

Low-fire, lead-free glazes

Achieve consistent firing success with these simple guidelines.

"I fired my kiln, and the shelf cones look okay," said a telephone caller, her voice shaking slightly. "But my glaze looks bubbly."

"Have you read the label on the glaze jar?" asked the firing technician.

"Read the label?" the customer echoed. "You don't understand. I've been firing ceramics for 20 years." Her voice started rising.

By **Arnold Howard**

Kiln, glaze and clay manufacturers hear this daily. Firing seems more difficult than in the past, because glazes contain fewer heavy metals, such as lead.

Lead makes glazes flow smoothly at high temperature, leaving a beautiful sheen. Glazes of the past could tolerate poorly vented or underfired bisque. The leaded glaze expanded and contracted with the underfired body.

On the positive side, lead-free glazes also offer benefits. Leaded glazes flow freely at high temperature, whereas most lead-free glazes are stiffer. Apply lead-free glazes of different colors right next to each other. Since they don't flow when hot, gravity won't make them run together. You can also layer lead-free glazes. Paint a pink flower onto a white background, for instance.

Lead-free glazes won't drip onto the kiln shelf as readily as leaded glazes. Stilts are easier to remove from the ware. Christmas ornaments, eggs, or other difficult shapes are easier to stilt, because the glaze doesn't run as much.

"Lead-free glazes are tricky," says Merle Peratis of Capital Ceramics. "They're not as forgiving as leaded glazes. But if people will take the time to learn to fire them correctly, the results will be just as good as with leaded glazes."

Application Basics

1. Don't apply the glazes too thick.
2. Lead-free glazes must dry naturally without force-drying. A cool breeze or a fan is okay, but avoid using heat lamps or hair dryers or a kiln to dry the glaze.
3. Dry the glaze completely between each coat. When it is dry, the glaze will look dull and will feel

warm, not clammy. Lead-free glazes should dry 24 hours before firing.

What Type of Kiln?

Lead-free glazes are easier to fire in an electronic kiln. One reason is that controllers can hold, or maintain, the firing temperature at the end of the firing. You needn't replace your kiln to fire lead-free glazes, though. Switch-operated kilns work well, too.

Pyrometric Cones

"When you ask people about the shelf cones in their kiln, they come back with, 'What's a shelf cone?'" says Frank Kahanic of Ceramichrome, Inc.

"A big problem is that people are not using witness cones, and never have," says Ann Alvarez at Duncan Enterprises.

Yet pyrometric cones on the shelf are essential in firing lead-free glazes, even in electronic kilns. To save on the cost of shelf (witness) cones is gambling with a whole load of ware. Without shelf cones, you will never know if the Kiln Sitter or electronic controller is out of adjustment.

Pyrometric cones are small pyramids of clay and fluxes that soften and bend when heated to maturity. The small 1 $\frac{1}{8}$ " cones are mounted in the Kiln Sitter. Large 2 $\frac{1}{2}$ " cones are placed on the kiln shelf near the ware. Self-supporting large cones are easier to use than the original cones that mounted in a clay or wire holder. The correct slant is built into the base of the self-supporting cone.

Place three cones on each shelf: the firing cone, and the next cooler and hotter cone. For instance, if you are firing to cone 06, place 05, 06 and 07 cones on each shelf. Keep them at least 3" from a peephole to avoid cool

air. The shelf should be kiln-washed, or over-fired cones will stick to it.

As your firings become consistent, you may decide to use only the shelf cone you are firing to instead of the three cone system. But even with consistent firings, place a cone on every shelf.

Place extra cones near heavy masses of ware, such as thick plates. This will indicate whether the ware received enough heat. Thicker ware requires more heat. This is why heavy pieces are often underfired.

Even Heat Distribution

Cones are placed on every shelf to check how evenly your kiln fires. Even heating is important in firing lead-free glazes.

Moving ceramic mass inside the kiln changes heat distribution. The greater the mass of ware and furniture, the more heat is absorbed. Therefore, distribute the ware evenly throughout the firing chamber.

What can you do if your kiln fires unevenly? Distribute the ware inside the kiln to compensate for it. Place the heavier pieces where the kiln fires hotter. They will absorb more heat. Place lighter or fewer pieces where the kiln fires cooler.

For instance, if the kiln fires hotter in the center section, place the heaviest pieces there. If the bottom fires cooler, place lighter pieces on the bottom. By checking the shelf cones after each firing, you will soon learn to load your kiln for even heat distribution.

Venting the Kiln

As the ware is heated, impurities in the clay are pushed to the clay surface and burned. Without enough oxygen flowing through the kiln, though, impurities remain trapped inside the ware.

When bisque ware is heated during the glaze firing, remaining impurities in the clay will surface as a gas. The escaping gas passes through the glaze, leaving small ruptures, such as pinholes and craters.

Since leaded glazes flow, the small ruptures in the leaded glaze usually smooth out and disappear. Lead-free glazes are stiffer, so escaping gases leave craters in the glaze. This is why greenware destined for lead-free glazes must be well-vented. Im-

purities must be burned off in the greenware firing.

To vent the kiln, leave the peephole plugs out and raise the lid to the venting position for the first hour of firing. Keep the switches at a low setting during venting. Lower the lid and insert peephole plugs only after firing odors disappear. You can also hold a mirror above the peephole for a couple of seconds. (The mirror should be at room temperature, not hot.) If it fogs, moisture is still escaping, and the kiln should remain vented. The heavier the load of ware, the longer the kiln should remain vented.

If the kiln is fired too fast during the venting period, impurities remain locked inside the piece. If you break the piece, you can sometimes see the impurities as a black line. Examine the clay at the break. The impurities will look like a pencil line running along the center where the inside of the clay is exposed.

If the bisque turns out gray instead of white, it is usually because the carbon pushed to the surface, but because of lack of oxygen, it didn't burn off. Refire the piece with better venting before applying glaze.

The down-draft kiln vent pulls oxygen through the firing chamber throughout firing. When using the down-draft vent, leave the peephole plugs inserted and the lid fully closed during the entire firing. No further venting is needed. The down-draft kiln vent also improves heat distribution.

Firing Time

The modern trend is to fire faster. The heavier the load, however, the slower the kiln should fire. Otherwise the heat won't penetrate the ware completely. "It takes longer to cook six potatoes in a microwave than it does to cook one," explains Frank Kahanic. "It's the same with kilns."

The Greenware Firing

"Nine out of 10 times," says Jean LeBlanc of Duncan Enterprises, "the problem with lead-free glazes is under-fired bisque."

Firing experts all seem to agree. Chuck Trott, a ceramics engineer at Mayco Colors, Inc., says, "I see more lead-free failure because of improper greenware than anything else in the industry."

"If bisque is underfired when you apply lead-free glaze," says Ann Alvarez, "it is likely to cause crazing, fine cracking in the glaze. This is the most common problem we see."

Lead-Free Glaze Trouble-Shooting

Cratering

Fired the greenware too fast or without sufficient venting. Mike Conroy suggests trying a fast glaze fire, without hold, when dealing with underfired bisque.

Crazing

a. Often due to under-fired bisque. The bisque should be fired two cones hotter than the glaze.

b. The glaze doesn't fit the clay body, which means the glaze expands at a different rate than the clay. Test glaze and clay combinations that you are not sure of.

c. Dry-footing is not recommended, because water absorbs into the ware, expanding it and causing crazing. This type of delayed crazing is often visible in dry-footed coffee cups.

Crawl Back or Peel Back

Caused by force drying and not drying evenly. Between coats, the glaze should dry naturally without forcing. Lead-free glazes should dry 24 hours before firing.

Dull Surface

Under-fired glaze.

Faded Colors

Over-fired glaze.

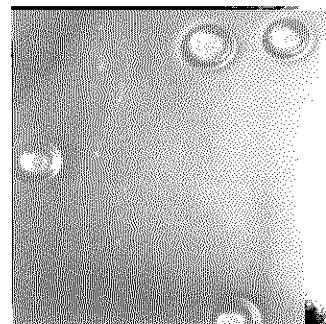
Pin Holing or Blistering

Over-fired glaze. With severe blistering or crawling, add a little glaze to the bare areas and fire again.

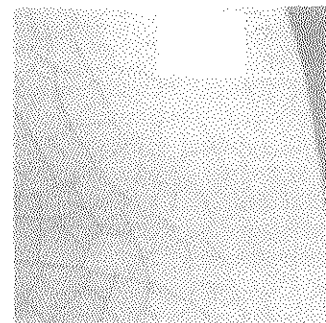
Small Bubbles Beneath the Surface

Lead-free glaze may have been applied too thick. Refire the piece to a normal temperature. The bubbles should disappear.

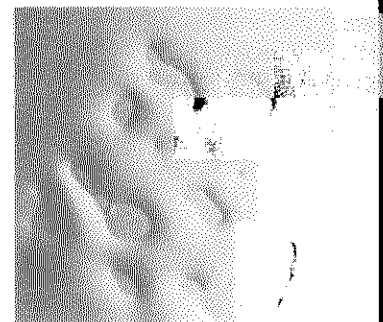
*Photos courtesy of
Duncan Enterprises*



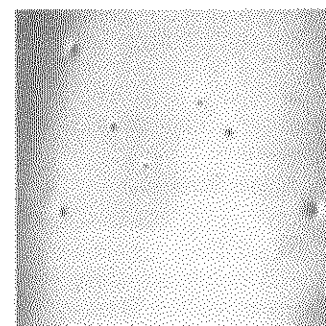
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