

Pottery Glazes

Materials:

Item	Amount per student	Amount for 24 students
1.5" X 1.5" bisqued ceramic tiles	2-4	100
Gertsley borate	0.8 g	20 g
Soda spar	0.2 g	5 g
Copper Carbonate	0.02 g	1 g
Manganese dioxide	0.02 g	1 g
Chromium oxide	0.02 g	1 g
Copper chloride	0.02 g	1 g
Silver nitrate	0.02 g	1 g
Titanium oxide	0.02-0.04 g	1 g

Equipment:

Item	Amount per student	Amount for 24 students
Kiln	-	1
Asbestos gloves and tongs	-	1
Metal can with lid	-	1
Sawdust or wood shavings	-	$\frac{3}{4}$ can
Bunsen Burner	1	24

Safety Issues:

- MnO_2 and CrO_2 are strong oxidizers, especially irritating to the skin, lungs, and other mucous membranes. AgNO_3 is poisonous, caustic, and irritating to the skin and mucous membranes. CaCl_2 is a minor irritant as well. Gloves would be sensible during this experiment!
- All heavy metal waste should be disposed of in a properly labeled waste bottle.
- The tiles and the kiln will be extremely hot, so be careful! Use gloves, tongs, or other devices to handle these hot objects.
- Open flames are generated in the reductive firing process. Watch out!

Procedure:

1. Mix 80% by weight Gertsly borate with 20% soda spar in a beaker.
2. Add 1-2% of a desired colorant.
3. Add enough water to make a paste with the consistency of toothpaste. Mix out any lumps.
4. Spread the paste onto a bisqued tile in an even layer, approximately 1 or 2 mm thick. Dry by gently heating over a Bunsen burner.

5. Fire the tile in a furnace or kiln heated to approximately 1100°C until the glaze appears liquefied and glassy. This usually takes several minutes for the size pieces that we work with.

Oxidative versus Reductive Firing

When the glaze has melted, the tiles can be removed from the kiln and allowed to cool in the atmosphere. The color produced is that of the oxidative type of firing. However, you can achieve the reduction of metallic elements such as copper, manganese, chromium and silver in glaze coloring agents by removing the tiles and placing them into a metal container filled with sawdust, wood chips, or leaves. The burning of the organic material in the closed container produces C and CO, both of which act to reduce the metals producing a metallic luster on the surface of the glaze.

1. Carefully with gloves and tongs, remove the hot tile from the kiln and drop it into the metal can filled with sawdust. Cover immediately with the lid to smother the flames.
2. After 1-2 minutes, remove the tile from the sawdust with the tongs (Be careful!! It is still very hot!) and cool it under running water.
3. Clean any carbon or soot off the tile with mild detergent or soap.

Variations to Try:

The class may want to organize itself so that most of these variations are tried by someone and then share the data!

1. Apply thick versus thin layers of glaze to the tile and compare final glazes.
2. Add 2-5% by weight TiO_2 to produce an opaque glaze.
3. Vary the % of colorants added and compare the glazes.
4. Systematically vary the proportions of Gertsley borate and feldspar and compare the final glaze properties.
5. Add a refractory oxide like Al_2O_3 and compare the final glaze properties.

CLEAN-UP: See safety issues.

Reflections:

1. What adjustments would you make in your procedure to change or improve your finished product?
2. What reaction chemistry is being beautifully illustrated in these glazes?