Basic Ceramic Glazes

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A Basic Glaze Manual

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Introduction to the Basic Ceramic Glaze Manual

High-school and college curriculum do not commonly cover the formulation of glaze tests outside of available recipes. A basic guide for the preparation of test glazes is necessary to overcome the initial complexity of the issue for those without years of personal research or a degree in physical chemistry. Although school libraries have books that address the matter, they are often written with the professional potter or glaze chemist in mind and are difficult to understand. The proposed guide will give teachers and students a reference to glaze formulation that is easier to understand and apply in the classroom and school studio.

The intent of the proposed guide is to provide to teachers and students an understandable reference to glazes. The guide will also provide instructions for tailoring a glaze, or producing a glaze for a specific clay body or purpose. If a student wants more than a simple clear glaze he will have the ability to create and test tiles to make a glaze to suit his purposes. Likewise, teachers will also be able to use this guide to better tailor studio glazes that do not work well with their available clay.

What this guide does not provide is the math, chemistry, and physics behind the formulation of glazes. Although this entails a little more labor on the part of the student or teacher, it is a substantially simpler solution to a very common issue.

Chapter 1

Chapter 1 – What is a Glaze

Ceramics has many different types of surface treatments. The two most common surfaces seen on ceramics are bare surfaces or glassy surfaces. Glassy, or glazed, surfaces are almost always glossy. The purpose of the glaze is to seal the clay body from the elements whether it's rain or porridge.

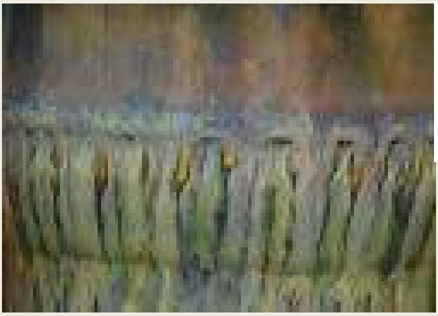

Figure 1 : Rutile Blue Glaze on Porcelain

What is a Glaze Made of?

Glazes are mostly made of silicon dioxide. In the world of ceramics silicon dioxide is commonly referred to as glass, quartz, flint, or frit. Silicon dioxide is also the main component of your clay body. This is what helps the glaze bond to the clay body

Figure 2 : Glaze Materials and Ingredients

One important thing to note is that glazes look completely different before and after firing. Copper based glazes are a good example where the raw glaze is usually greenish but the fired glaze can vary from green to blue to red depending on a number of factors. You can see in Figure 2 at the beginning of the chapter many ingredients for glazes. Most are white to brown powders and most wet unfired glazes are the same. Figure 3 shows an ash glaze over a Japanese shino with iron oxide decorations.

Figure 3:
Unfired vs. Fired

What is a Colorant?

Colorants in glass are like some dyes in the traditional sense but must be able to resist the intense heat of firing in a kiln. Because of this, nearly all glaze colorants are basic elements or elemental compounds. The most common compounds are Oxides and Carbonates. You can also find colorants as "stains" which are industrially smelted. One example is cobalt which is found as a colorant in the forms of cobalt oxide and cobalt carbonate. Cobalt as a colorant becomes a rich blue like you see in classical Chinese blue-on-white pottery.

Figure 4: *Wine Jar with Fish and Aquatic Plants.* China, Yuan dynasty, 1279–1368.

What is a Flux?

In chemistry, whenever you introduce new elements to a mixture you flux it, or lower it's melting point. Lowering the melting point of the glass is necessary because pure Silicon Dioxide melts at a higher temperature than your average clay body. If you fired an earthenware pot at that high temperature it would melt into a puddle. This is because the clay body is already mixed with many other ingredients, or fluxes. When potters talk about fluxes though, they are usually talking about strong fluxes like cobalt, or boron. Some fluxes like cobalt, are also strong colorants.

Figure 5: How runny?

Chapter 2

Chapter 2 – Test Tiles

Making test tiles is an important part of glaze testing. When you make test tiles you get a good idea as to how a glaze will behave once it has been fired. Test tiles can be used to test nearly every aspect of glaze behavior.

Some of these aspects are:

- How runny the glaze is. See Figure 2.
- If the glaze fits the clay body.
- The glaze's color.
- The glaze's opacity
- If the glaze is transparent, translucent, or opaque
- Other characteristics of appearance
- The glaze's interaction with another glaze or treatment

The kind of tile you use depends on the characteristic you are testing. Glaze tests can also be done with pieces of pottery like the final product, be it a plate, vase, or sculpture.

General glaze test tiles are often fired vertically with both a flat surface and a textured surface. General glaze tiles are usually sufficient for the purposes of a glaze test.

Common Test Tiles

Figure 6: Standard test tiles for wall mounting

Figure 7: Glaze Bell for potentially runny glazes. From Mark Palandri's Blog at palandri.com

Figure 8: Unglazed textured-halves from Fire When Ready Pottery

Figure 9: Digital-Fire's glaze test cones

Making Test Tiles

Figure 4 shows the standard tile you will find in nearly every studio. Their purpose is to show the basic appearance of a glaze.

1. To make these tiles, roll out a slab ¼” thick and cut it into 1” to 2” squares or rectangles
2. Use a pointed dowel or pencil to poke holes through the tiles.
3. Bisque the tiles in a large bowl.
4. The glaze tiles are ready for glazing.

Figure 7 shows a Glaze bell. Glaze bells are used to test potentially runny glazes. Glaze bells can be textured or smooth. The purpose of the lip is to keep glaze from running off the test and fusing onto the kiln shelf.

1. Throw a basic glaze bell on a potters wheel.
2. Wait until the bell is leather hard.
3. Prepare a plaster mixture and push the bell into the plaster mixture until its bottom is level with the plaster.
4. While the plaster is still liquid, use your fingers force out air pockets in the submerged lip.
5. Let the bell and plaster sit for one or two days until the clay shrinks and can be easily pulled from the mold.
6. Use a small scrubber or sponge and clean out the plaster mold thoroughly.
7. Prepare some casting slip and fill the mold completely. The plaster will absorb some water creating a harder clay layer.
8. Let the mold sit for several minutes before pouring out the excess clay.
9. Let the mold and cast sit until the cast comes away from the mold. Press into it occasionally. When it feels cool and hard to the touch it can be removed.
10. Dry the cast and bisque it.
11. The Glaze bell is ready for glazing.

Figure 8 shows unglazed textured halves. These show the effect of a glaze on a texture use in production wares. Figure 6 also has some mild texturing which is not nearly as apparent as in figure 8. The bases on these tiles help the tiles stand and also help catch runny glaze drips.

1. Roll out a ¼” slab.
2. Cut some 2” square pieces that will be used as bases for standing the halves.
3. Cut a 3” tall strip and trim the edges so they are square.
4. Take a textured roller and run it across the entire strip.
5. Flip the strip so the texture is facing into the table
6. Take a 1” dowel and begin to form the halves by holding the clay against the dowel.
7. When you have rolled up half a cylinder, cut it free.
8. Repeat with enough halves to match the number of bases.
9. Slip and Score the Halves to the bases thoroughly.
10. Let the completed pieces dry thoroughly before putting them though a bisque cycle.
11. The Textured halves are ready for glazing.

Figure 9 shows some test cones. These can also be made as cylinders. The purpose of the chevrons is to act as texture to see how the glaze looks where the glass thins and pools.

1. Roll out a ¼” slab.
2. Cut the slab into 3” wide strips.
3. Pick up the short edge of one of the strips along the dowel and roll the slab around the dowel until it touches clay.
4. Cut the rolled section and smooth the edges together.
5. Repeat steps 2 through 4 until you have the number of test cones that you need.
6. Bisque the cones when they have dried.
7. The test cones are ready for glazing.

Chapter 3

Chapter 3 - Glaze Test Grids

What is a Glaze Test Grid

A glaze test grid is a slightly different type of glaze test. Its purpose is to show how varying the amounts of ingredients can affect the fired product. Potters that use commercial glazes often do not have to worry about this method as the glazes have been specially formulated. If you are making your own glaze a glaze test grid is a good method to learn about the glaze and find a recipe that fits your intent.

Making a Test Grid

A glaze test grid can be small (2x2) or large (10x10). Even though a 2x2 grid is technically a grid, it does not allow you to test very much so it is recommended to use a larger grid. Likewise, a large grid is time consuming to produce and may not be necessary. A 5x5 grid is a good place to start.

The first step in making a test grid is preparing a stamp for making indentions for a glaze. This stamp can be made of any relatively durable material like wood, metal, or fired clay. The stamp can be made completely flat or textured, or both. This stamp does not need to be complex. 1” square dowel or rod, the end of a ruler, or even a large eraser is suitable.

The second step is to prepare the tiles. When you know the size of the grid you will be using, follow the steps below.

1. Roll out a slab of clay ¼” to ½” thick.
2. While the slab is soft, make even and shallow impressions. Ensure they are at least ¼” apart.
3. When the slab has hardened enough to handle, cover it with a sheet of plastic and let it dry on a plaster slab.
4. When the tile has dried completely, bisque it.
5. The tile is ready for glazes.

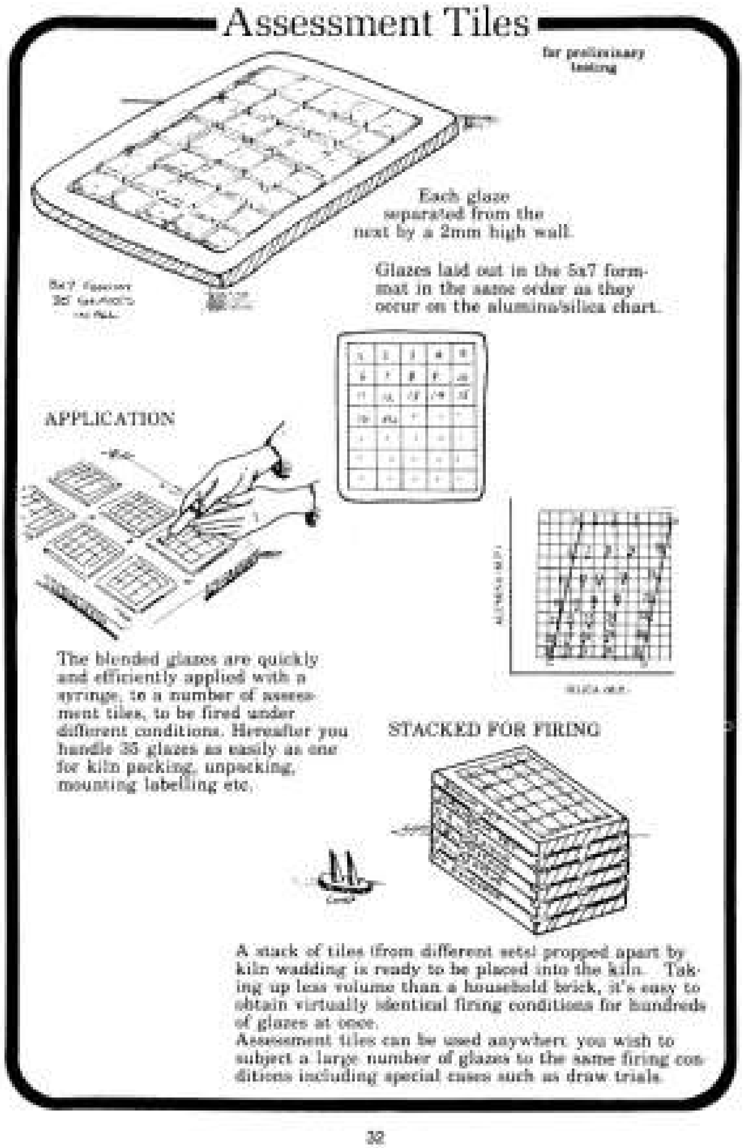

Figure 10: An example of Ian Curries Glaze Test Grid Method (Stoneware Glazes)

Chapter 4

Chapter 4 - Adjusting Glazes

Adjusting Glazes to Fix Defects

Sometimes it is necessary to adjust a glaze's formula if certain problems occur. This can be done fairly accurately with or without knowledge of the glaze's recipe. Common and easily fixed problems are shown below.

Crazing

Crazing is one of the most common problems. Sometimes crazing is a desired effect so the remedy is up to the potter. Crazing in caused by the difference in shrinkage between the clay body and the glaze. When the pottery is cooling and the glaze shrinks more than the clay, this causes the small cracks to form.

Two common remedies to reducing crazing are:

a. Addition of Alumina/Clay content

b. Addition of Silica

Shivering

Shivering is a similar problem of fit between glass and clay. When the pottery is cooling and the clay body shrinks more than the glaze, the glaze will begin to flake of. Sometimes this can even cause the clay body to fall apart completely.

Two common remedies to eliminate shivering are:

a. Addition of any sodium containing feldspar, nepheline syenite, or other similar mineral

b. Addition of a color free flux like a borax frit.

Pitting

Pitting is another type of problem. Pitting can be seen as little pinholes or craters in the glaze's surface. Pitting can be seen best under bright light. Gasses that escape the clay body and the glaze during firing creating bubbles in the glaze. Pitting is usually a sign that the firing time is too short.

Re-firing the piece is the most common recipe for getting rid of pitting.

If the pitting is bad, the individual pits can be filled with a suitable glaze and re-fired.

Test Grids for Defects

The instructions for the test grids below all use a 1x6 grid. To test additional ingredients, simply add more grids. (e.g. 2x6, etc.)

To prepare a test grid for any of the defects:

1. Make a grid 6 units long by 1 unit wide.
2. Mark the first grid position by placing a dot of iron oxide at one end of the grid.
3. Prepare 6 small 1oz cups of the glaze that is being tested. Each cup should weigh the same.
4. Prepare 8 fluid ounces of the respective remedy in a water solution.
5. Add 5 percent of the cup’s weight in slip to the first cup.
6. Add an additional 5 percent to each following cup.
7. Mix the glazes well and check the specific gravity of each with a hydrometer.
8. Use a cleaned syringe to pour an even amount of glaze into each respective well.
9. Fire the test grid.
10. Find the first test grid that is devoid of defects.
11. Make the percent weight addition to the bulk glaze.

Adjusting Glazes for Artistic Effect

Adding colors and effects to glazes can be a very fun and educational project for teachers and students. Being able to see the result of different mixes is often much more educating than an already prepared glaze test board. The instructions can be modified to fit as many colors as necessary. Each color should have its own column.

1. Make a grid 6 units long by 1 unit wide.
2. Mark the first grid position by placing a dot of iron oxide at one end of the grid.
3. Prepare 6 small 1oz cups of the glaze that is being modified. Each cup should weigh the same.
4. Prepare 2 fluid ounces of a colorant remedy in a water solution.
5. Using a syringe, add 1ml of colorant to the first cup.
6. Add an additional milliliter to each following cup.
7. Mix the glazes well and check the specific gravity of each with a hydrometer.
8. Use a cleaned syringe to pour an even amount of glaze into each respective well.
9. Fire the test grid.
10. Select the color or effect that suits your purpose and make the respective addition to the bulk glaze.

Colorant Additives:

Many different types of minerals are used as additives for coloring glazes and clay bodies. The ones listed here are among the most common. Oxide additives in glazes are much stronger than carbonate additives. A good rule to follow when adding colorants is to avoid adding more than 2 percent of the glaze’s weight in a pure oxide. If you are adding a carbonate it is safe to add as much as 10 percent.

Cobalt Carbonate or Cobalt Oxide:

Cobalt by itself provides a blue hue to glazes it is added to. Cobalt is a strong flux and colorant so its addition to glazes should limited(Digital Fire Materials Database).

Copper Carbonate or Copper Oxide:

Copper by itself usually provides a green hue to a glaze. Copper fired in a reduction atmosphere can turn red(Digital Fire Materials Database).

Tin Oxide:

Tin by itself is often used to make a glaze opaque. This can make other colorants more vibrant. Tin can be combined with chrome oxide for pinks and maroons (What Makes a Matte Glaze).

Potassium Dichromate or Chrome oxide:

Chrome as an oxide or with potassium both provide a deeper green color than Copper (Digital Fire Materials Database).

Iron oxide:

Potters use several kinds of iron oxide in ceramics. The orange color you see in many clays comes from small amounts of iron oxide. Iron oxide produces that same color in most glazes. In a reduction kiln, Iron can turn green instead. Some celadon glazes are a good example of this.

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