



## Best Practices in Glass Recycling

### Using Recycled Glass in Ceramic Glazes

#### Material: Recycled Glass

**Issue:** Many of the elements making up soda lime container glass are the same as those used in glaze formulations, although in somewhat different proportions. This Best Practice describes some of the issues involved with using recycled glass as a constituent of ceramic glaze formulation. In order to make effective use of this Best Practice, some knowledge of glaze chemistry is helpful.

**Best Practice:** Although the exact content of soda lime container glasses vary somewhat by manufacturer, color, and container application, a typical average chemical content of the oxides in container glass is given by the following:

<u>Oxide</u>	<u>Percentage by weight</u>	<u>Molecular weight</u>
SiO <sup>2</sup>	73.3	60
Na <sup>2</sup> O	14.1	62
CaO	9.4	56.1
MgO	1.9	40.3
Al <sup>2</sup> O <sup>3</sup>	1.3	101.9

The ceramic industry has developed a method for analyzing the chemical constituents of any material as a possible raw material for glaze formulation. The method, often called the “Unity formulation,” uses the molecular weight of the oxides and the percentage by weight in the chemical make-up to derive a chart showing the relative numbers of molecules of each oxide contained in the raw material. The oxides are expressed in the “R<sup>n</sup>O<sup>m</sup>” format, where R stands for any element, n stands for the number of atoms of the element R in one molecule of the oxide form of the molecule, and m stands for the number of atoms of oxygen in one molecule of the oxide.

The analytical method is called the unity formulation because it normalizes the chemistry of the oxide for one molecule of the RO, or flux column of the chart. The physical characteristics of glasses result in the fact that for most chemicals found in glazes, the elements that have one molecule of oxygen for each molecule of material are “fluxes.” That is, they are materials that promote the melting of other materials in the glaze at elevated temperatures.

The material in the middle, or R<sup>2</sup>O<sup>3</sup> column, usually alumina (Al<sup>2</sup>O<sup>3</sup>), affects the final characteristics of the glaze by reducing devitrification and by making the glaze harder and more chemical resistant. The material in the third column, almost always silica (SiO<sup>2</sup>), is often called the “glass former.” It forms the basic structure for the glaze. Glazes formulated for ceramic applications are designed to become glasses at elevated kiln temperatures. Then, depending upon the desired aesthetic, the glazes may remain glass upon cooling or may be devitrified to form crystalline glazes.

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Using this convention, the following chart shows the breakdown of the oxide molecules in an average formulation of soda lime container glass:

<u>RO</u>	<u>R<sup>2</sup>O<sup>3</sup></u>	<u>RO<sup>2</sup></u>
Na <sup>2</sup> O .516	Al <sup>2</sup> O <sup>3</sup> .029	SiO <sup>2</sup> 2.762
CaO .379		
MgO .105		

By this method, the effective molecular weight of soda lime glass is 226.

The ratios of the oxides determine the firing characteristics of the glaze. For example, glazes that fire at 1650 Fahrenheit are expected to have a silica ratio in the range of 1.0 to 1.5 in the unity formulation. Higher temperature glazes have higher silica ratios. Higher temperature glazes also tend to have higher alumina ratios, and different combinations of flux than are present in container glass. This means that other materials must be added to glass to make an effective ceramic glaze.

In addition, the coefficient of thermal expansion, which must match the clay body under the glaze for proper “fit,” may need to be adjusted to use glass as a glaze. Many excellent books have been written on glaze formulation. The reference below is one good one for introductory information.

Glass used in glazes must be ground very fine in order to be reactive with the other materials in the mix.

**Implementation:** These instructions can be used as an introduction to those interested in formulating ceramic glazes using recycled soda lime container glass.

**Benefits:** Glass can be an effective and inexpensive constituent of ceramic glazes, if properly processed and combined with other appropriate raw materials.

**Application Sites:** Glaze formulators.

**Contact:** For more information about this Best Practice, contact CWC, (206) 443-7746, e-mail [info@cw.org](mailto:info@cw.org).

### References:

Rhodes, Daniel, *Clay and Glazes for the Potter*, Chilton Book Company, 1973.  
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