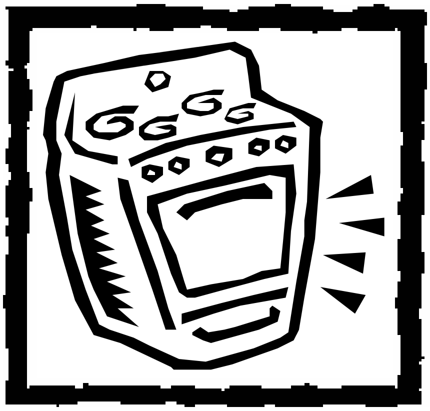

P r o d u c t i o n :

Testing Ovenware

by Dick Lehman

Regardless of how we finally come to our ovenware recipes—or what those recipes are—we need a methodology by which to make thermal shock tests that are thorough, inclusive, severe and comparative.

Right before Christmas a few years ago, several customers returned baking dishes to my studio due to unexplainable and unexpected cracking (after 2 to 3 years of use). The customers assured me that all appropriate care had been afforded these pieces, and I had no reason to believe that they had not followed all the normal safeguards and recommendations for using handmade ovenware pieces. Additionally, some mugs were returned to me that had multiple cracks going about one or two inches from the rim down the side. These cracks reportedly appeared through normal or less than normal use.

I had a problem. What to do? The failures were so few, considering the number of pots I sell each year, that I could have just replaced the pieces and chalked it up to the cost of doing business. And it could have been just a coincidence that these pieces had all come back to me within a few weeks time—perhaps I should just ignore all this. On the other hand, it may have been that I was on the front end of an avalanche of all the ovenware pieces I had made within the last three years. That was an awful prospect!

Regardless of not knowing whether there would be more failures in my ovenware, I thought it important to try to improve the clay body if possible. And I hoped to do so without changing the recipe to such an extent that it would alter the colors of all my glazes.

So I set out to attempt to create several new ovenware bodies. My knowledge and abilities in ceramic engineering are limited, and my attempts at altering and improving my own ovenware recipe were more intuitive than academic, relying more on anecdotal information and "common knowledge" than on my acquaintance with good science or accepted research.

Designing a Test

I created and gathered six new ovenware clay bodies, then developed a series of tests to see if any of the new formulations were actually an improvement over what I was already using. I needed a methodology to make thermal shock tests which were thorough, inclusive, severe and comparative; and these testing procedures needed to be accessible, repeatable and, to some extent, reliable.

I found no published recommendations for uniform thermal shock testing or integrity testing of ovenware bodies—at least none geared to the low-tech production potter. This test was not informed by any of the existing normative standards that exist within industrial ceramics related to "mean of first failure"—the average number of times a piece must be shock tested before it will fail. What follows are the methods and approaches I developed after talking with numerous other potters, and reflecting on the kinds of pot-failures we had all encountered.

I decided to test both mugs and baking dishes. The mugs were of a variety of shapes, and utilized all six of the different clay bodies I was testing. The baking utensils were of two kinds—flat-bottomed dishes (two sizes) and bowl-shaped bakers. The tests were made in conventional ovens, and no microwave tests were attempted (that is a separate testing procedure). Furthermore, this test provided no information about the effects of "glaze fit" on a particular clay body, or the implications of glaze fit upon thermal shock failure.

Measuring Results

Following each step of the shock test, the pots were individually tested for integrity. The integrity check, though somewhat colloquial, tested both the sound of the piece (the noise it makes when it was struck with a metal rod) and the look of the piece (could I see any cracks?).

Thrown and altered open-face baker, 13 inches in diameter. This piece was formed by separating side walls from the "floor" of the pot (along the two long sides) while it was still on the wheel. The walls were then repositioned in this "Baroque" pattern and reattached to the floor. Pieces that have been so-stressed in this way during the making process and that have sharp angular direction changes, are more prone to thermal shock.

Most all of us recognize the difference between the beautiful “ring” that a pot of integrity makes when struck, and the dull “thud/thunk” that occurs when pots have been cracked, overly stressed or damaged. To perform the sound test, I placed each pot on a metal stand, then struck it on the rim with a metal rod. This striking was done “gently” so as not to break the piece with the rod. Each piece was struck with as similar a stroke as possible, and struck at the same position on the pot. While each piece did not sound the same (due in part to small unavoidable variations in shape and thickness and also differences in recipe formulation), I did note the sound, or “ring,” of each. I compared these sounds to “control” pieces—pots of similar shapes made with the same recipe—which had not yet been shock tested.

The visual test involved putting water (heavily stained with food coloring) into each piece for at least 10 minutes. I looked for small cracks, which might not be visible to the naked eye, and which might not have revealed themselves in the sound test. I assumed that any crack would collect, through capillary action, some of the food coloring, and maintain some color in the crack when the tinted water was poured out. To eliminate as many variables as possible, all pots used for this test were glazed white and I used blue food coloring to heighten the contrast. While the food color revealed that most cracks went all the way through the bodies, there were rare cases where really small or beginning cracks were visible only on the inside.

Testing Mugs

The mugs went through two tests, which were designed to provide progressively more thermal shock.

Test 1: The first test was simply to fill each room-temperature mug half full of boiling water. By filling the mug only half full, I reasoned that there would be more dissonance within the piece itself. Not only did the piece suddenly go from ambient temperature to boiling temperature, but only part of the piece would make this transition, thereby causing the piece, within itself, to have both ambient and hot surfaces, which would increase the interior thermal stress.

Test 2: The second test was to freeze the mugs at –10°F for 45 minutes. Upon taking the mugs out of the freezer, they were immediately filled halfway with boiling water. While the mugs I tested passed each of these tests, the tests could be continued for perhaps hundreds of cycles to determine where the clay bodies would eventually fail. This would establish my own “mean of first failure.”

Testing Baking Dishes

For each of the six recipes, I tested multiple pieces consisting of two basic shapes—two sizes of flat-bottomed baking dishes with right-angled corners where the bottoms of the pots met the side walls; and baking dishes with rounded bowl-like contours. I devised five tests, which would expose pieces to progressively more dramatic shock in each subsequent step. I determined that I would continue testing until at least some (if not all) the ovenware bodies failed.

Test 1: Baking dishes at room temperature were placed into a preheated 500°F oven, and allowed to remain there for 10 minutes. The pieces were then pulled out, allowed to cool naturally, then tested for integrity. (I included this fairly benign test since I have always cautioned my customers never to place the baking dishes into a preheated oven.) This test was repeated three times for each piece, for each of the six clay bodies. No failures were observed in any of the clay bodies, or any of the shapes.

Test 2: Reasoning that sometimes my customers may put food-filled baking dishes into hot ovens, I tested each piece several times by placing an ambient temperature piece, half-filled (and not fully filled as I recommend to my customers) with water, into 500°F oven. Having the pieces half-filled created the potential for exacerbating the shock within each individual piece. Repeated tests yielded no failures for any of the six clay bodies.

Test 3: I next froze empty baking dishes in the freezer for 45 minutes, then placed them directly into a preheated 500°F oven where I left

Thrown and altered open-face baker, 12 inches in diameter. The rims have been pinched and thinned on the "ends" to form handles. The resulting variation in thickness of the side wall or rim tests the integrity of an ovenware body.

them for 10 minutes. Multiple tests yielded no failures in any of the clay bodies, or in any of the shapes.

Test 4: Next, I froze a half inch of water in the bottom of the baking dishes before taking them directly to the preheated 500°F oven. The pieces remained in the oven until the ice had melted and the water began to boil. This is the first point at which I experienced failures. Two of the clay bodies failed; however, only the flat-bottomed pieces failed. And both sizes of flat-bottomed bakers failed in these two recipes. The cracks were clear and obvious.

Test 5: I had predicted that the frozen water test would crack all the pieces. That not being the case, I moved forward to a more dramatic shock test—I froze all the pieces (empty), placed them in the preheated 500°F oven for 15 minutes, then took them directly to the sink where I poured an inch of cold water into them. At this point all 6 bodies failed, but in different ways. Two bodies failed with large audible cracks; two other bodies failed with shorter thinner cracks; one body cracked only on the bottom, but was visible only through the visual dye test; and one body failed only as a flat-bottomed form. This sixth body, when used to make a bowl-shaped baker, survived repeated severe testing with no failure.

Observations

In the process of performing these tests, I was able to make several observations. Some may be obvious while others may be merely colloquial. All may be worth considering as you make your next ovenware forms:

The bowl-like contour of the body of this casserole minimizes and softens direction changes, i.e., the line between the floor and side walls. Such shapes with a smooth transition help to minimize the effects of thermal shock.

Small baking dish with altered rim, 6 inches in diameter. The sharp angle change from floor to side wall, altered rim, and asymmetrical handle placement exacerbate thermal shock problems.

- The larger the piece is, the more likely it is to fail in ovenware applications.
- The broader and flatter the bottom of the pot is, the more likely it is to fail.
- Pots with soft, rounded corners, curves, and lines seem to survive better than ones with sharp corners and direction changes, regardless of the size.
- Filling the entire exposed inner surface of a baking form with food (thermal mass) lessens the thermal shock and prolongs the life of the piece. An important fact users need to know.
- Bowl-shaped forms required additional applications of the most severe test in order to cause five of the six clay bodies to fail (the same five clay bodies that failed in the flat-bottomed-shaped pieces). The soft line of the curvilinear form seemed to distribute and withstand more stress before failing.

Recommendations

Use a proven industrial or premixed ovenware clay body. This option may not satisfy our individual taste with regard to texture, color, glaze compatibility, or workability. It may or may not be truly a quality ovenware body under the conditions by which any particular individual makes and fires. And additionally, to make such a choice determines that one will be fully subject to the quality control methods in mixing and composition, which someone other than ourselves utilizes and enforces.

Use and test your own products before marketing them. While this is costly, you may avoid the necessity of replacing years worth of product to unhappy customers.

These tests do not give conclusive evidence about how a particular ovenware body is going to fare after 3-10 years of regular use (or, sometimes, abuse), but the tests do provide immediate comparative evidence regarding how different ovenware clay bodies respond to a series of increasingly severe thermal shock tests.

Conclusion

Even with all the limitations of my methodology, one can take heart that these severe tests indicated that some clay bodies (at least in the short run) would perform far above the normal expectations and requirements of most studio potters, with respect to the environments in which they might expect their ovenware clay bodies to satisfactorily function.

The method I developed and used, though not foolproof or even nearly fully proven, at least provides a methodology for uniform comparison of clay bodies in the light of severe and multidimensional thermal shock. For those of us who choose to mix our own clay bodies, it will provide some useful information upon which to make comparative, informed decisions.

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