °F (20 Channel Logger) TS04-XX (XX = Height mm) (TS04-60 0.8 hrs, TS04-113 3 hrs & TS04-135 4.8 hrs)

Thermocouplesdesigned to suit all your process/product challenges

Although often overlooked by many probably the most important aspects of the temperature profiling task is making sure you are measuring what you want accurately and repeatably run to run. The range of thermocouples offered with the PhoenixTM system have been designed to guarantee easy quick yet accurate placement at the location required. With the ever-increasing use of mixed materials in the automotive market, primarily to reduce weight and reduce emissions, (Aluminium & Composites) this challenge becomes ever more demanding. PhoenixTM though prides itself on working with customers to develop the new thermocouples they need.



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The range of typical thermocouples offered with the Finishing range are shown in Figure 5. Provided with a triple wrapped PTFE cable the thermocouples are flexible yet cable of withstanding temperatures up to 265 °C/ 509 °F. Complying to ANSI-96.1 the thermocouple accuracy is certified to $\pm 0.4\%$ or $\pm 1.1\text{ }^{\circ}\text{C}/1.98\text{ }^{\circ}\text{F}$ providing a measurement accuracy (Logger + thermocouple) of the system in most paint applications of $\pm 1.4\text{ }^{\circ}\text{C}/2.52\text{ }^{\circ}\text{F}$.



Figure 5: Thermocouple Range for Paint Applications (Surface and Air Options)

- 5.1 Magnetic – Attaches to Ferrous materials such as Steel Car body
- 5.2 Clamp – Designed for use with non-ferrous materials such as Aluminium Extrusion
- 5.3 Long Reach Clamp – Designed specifically for use in Aluminium Car Body Shells
- 5.4 Exposed Junction Probe – Taped directly to any material (plastic/composite), Rapid IR processes
- 5.5 Washer probe – Screwed directly to product. (Permanently rigged car shell test body)

With the rigors of daily operation, it is possible for the PTFE cable to occasionally get damaged. Under normal circumstances this would require a complete thermocouple replacement. To minimize cost the PhoenixTM magnet and clamp probes come with the unique design feature that only the cable and sensor need to be replaced retaining the existing magnet mount or clamp. Over the life of the system this can make a significant effect on the total cost of ownership especially if using 20 thermocouples per run and frequent runs.

Remote Monitoring.....see process data live direct from the oven

Complementing the traditional USB communication cable, the PhoenixTM logger can be even used with Blue Tooth communications to PC or alternatively Android smart phone or tablet (Figure 6) allowing added portability of the system on the production floor. The logger can be reset and downloaded at the oven to allow quick review of the run (Graph and Time @ Temperature Analysis). The run data file can be e-mailed directly to a PC running the PhoenixTM Thermal View Finishing software to allow further full analysis and reporting.

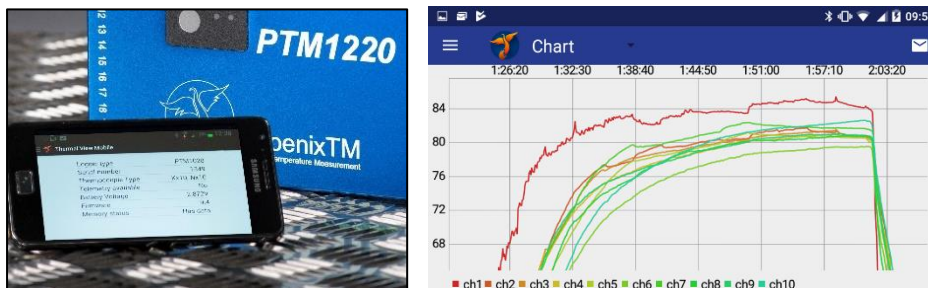


Figure 6: Thermal View Mobile software running on Android Smart Phone

Direct communication with logger either via Blue Tooth or Communication cable allowing Remote Reset or Download of the logger.



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In today's modern industry instant access to information is becoming more and more important. This applies equally to temperature profiling. Provided with a unique two-way RF telemetry capability option the PTM1210 is able to transmit temperature data stored by the logger live from the process. Operators not only can see the live process/product temperature information but in fact wirelessly communicate directly with the logger, in the thermal barrier, to reset or even download stored data. The 'Lwmesh' networking protocol (Figure 7) allows receipt and retransmission of data through a variety of router configurations allowing successful data transmission back to the control office where the monitoring PC is located. The routers communicate with each other wirelessly allowing them to be installed quickly and conveniently, where needed, without any of the problems associated with routing physical cables, and providing power, necessary for alternative hardwired commercial systems. In processes there may be areas or sections where the RF signal cannot escape the process, with the PhoenixTM RF system this is not a concern. Employing a unique 'catch up' feature any missing RF data is resent 'auto corrected' once communication is re-established.

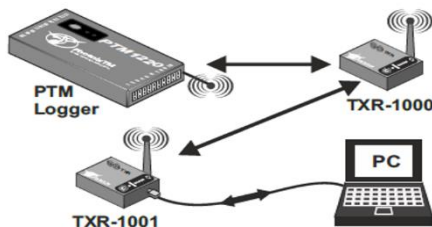


Figure 7: PhoenixTM RF system schematic showing 'Lwmesh' network permitting high performance communication via remote battery powered wireless routers.

Analysis Software the power of Process understanding, optimization and validation

A critical component of the PhoenixTM Finishing system is the Thermal View Finishing software. Designed specifically for the needs of the coating market it allows not only the set-up/download of logger but the raw process data to be converted into meaningful information. Such information can be used to understand exactly how the process is operating, allow informed changes and provide certified evidence to prove to others of the quality you are providing. Refer to Figure 8 and Table 2 to discover how the Finishing software can add value to your cure monitoring operation.



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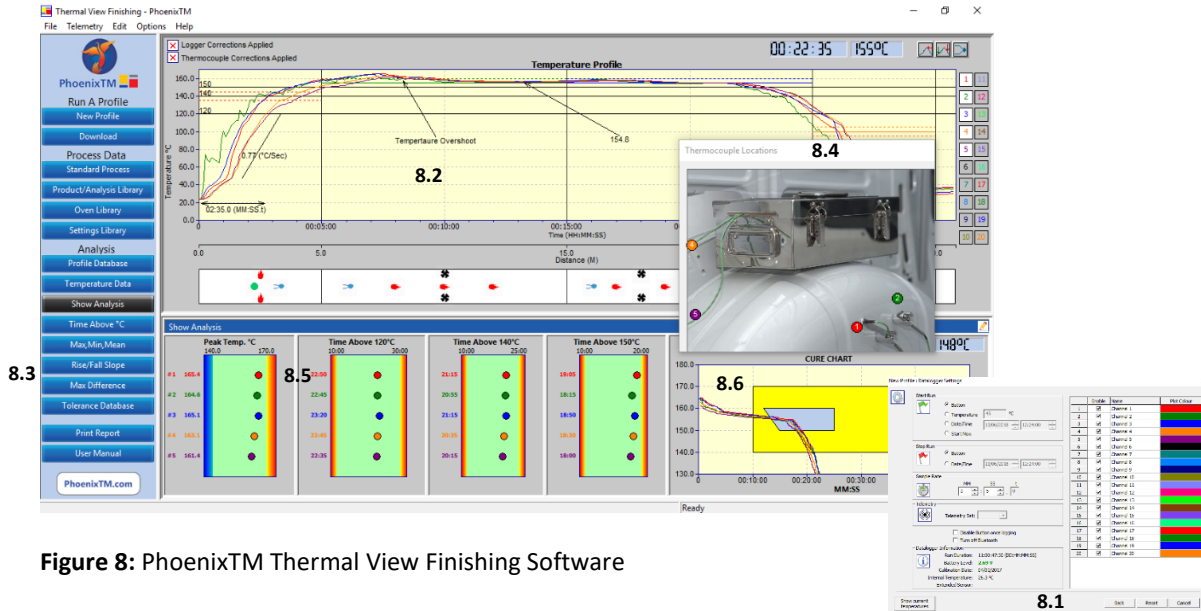


Figure 8: PhoenixTM Thermal View Finishing Software

Main Features of the Finishing Software:

- 8.1 Configurable Datalogger Settings (Start Method, Sample Interval, Number & location of Thermocouples).
- 8.2 Clear Full Colour Graph with zoom capability on screen Notes.
- 8.3 Detailed Analysis Calculations – Customise to your specific process requirements.
- 8.4 Process Files to describe fully the Process Conditions – Oven Settings (Zones & Features) Product/Cure criteria.
- 8.5 Cure Analysis – Graphical Analysis showing Time @ Temperature & Peak Temperature against Pass Fail Criteria.
- 8.6 Cure Chart – Create copy of Paint Supplier Bake Window and perform automatic analysis against it.

Table 2: How Features of the PhoenixTM Finishing Software can help give value to understand your cure process

Software Feature	Value to Cure Process
Time @ Temperature Analysis (Numerical/Graphical or CureChart)	Identify whether or not the coating is cured correctly against paint supplier specification. Prevent under cure of coating which may create risk of future damage.
Peak Temperature	Confirm that the product doesn't exceed temperatures that may damage the coating or the product if delicate (Warping of plastic)
Slopes / Rise & Fall	Paint - Prevent Solvent pop problems during the flash off zone and control gloss Powder - control melt and flow to give desired texture and gloss characteristics
Max Difference	Identify areas on the product showing extreme temperature differences. (Confirm that on a car body that temperature difference left to right is within tolerance)
Reference / Tolerance Curve	Compare the profile graph against ideal reference or Tolerance curves to identify process changes or oven deterioration.
Process Data	Create Template files to describe all your oven and test conditions. Select process file matching your run to quickly load all information and immediately allow full analysis without repeated parameter entry run after run. See how the profile data relates to your oven design and set-up. Identify location of cold spots quickly and accurately making corrective action easy.
Customized Report	Configure the report to match your specific documentation needs. Create PDFs and share digitally with colleagues, customers, auditors and archive. Win new business on the basis of being able to certify product quality.



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Conclusion – PhoenixTM Your Finishing Oven

To fully control your paint cure process and the quality of your coated product it is critical that you determine accurately what temperature and for how long your product experiences in your cure oven. The PhoenixTM Finishing temperature profiler provides you the means to achieve this. With a purpose designed system incorporating some unique features such as Live Blue Tooth / RF communication, portable operation using Android smart phone or Tablet the coating company can maximize the potential of their operation and secure existing and new future business.

Don't forget to 'Phoenix Your Finishing Oven!'

For more information Contact:

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