Basic Info about Glaze Formulations:

Ceramic glazes generally contain silica to **form glass**, in combination with a mixture of metal oxides such as sodium, potassium and calcium which act as a **flux** and allow the glaze to melt at a particular temperature, alumina (usually from added clay) to **stabilize** the glaze and prevent it from running off the piece, **colorants** such as iron oxide, copper carbonate or cobalt carbonate, and sometimes **opacifiers** such as tin oxide or zirconium oxide.

FLUXES:

- Barium Oxide Na_2)
- Potassium Oxide K2O
- Lithium Oxide Li_2)
- Calcium Oxide CaO
- Magnesium Osice MgO
- Zinc Oxide ZnO
- Strontium Oxide SrO

STABILIZERS

- Aluminum Oxide (Alumina) Al_2O_3
- Boric Oxide B_2O_3
- Iron oxide Fe_2O_3

GLASS FORMERS

- Silicon Dioxide (Silica) SiO_2

Wgt % VS Seger Unity (molar composition)

So, **don't freak out** here…this is just to "expose" you to the basics of glaze chemistry. We will be working with glaze recipes. If you want to work on the Unity formula of a particular glaze, we can do that.

The weight % glaze formulas describe how to mix the glaze; it provides you with little information upon which to compare 2 glazes, or predicting the stability of a glaze.

EXAMPLE (from Mastering Cone 6 Glazes, John Hesselberth & Ron Roy, 2002)

Jade Green, Cone 4 - 6				
Glaze Recipe			Unity Formula	
Potash Feldspar	40.0		Fluxes	
Barium Carbonate	20.0		K_2O	0.127
Gerstley Borate	10.0		Na_2O	0.080
Zinc Oxide	9.9		CaO	0.138
EPK	10.1		MgO	0.041
Silica	10.0		Li_2O	
	100.0		ZnO	0.336
Add Copper Carbonate	5.25		BaO	0.278
			Stabilizers	
			Al_2O_3	0.295
			B_2O_3	0.157
			Glass Formers	
			SiO_2	2.011
			Si:Al	6.5

The left side of the table shows us how to mix the glaze, but it tells us nothing of the composition. On the right hand side of the table, the level of silica (SiO_2) level of 2.001 violates the first "rule" of making stable glazes and indicates instantly this glaze is likely to be unstable. Testing shows you need a unity formula of at least 3.0 SiO_2 and above to produce a stable glaze. Indeed, the Jade Green is found to easily leach copper and barium from the glaze in an acidic environment.

WEIGHING THE GLAZE MATERIALS

Clean and Tare the scale

Have a good check list – avoid interruptions

Wear a face mask / respirator / protective lenses / gloves

MIXING GLAZES:

- Dry mix: try not to raise too much dust…please wear respirator / eye protection
- Always add powder to water (approx. 90 cc's water per 100 grams of dry glaze mix, i.e., 8000 gram recipe should take about 1.9 gallons (7.6 Qts) of water.
- Don't add dry glaze too fast (don't let it accumulate into a pile on top of the water. Let it sit. Powder should be completely wetted.
- Initial mixing can be done with a spoon, stir stick.
- Screen / sieve thru 80 mesh. Some recommend doing this twice, and again before each use.
- Dip test with a bisqued shard. Scratch thru and visually examine the thickness of application. If glaze is a translucent/runny glaze, should be <u>less</u> than 1/16 of an inch thick. Most others no more than 1/16 of an inch
- Specific Gravity: Should be about 1.45 gms/cc. An easy way to measure this is to weigh a container (1 C. will do) = W_1; measure and add 100 cc of your glaze. Reweigh = W_2. Determine Gms/CC = $W_2 - W_1$ / 100 If your Specific Density is greater than 1.45 gms/cc, add more water. If it is less, let the glaze sit overnight, settle, and carefully remove excess water from top of glaze.

TESTING GLAZES for durability, longevity, safe usage.

- Resistance to Acids – insert half test tile in vinegar for 3 days. Goal is no color change/bleaching
- Resistance to Alkalis (usually in dishwasher) - 5% soda ash (50 gms soda ash in 1 Liter of water), in stainless steel pot, bring to a boil, reduce to simmer gently. Put in pan, cover, simmer gently for 6 hours. = 250 cycles in a dishwasher . Goal is no color change
- Resistance to Thermal Shock – Freeze piece for 2 hrs, then carefully place in boiling water. Look for cracking, crazing, shivering. Use black ink to bring out cracking. Compare with non-exposed sample.
- Microwave Oven proof – place test mug in boiling water & let it simmer for 2 hrs (absorbs as much water as is possible). Take another mug, fill with water. Place both test mug and filled mug in microwave and nuke on high for 10 seconds (no more). Open carefully. If your test piece is too hot to handle, it is NOT microwave safe. It is important when conducting this test to have the mug of water present in the test as you could otherwise damage your microwave.

GLAZE TRIAL BLENDS

Using Existing Glazes

Overlap: 2 Glaze overlaps: Dip one glaze covering most of test tile. Dry. Dip second glaze over 50% of test tile.

Dry Blends: Using 30 gm quantities of base glaze, add known % of oxides

Wet Blend: Use 2 existing glazes (wet), try blends of 25:75, 50:50, 75:25

Using Base Glazes

Select a base glaze recipe: Matte, Semi-matte, Glossy

Dry Blends: Using 30 gm quantities of base glaze, add known % of oxides. With small quantities, you must be VERY accurate in weighing the oxides. Recommended amount ranges:

Cobalt Oxide or Carbonate	½ - 1%
Iron Oxide	1 – 10%
Copper Oxide or Carbonate	2 – 5%
Chrome	2 – 5%
Nickel	½ - 3%
Manganese	2 – 6%
Vanadium Stain	4 – 10%
Rutile	2 – 10%
Ilmenite	1 – 5%

Line Blends / Tri-axial Blends: See Rhodes, Clay and Glazes for the Potter, 1967, Pg 136 - 138

Pg 138 provides a color description of oxide combinations.

Pgs 127 – 134 provides information on specific oxides.

As well as About.com Pottery Ceramic Glaze Colorants

Wikipedia – Ceramic Colorants

General Resources:

Glaze Chemistry (Ceramic Arts Daily

Mid Range Glaze Recipes (Ceramic Arts Daily)

Glossary of terms (Ceramic Arts Daily)

Ceramic Colorants (Ceramic Arts Daily)

Mason Stains Color Charts

MSDS (Material Safety Data Sheets)