



Cycle verification identifies thermal nonconformance, ensures deviation from requirements is reported

By Jason Schulze



For those of us in the thermal-processing industry, a thermal cycle that does not meet the specified cycle parameters can amount to quite a bit of unplanned time, effort, and money. A less experienced heat-treater may feel confident that the post heat-treat testing will yield positive results. However, a more experienced heat-treater will understand that, no matter the results, it must go through the standard nonconforming

material process that applies to the approved quality system.

In this article, we will explore the subject of nonconforming thermal cycles and how they apply to a quality system.

DESIGN AUTHORITY

It's important to understand the term "design authority" when dealing with nonconforming product in any manufacturing setting. My background is in aerospace metallurgy, so this is where I intend to draw my examples. To be the design authority, that particular organization (in most cases, it's not a single person) has a complete understanding of the product and its intended use regarding form, fit, and function. It may also be that an organization purchased the design rights to a product as well. Regardless, that particular organization holds the right to disposition the product as a whole, or in part, when any part of the manufacturing process (including order of operations) of that product is not in accordance with what is specified.

It's safe to assume that most commercial heat-treaters do not have design authority for any product they heat-treat. There may be certain instances where captive heat-treating is performed on a product produced by the design authority, but, in many instances, this is not the case. If a heat-treater, whether captive or commercial, does not heat-treat in accordance with the specified instructions set forth by the design authority, the product requires disposition from those who do have design authority, regardless if it passes specified hardness, mechanical, or chemical analysis.

Evidence of this can be seen in the Nadcap AC7102 baseline checklist for heat-treat that asks if incoming contracts and purchase orders are reviewed to ensure that the "identification of the prime aerospace customer that has design authority" is stated.

THERMAL CYCLE VERIFICATION

It is important for all heat-treaters to have a cycle verification process in place to ensure nonconforming cycles are identified. In my field,

I see many ways this can be accomplished and, more often than not, it is based on the heat-treater's operations (including furnace instrumentation) as well as customer requirements. Typical cycle verification takes the form of a quality representative, or designee, who reviews the thermal cycle record to ensure all variables (i.e. temperature, carbon potential, vacuum, time, etc.) are conforming. Once this review is completed, some form of evidence of review is documented. This may be a stamp or signature and date on a physical chart or paper copy, or an electronic signature and date. Some suppliers also go as far as to include a separate operation on the router or other job planning that has instructions on how to perform the cycle review and a field to sign/stamp and date.

Regardless of the review process, the reviewer(s), whether quality or designee, should have evidence of training that ensures they are competent to perform the verification.

Any review process should be designed in such a way that product that has not successfully passed the process verification and subsequent testing is not shipped.

NONCONFORMING THERMAL CYCLE

A nonconforming thermal cycle may consist of any variable that has not met the heat-treat cycle that is required by the governing specification and/or instructions. This also may include the lack of evidence the thermal cycle was performed, or any variable within the thermal cycle that was not recorded as a permanent record.

Let's look at an example. A supplier receives 150pcs of INCO 718 parts for solution and age heat treatment. The specification requirements for the solution heat treatment are 1,800°F ±25°F for 1 hour +10 minutes / -0 minutes. The age heat-treat requirements are 1,325°F ±25°F for 8 hours, then vacuum cool at 100°F per hour to 1,150°F within one hour and hold at 1,150°F ±25°F for 8 hours +10 minutes / -0 minutes. Both the solution and age treatments are required to be performed in a vacuum of <1 micron.

While reviewing the cycle, it is found that the age cycle was held for eight hours and 16 minutes — six minutes over the time tolerance. At this point, quality will need to segregate the material in question and process this as a nonconformance through its approved quality system. During the nonconformance process, there should be a step that requires the quality team to notify the purchaser of the nonconformance. The purchaser may, or may not, be the design authority. If the customer is in fact the

design authority, they would be able to disposition the material themselves. If not, they may need to contact the company that does have design authority to obtain disposition on the material.

Nonconforming thermal cycles should be kept with the corrective action paperwork to ensure evidence of review, and either approval or rejection is able to be produced when required.

WHAT CONSTITUTES AS A NONCONFORMANCE?

To determine what constitutes a nonconformance, we have to look at the requirements that are specified by the customer (in some cases, the design authority) to the heat-treater. Some heat-treaters are given only a material type and, say, a hardness range to achieve. In a scenario such as this, the heat-treater designs the thermal cycle needed to achieve the required hardness, making any variation to the thermal cycle acceptable as long as the required hardness has been met. Considering this same scenario, if a customer also required that the thermal cycle the heat-treater designed be approved and

“fixed,” then the heat-treater would need to notify the customer of the nonconforming thermal cycle, even if the hardness requirement had been met.

Also, if thermal cycle parameters (including tolerances) as well as post heat-treat testing results and methods are specified, any deviation from those requirements must be dispositioned by the customer.

SUMMARY

This type of topic can be difficult to discuss as there are many different ways in which requirements are flowed down to commercial and captive heat-treaters. In this article, I attempted to cover the most basic of scenarios while maintaining the basis for nonconforming thermal cycle disposition authority. In addition, not all customers flow down requirements to heat-treaters in the same way. Due to this, the heat-treat quality representative must understand and have a system for each customer requirement with regard to nonconforming thermal cycles. 🌱

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