GLAZE TALK

By Karen Latorre

This is the fourth in a series of columns focused on glazes.

In the last column we walked through the unity formula, the silica to alumina ratio, and limit formulas, and used these representations of glazes to set an expectation of what a glaze will look like, and to make decisions on what to alter in a glaze to achieve a different desired result.

Each of the oxides in a formula provides it's own properties to a glaze and can influence the end result we're trying to achieve. In this column I will cover a brief description of the base oxides, and what we can expect from them. I will not be covering the effects of lead on glazes. Should anyone be interested in this oxide, please refer to "The Potters Dictionary" by Frank and Janet Hamer.

Firing temperature references indicated below for earthenware refer to cone 08 – 02 firing levels, mid range references refer to cone 4 to cone 7, and high fire refer to cone 8 and above.

ALKALINE OXIDES	
Sodium (Na_2O)	Most active flux. Useful flux for earthenware, mid range, and high fire glazes. May volatize at higher temperatures. Tends to produce a soft glaze (easily scratched) which will weather and deteriorate over time. Highest coefficient of expansion which increases possibility of crazing. Intensifies the effects of colouring oxides. Brilliant alkaline colour response (turquoise blue with copper, mauve with cobalt, reddish purple with manganese).
Potassium (K_2O)	Second most active flux. Useful flux for earthenware, mid range, and high fire glazes. Provides brilliance to a glaze. Intensifies the effects of colouring oxides. Brilliant alkaline colour response (bluish purple with manganese, greens with copper, blue with cobalt).

Lithium (Li_2O)	Potentially poisonous oxide. Care should be taken in handling this raw material. Useful flux for earthenware, mid range, and high fire glazes. In low amounts adds gloss and strength to a glaze, and can reduce pinholing. Lower coefficient of expansion than sodium and potassium thereby reducing tendency to craze. In a glaze with boron, may form crystals in the glaze bucket. Intensifies the effects of colouring oxides. Alkaline blues with copper and pinks with cobalt.
ALKALINE EARTH OXIDES	
Barium (BaO)	Poisonous material which should not be used on food surfaces. Handle raw materials containing barium with caution. Useful flux for mid range and high fire glazes. Provides the most brilliance of the alkaline earth oxides. Can provide a soft satiny matt glaze surface (except in the presence of boron). In oxidation gives alkaline blues with cobalt and copper, yellow greens and apple greens with chrome, and a range of colours (blue, pink, plum, red, purple) with nickel. In reduction can give celadons and iron blues.
Calcium (CaO)	Useful flux for mid range (down to cone 01) and high fire glazes. Increases hardness and durability of a glaze. Enhances whiteness. Can provide a slight dulling to the surface of a glaze without affecting transparency. Tends towards alkaline colour responses in presence of small amount of colouring oxide, and can bleach red iron oxide causing yellowish colouration. In high fire reduction, calcium produces the grey-green colour known as celadon.
Strontium (SrO)	Useful flux for mid range (down to cone 01) and high fire glazes. Similar to calcium and zinc. Can be used to replace barium but may provide a different colour response depending on the colouring oxide.

Zinc (ZnO)	Useful flux for mid range (down to cone 01) and high fire glazes. Low coefficient of expansion – useful in reducing crazing. Increases strength and durability of a glaze. Basis of macro crystalline glazes in low alumina base and the presence of titanium (requires special firing cycle). If uncalcined* can produce crawling. Glazes high in zinc tend to crack while drying on a pot. With copper gives brilliant turquoise green, and brilliant blue with cobalt. Burns out other colourants, changes chrome to dirty brown, and iron colours tend to be dull and dingy. Zinc with tin can produce slight pinks.
Magnesium (MgO)	Useful flux for mid range and high fire glazes. Low coefficient of expansion – useful in reducing crazing. Very high surface tension – tends to produce crawling and pinholing. Can provide a smooth buttery glaze surface (especially in reduction). Gives purples when coloured with cobalt, with streaks of pink or red at very high temperatures, and lime to olive greens in presence of small amounts of nickel.
STABILIZERS & GLASS FORMERS	
Alumina (Al_2O_3)	Stabilizer. Excessive amounts can cause crawling and pinholing. Tends to prevent crystallization on glaze cooling. Adds to hardness, durability and strength of the glaze. Orange/pink when glaze is high in alumina, low in silica, and contains copper.
Boron (B_2O_3)	Glassformer and flux at low temperatures. Useful flux for earthenware, mid range, and high fire glazes. Very low coefficient of expansion. Useful to decrease crazing, but in amounts over 15% of a glaze, can increase crazing instead. Tends to inhibit crystallization of other oxides in a glaze (tendency away from matts). Intensifies the effects of colouring oxides. Excess harms underglaze reds and greens. Tends to disperse colourants through a glaze layer, and may mottle or break the colour effect. In presence of minor amounts of iron may produce milky or opalescent blues.

Silica (SiO_2)	Glassformer. Very low coefficient of expansion – tends to control crazing, but in excess will promote more crazing. Addition will increase hardness, strength, and gloss of a glaze.

* Calcining: a process of purifying a material by taking it to 700C (1292F), or bisque firing, thereby burning off molecular water and other volatile substances.

Concepts mentioned above which will be covered in a future column include Coefficient of Expansion and Surface Tension concepts, along with Crazing and crawling.