Post Curing PTM&W High Temperature Resins

DISCUSSION

The curing of high temperature tooling (HT) or parts should be viewed as critical an aspect as any other part of the building process. With very few exceptions, curing should always be done in a slow and controlled manner, in a convection type oven that has uniform, forced circulating air flow. If the starting temperature is too high or ramp rates (temperature increases) are too fast, they can lead to excessive softening of the resins. This in turn can create surface imperfections, increased shrinkage, distortions, warpage and dimensional issues. Since these factors are also highly influenced by the fabric selection, resin content and the type of support structure used, it is important that the curing process be carefully monitored.

For tooling, there are numerous types of materials being used for "Master's," which represent the surface being recreated. These materials also have an influence on the curing, surface quality and dimensional stability. Many have very different coefficients of thermal expansion (CTE) from the epoxy resin being used and if not understood can lead to dimensional problems. This is because they grow or expand at different rates. Some also act to insulate, so the back or exposed surface may be hotter than the mold surface. Thermocouple placement is very important in these instances.

INITIAL CURE

Many HT epoxies will cure hard overnight, but can be brittle or glassy in this "green" state. Care must be taken with regard to trimming, grinding and aggressive movement. Before the tool or part is removed from the master it must reach a certain "set" or level of cure. To achieve a sufficient set before the actual cure begins, we like to see all of our HT systems get a 120^{O}F cure overnight, which is 14-18 hours. This is an important temperature for a couple reasons. One, most master materials used today for HT tooling can withstand 120^{O}F with little regard for expansion or growth. Two, the long overnight soak advances the Tg (heat resistance) of the resin to a place where it will lead the oven temperature. Meaning, the Tg of the resin will be higher than the temperature of the oven as it is raised. This is an important point because as the temperature is raised during final cure the resin is more stable from one temperature to the next, minimizing movement.

After the overnight low temperature soak, a sufficiently supported tool (meaning flanged and/or tied-in back-up structure) can be removed from the master and cured "unsupported," meaning off the master. This is where parts and tools may differ, since parts are more likely to be thinner and may or may not be supported with a sufficient back-up or support structure to hold its shape. It's important to note that when tooling is cured unsupported, the base or frame still needs to be in contact with as much of the oven floor as possible. Since cement floors may not always be level or flat, shims may be needed to ensure full contact and eliminate any possibility of slumping or sagging while curing.

FINAL CURE

At this point, the tool is ready to start the final cure. From a cold oven, there are two methods we advocate, which are largely dependent on the equipment a shop may have. Keep in mind, you can't cure a tool or part too slowly but as previously stated, you can go too fast or too hot too soon.

First method is a ramp rate of ½° per minute. What this means is the oven temperature will increase 30°F per hour and allows the user to cure without stopping to dwell at intermediate temperatures up until the final temperature has been reached. We generally recommend going 25°F beyond the service temperature the tool will see in use. So if the service temperature will be 350°F then the curing should continue to 375°F. The final temperature should be held for at least 2 hours.

Second method is to divide up the cure cycle into 40°- 60°F increments. In example, starting from 75°F and slowly bringing the tool back to 120°F and hold for an hour. Since the tool has already been cured overnight at 120°F you do not need to dwell or hold as long there as in the rest of the cycle. If 375°F is your end temperature, raise the temperature 2-3°F per minute in 50°F increments (120°F, 170°F, 220°F, 270°F, 320°F and 375°F) and hold for 2-4 hours at each temperature. It's a good idea to give the top end a little longer soak than the intermittent temperatures. Part of the equation on dwell or soak times is partially dependant on the thickness of laminate, or, if it's a thermally conductive material like an aluminum-filled epoxy casting resin which normally would not use fabric.

For successful post curing there are two key words to remember: "low" and "slow." Start the temperature low and keep the ramp rate slow. If you have any questions regarding curing PTM&W HT resins please contact your local PTM&W representative or call us direct in California.

PTM&W Industries, Inc.
10640 S. Painter Avenue Santa Fe Springs, CA 90670-4092
562-946-4511 800-421-1518 FAX: 562-941-4773
Visit Us At: www.ptm-w.com Send Questions To: info@ptm-w.com