Driving powder coating quality in the architectural aluminium industry

By **Dr Steve Offley***

Benefits of Temperature Profiling – the value speaks for itself

The use of 'thru-process' temperature profiling in the architectural powder coating market has long been established as the preferred default method for proving quality assurance of the powder cure process. For a 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. With demanding product warranty challenges finding product failure in the field is catastrophic.

Fig 1. PhoenixTM Compact System travelling through a Powder Coating Oven monitoring Aluminium Extrusions

For many quality certification schemes such as 'Qualicoat' the regular application of temperature profiling is a prerequisite for proving process control and quality of the product being supplied necessary for accreditation.

Obtaining Accredited Applicator status, allowing use of approved branded powder coatings, also critically requires the use of oven profiling to provide validation of production batches to satisfy product lifetime warranty claims.

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 incorrectly cured but why? Was the oven set at the wrong temperature or line speed? Has a burner or fan failed, if so which and where?

*Product Marketing Manager PhoenixTM www.phoenixtm.com

Fig 2. PhoenixTM Compact 6 Channel data logger

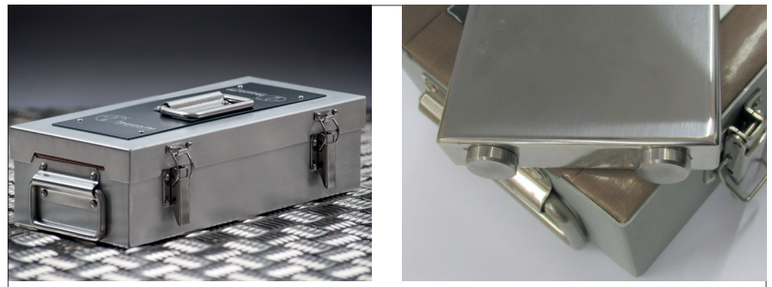
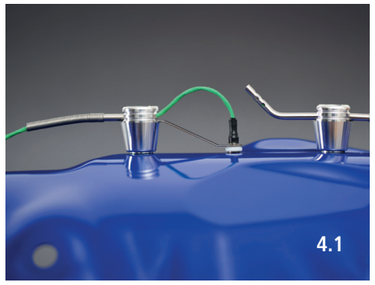
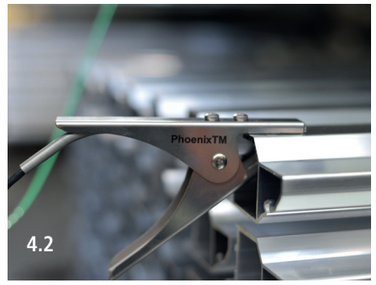
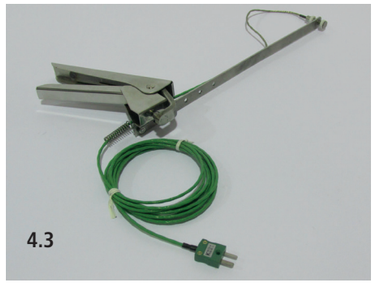
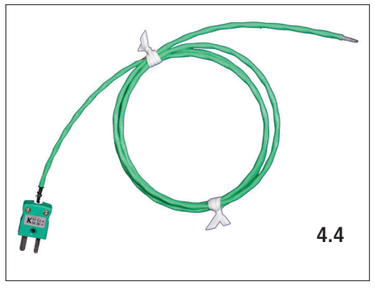


Fig 3. Aluminium, Silicone Free Finishing Thermal Barrier – (3.1) Enclosed Barrier (3.2) Heatsink
Thermal Protection @ 200°C ⟶ TS04-XX (XX = Height mm) (TS04-60 0.8 hrs, TS04-113 3 hrs & TS04-135 4.8 hrs)









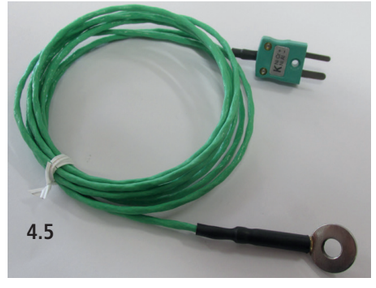


Fig 4. Thermocouple Range for Powder Applications (Surface and Air Options)
4.1 Magnetic – Attaches to Ferrous materials
4.2 Clamp – Designed for use with non-ferrous materials such as Aluminium Extrusion
4.3 Long Reach Clamp – Designed specifically for use in Aluminium Car Body Shells
4.4 Exposed Junction Probe – Taped directly to any material
4.5 Washer probe – Screwed directly to product. (Permanently rigged Test Piece)

PhoenixTM Finishing system: Customised for coating process

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

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. A range of loggers are available to suit the needs of both the coating application and the budget. For standard powder coating applications, the Compact system gives an easy to use 6 channel system **(Fig. 2)**. 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. Employing a replaceable battery there are no battery recharging delays or availability issues, during battery replacement at a service centre, as with other commercially available product offerings. For more demanding processes loggers with up to 20 Channels can be provided, with optional, high performance 2way RF allowing remote logger communication, providing direct logger control and live data review.

Thermal Protection: Fit for purpose in the Powder Cure oven

Protecting the logger as it travels through the cure oven, a thermal barrier maintains the logger temperature < 80°C to guarantee measurement accuracy and prevent thermal damage **(Fig. 3)**.

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

Designed for the paint market specifically all PhoenixTM finishing barriers are manufactured from completely Silicone free materials eliminating any risk of silicone contamination and potential for paint defects/craters.

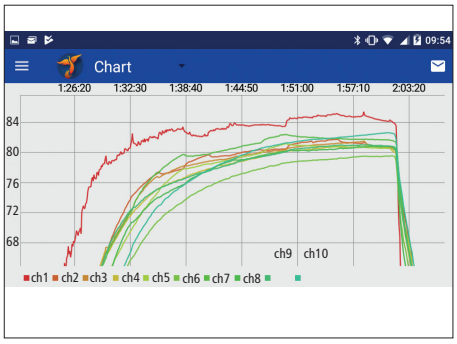


Fig 5. Thermal View Mobile software running on an Android smart phone allowing remote reset or download of the logger

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 Optimisation	Maximise the productivity and efficiency of your process with confidence. Optimise settings to improve throughput, fuel economy with no risk to cure quality. Optimise 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 Qualicoat, Accredited Applicator Status or other quality standards.

Table 1. Top level Benefits of Temperature Profiling

Thermocouples: Designed to suit 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 typical thermocouples offered with the Finishing range are shown in **Fig 4**. Provided with a triple wrapped PTFE cable the thermocouples are flexible yet capable of withstanding temperatures up to 265°C. Complying to ANSI-96.1 the thermocouple accuracy is certified to +/-0.4% or +/- 1.1 °C providing a measurement accuracy (Logger + thermocouple) of the system in most paint applications of +/-1.4 °C.

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 minimise cost the PhoenixTM Clamp and magnetic 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 significantly reduce the total cost of ownership.

Fig 6. PhoenixTM Thermal View Finishing Software

Main Features of the Finishing Software:

6.1 Configurable Datalogger Settings (Start Method, Sample Interval, Number & location of Thermocouples).

6.2 Clear Full Colour Graph with zoom capability on screen Notes.

6.3 Detailed Analysis Calculations – Customize to your specific process requirements.

6.4 Process Files to describe fully the Process Conditions – Oven Settings (Zones & Features) Product/Cure criteria.

6.5 Cure Analysis – Graphical Analysis showing Time @ Temperature & Peak Temperature against Pass Fail Criteria.

6.6 Cure Chart – Create copy of Paint Supplier Bake Window and perform automatic analysis against it.

Mobile Operation: Profiling on the move

For powder coating suppliers oven profiling is often performed on the fly under significant time pressure. Complementing the Windows based operating software the system can be run from an Android smart phone or tablet (**Fig 5**) allowing added portability of the system. 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.

Analysis Software: The power of Process understanding, optimisation 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 the quality you are providing. (Refer to **Fig 6 left**).

A unique feature of the Thermal View Finishing software is the graphical cure analysis tool (Show Analysis).

The operator can see quickly at each specified cure schedule whether the Time@Temperature analysis from the profile meets the powder supplier specification.

For each thermocouple it is easy to identify under or over cure at each cure temperature.

Conclusion

The PhoenixTM Finishing Temperature profiler provides a purpose designed system to Understand, Control, Optimise and Certify the thermal cure process of powder coating aluminium extrusions. Ideal for any manufacturer or coating supplier to maximise the potential of their operation and secure existing and win new future business. ■