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Ceramic glazes

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The University of Montana

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CERAMIC GLAZES

by

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INTRODUCTION

The intent of this thesis is to posit an active approach to the problem of glazing. It is an isolation and magnification of one facet of the total pottery process. The brevity of this presentation implies that the significant bulk of the thesis work consists of non-verbal, visual and tactile experiences. It is work that leads to a realization of the plastic sense of clay and enables one to be articulate in the mute language of form.

Generally, good pots exhibit simplicity of form and directness of execution. In the process of wheel-throwing, if a piece of clay is worked too long, it is weakened from saturation with water and collapses. Similarly, in glazes, too much time between formulation of glaze theory and its execution kills the initial idea.

Glaze making has become needlessly complex to the beginning student. The emphasis inevitably falls upon theoretical analysis of raw materials rather than simple observation of their natural characteristics in firing. "Work in high-fired glazes should always be directed toward finding out what the materials will do with the least involved or least forced techniques."\(^1\)

The implicit starting point is to get at the foundation of glaze making, an understanding of the basic raw materials.

In order to do this, three essential steps are necessary:

(1) Restricting the number of materials to be used,

(2) Testing them in regular firings and (3) Combining them into simple glazes.

The rest is a matter of studying the reactions of the materials by themselves and in combinations after firing. The only rules or limits are those which are implied by their intrinsic qualities. Results are commensurate with the time spent in honest work and persistency.
RESTRICTION OF MATERIALS

To potters of earlier centuries, the difficulties in making glazes resulted from scarcity of a variety of raw materials. Presently, because of excellent communications and transportation methods, the problem is an over-abundance of ceramic materials. For the beginning pottery student today, glaze theory is a maze of technicalities requiring long hours of memorizing involved formulas and symbols. This maze cannot be avoided, but it can be simplified in order to give clarity and meaning to the essential materials.

A relatively well equipped ceramics shop will have from 25-35 kinds of chemicals for glaze use. (Pl. I) By eliminating (1) duplications (e.g. FELDSPAR, usually 6 or 8 available, only one necessary), (2) materials that are of little use at whatever temperature the kiln is usually fired\(^1\) (LEAD, which burns out at C/1), and (3) materials used for special effects (BORAX), the total number of materials can be reduced to ten.

1. Local sedimentary clay  6. Dolomite
2. Custer Feldspar        7. Magnesium Carbonate
3. Barium Carbonate      8. Silica
5. Kaolin                10. Whiting

The simple process of rejecting superfluous chemicals greatly clarifies the entire operation.

\(^1\)The temperature to which the kiln is fired is a large factor in the choice of materials. The present work is concerned with intermediate and stoneware temperatures, Cones 5-11 (2156° - 2345° F.).
Local sedimentary clay

Kingman feldspar
Custer feldspar
Oxford feldspar
#56 Glaze feldspar
Nephelene Syenite
Spodumene
Plastic Vitrox

Barium Carbonate
Bone Ash
Borax
Boric Acid
Colemanite
Kaolin
Cryolite
Dolomite
Flourspar
White Lead
Red Lead
Yellow Lead
Lead Chromate
Lithium Carbonate
Magnesium Carbonate
Niter
Potassium Chromate
Silica
Soda Ash
Sodium Bicarbonate
Strontium Carbonate
Talc
Whiting
Zinc Oxide
Zircopax
By working through a series of elementary tests using only these ten materials, the student can develop a full understanding of any type of glaze or engobe.
TESTING OF MATERIALS

Names of ceramic materials have meaning only when they can be linked to a visual image of the fired result. Like any other language, the symbol must be based on a reality — a visual reality in this case. The first step in understanding the units of glaze language is to apply each material to the clay body as if it were a complete glaze and fire it to the desired temperature. Many of the materials are glazes by themselves, perhaps not typical shiny-surfaced glazes, but they are vitrified and unchangeable surfaces for the clay body — the basic requirement of any glaze.

This is the point at which the student can begin to get a feeling for the various materials, seeing each material fired and observing its individual characteristics, rather than analysing it as a chemical formula or as a minor glaze ingredient. After the initial firing of materials by themselves, the next step is to combine them in equal proportions by weight and observe the reactions that take place in the fire.

Webster defines the word "Test" as "subjecting a thing to conditions that show its real character."¹ This is what is finally accomplished through the one and two-ingredient combinations of the basic raw materials. And after understanding something about their "real character," the student can carry on more extensive work with a certain measure of confidence.

Most countries, before their development and maturation into self-directed nations exhibit great periods of emulation in politics, clothing styles and art. The Japanese emulated the Chinese forms and glaze results in ceramics as did the Europeans and Americans. Looking through the various reference texts on glazes it is apparent that this problem remains. Many pages are printed describing methods of getting Sang-de-Boeuf, Celadon, Luster and other special glazes.

In combining materials into glazes, the emphasis does not fall on trying to match a special type of result, but rather on manipulating the materials to see how they work, pursuing their natural inclinations of being flux or refractory. By simply observing the fired results very closely and making sensible adjustments of proportion, most glaze types happen spontaneously.

An example is appropriate.

From the preliminary testing of materials in equal proportions by weight, several combinations looked good as being possible glaze combinations:

1. Kaolin-Whiting (Kao-Whit)  
2. Kaolin-Dolomite (Kao-Dol)  
3. Silica-Whiting (Sil-Whit)  
4. Silica-Dolomite (Sil-Dol)

These combinations had a melting reaction together somewhere in between the melting reactions of Kaolin-Silica and Dolomite-Whiting. There was some body to the melt.

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1 Rhodes, Stoneware and Porcelain, pp. 22, 24, 29.
It did not clear up into glass, but yet it was not a dry matt.

On the basis of the Kao-Whit and Sil-Whit results, the next test was to combine Kao-Sil with Whit in equal proportions. The result was a good transparent glaze. By understanding how Kaolin and Silica reacted together, as well as Kao-Whit and Sil-Whit, the test was not really a blind guess. But it was not infallible either.

The next test was to combine Dolomite with Kao-Sil, as Whiting had been used previously. Again, the combination proved fruitful, resulting in a white opaque glaze. By keeping the proportions of Kao-Sil the same and interchanging Whiting and Colomite, the flux qualities (that were apparent in the very first test of two ingredients) become amplified enough to be readily understood.

These two glazes, Kao-Sil-Whit and Kao-Sil-Dol, are excellent examples of pursuing the natural bent of a material, and they are easily understood because of their simplicity and generous proportions.
CONCLUSION

Problems remain essentially the same throughout the years: one can only try to relive the act of solution. It is not difficult to find perfectly adequate glazes and scientific limit formulas in the many reference publications on ceramics. They are vicarious successes, however, and cannot have the personal meaning that comes with individual work.

It doesn't make any difference which method is used in developing a glaze. A white opaque glaze achieved through molecular calculation is the same as one found through trial and error testing. The important thing is the re-enactment of the solution. It is a matter of emphasis: in this case, on the materials themselves rather than on the language used to describe and analyze them.
DEFINITIONS OF TECHNICAL TERMS

CELADON: A glaze containing a small amount of Iron Oxide that fires to a light green in reduction.

CONE: Ceramic pyrometric cones are small triangular pyramids of ceramic materials similar to glazes calculated to bend and melt at specific temperatures.

DOLOMITE: A natural mineral containing calcium and magnesium carbonates in equivalent parts.

ENGobe: A slip, or layer of colored clay applied to the surface of a piece of pottery to change its color or to add some decorative accent.

FEIDSPAR: One of the constituents of granite, made up of (a) an alkaline portion consisting of sodium, potassium or calcium, singly or in combination, (b) alumina, and (c) silica.

FLUX: A chemical that promotes fusion or melting.

REFRACTORY: A material that is resistant to fusion or melting.

KAOLIN: A primary clay formed by the weathering, on the site, of feldspar. Aluminum silicate.

"LIMIT FORMULA": A formula that indicates the minimum and maximum amount of each oxide which is likely to occur in a glaze of a given maturing temperature.

LUSTER: A form of overglaze decoration in which a thin metallic film is developed on the surface of the glaze.

SILICA: (Flint or Quartz) A mineral obtained from sandstone, quartz sands or flint pebbles.

SANG-DE-BŒUF: A glaze containing a small amount of Copper Oxide that fires to a deep red in reduction.

WHITING: Calcium carbonate. It is made by processing marble or limestone.
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