EFFECTIVENESS OF GLAZE CALCULATION IN THE FORMATION AND PRODUCTION OF CERAMIC GLAZES

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Abstract

Modern ceramics has gone beyond the era of trial by error when glazes are used based on the traditional method of putting together different raw materials without fully understanding the reactions of the components contained therein. This had led to prolonged firing for glazes that would have normally melted at a very reduced or lowered temperature if proper calculation were involved. The study takes an in-depth look at the importance of calculation in the formation of glazes for the purpose of improving glaze composition, surface appearance, save time, money and energy. When more light is thrown on simple approach towards establishing good glaze by using glaze calculation to the advantage of the potter this would go along way at overcoming the dislike for numerical and chemical calculations in glaze.

Introduction

Calculation in glaze had really improved and brought about a heave in the standard of glaze composition through the introduction of simple mental mathematics and physical tests. Otimeyin, (2008:129) defined Glaze as vitreous or glassy coatings fired on to the surface of wares" while the calculation is basically the process of using numbers to find out an amount in the formation and production of ceramic glazes.

Rhodes, (1972:158) opined that "Glaze calculation is a method of arriving at suitable composition of materials for glazes and for changing, adjusting and comparing glazes without resorting to more trials and error in the laboratory than is necessary" Also expressed in the words of Hammer, (1975: 44) "Most of the calculation which the potter is called upon to do depend on straight forward addition, subtraction, multiplication of known number" Before a set of tests and procedure is carried out to evaluate the glaze in terms of standard, there is the need to understand the materials in use. These materials which come in varying compound and molecular weights and go a long way at determine how well they interact, leads to easy melt in glaze composition.

Some people do believe and articulate that anything can melt saying it only depends on the temperature in which they are fired. If we now decide to follow this theory of any thing can melt, one would most often, spend precious time, energy and extra money on materials that would have ordinary cost less if proper calculation were carried out.

Purpose for this Study

This article enumerates the importance of calculation in glaze, explaining a fairly simple way of overcoming the dislike for numerical and chemical calculations in glaze by explaining the underlying issues involved, so that potters

and the ceramists can become more familiar with the method of addressing glaze problems.

Calculation in Glaze Formation

Calculation being the process of summing numbers to find out an amount is necessary in glaze formation so as to produce qualitative glaze at the lowest practical cost in terms of efforts, time and money. In analyzing the concept of molecular formula in the calculation of glaze and its origin Rado, (1967: 119-120) states thus:

> In the past at least up to one hundred years ago, The composition of glazes were arrived at by trial and error if not by accident. With glazes, there existed an enormous number of odd mixture apparently bearing no relation to each other.

He went further to give credit to Hermann Seger, who has brought order into the chaos of glaze composition by stating thus:

> It was the great merit of Hermann Seger to have brought order into the chaos of glaze composition. He was perhaps the first after the valiant attempts of Josiah Wedgwood a hundred years earlier and perhaps Bernard Palissy two hundred years before Wedgwood, to succeed in bringing science into the pottery industry.

Hermann Seger conceived the ideal of representing glazes as chemical formulae by observing successful glaze formulae before his time and was able to note that they follow certain well defined laws and rules which must have been unknown to their originator. Glaze materials are got from earth made up approximately hundreds of chemical elements of different molecular weights. These molecular weights are recorded and calculated in numbers using necessary calculations.

The good understanding of the materials used in ceramic production makes for an enhanced and effectual proficiency. When the right amount of material is known to react well at a particular ratio and at a particular temperature, it will make for easy and smooth operation. Since an understanding of the nature of clay is critical for most forming and firing techniques of wares, if the ceramist does not understand what is going on through the total process, then the greatest glaze in the world will not insure the effort. It was therefore of a necessity to understand the effects of these varied chemicals by knowing and the separation of the component oxides which already are grouped into the three major columns according to their molecular nature and the way they function. The three major grouping of the oxides are the basic, acid and amphoteric.

Glenn, (1971: 220) explained that “There are three principal component in a glaze. Silica gives the glaze its glassy transparent quality.” The silica could also be regarded as the major glass former with the symbol RO_2. Primmer,

(1974:172) further reveals that "The symbol 'R' represents an action of the element to form oxides" The presence of Alumina which is regarded as the amphoteric oxide with the symbol R_2 O_3 contributes toughness and abrasion resistance to the glaze in order words, it help the glaze to adhere to the clay body while the third in the column represented with the symbol RO refer to the fluxing agents which are mainly alkaline elements that form their oxides by combining with one atom of oxygen such as CaO or PbO .They are also known as base oxides which help neutralize the acid and reduce the melting temperature of glaze. So therefore, the need to understand this grouping cannot be overemphasized, if truly good glazes are desired.

Saibu, (2005:114) explained that chemical equations are used in glaze calculations and as such are convenient symbols to express the nature of the reagents and products of a chemical change. Stating further (ibid) "the use of chemical equation is based on the fact that all chemical calculations use formulae and equation in conjunction with atomic weights." The proper application of these simple calculations had gone a long way at enhancing, the surface quality of glazed wares.

Glaze Calculation in Relation to Low Firing

Calculation in glazes has brought about varieties of glazes that fire as low as possible. Many ceramists do assume that high temperature gloss firing is necessary for a glaze to be strong and durable but do not know that the understanding of the nature of materials involved in the composition coupled with fired strength is a product of the glaze maturity.

Maturity means that significant glass development has occurred and that the glaze is dense. Low strength at high temperature can occur in a glaze if it lacks sufficient filler. Understanding of these phenomenon resulted from the different calculations in glaze formulation. There are such simple calculations which can first be known such as the conversion of temperature from Fahrenheit to Centigrade then the finding of molecular weight, the conversion of glaze percentage recipe to batch recipe to a more advanced type of glaze calculation as finding unity formula of a glaze from a recipe or converting a unity formula into recipe.

Calculation in Glaze Adjustment

Adjusting a glaze formula is made possible by a good knowledge of the materials involved in its composition and the ability to incorporate the new materials through glaze calculation. For instance, preventing crazing is a matter of minimizing high expansion oxides i.e. sodium and potassium in favour of their low expansion counterparts and using as much silica and alumina. This could only be made possible by simple glaze calculation with the good knowledge of the molecular weight of the different components.

Armed with the formula viewpoint made possible by glaze calculation, one can frequently achieved unique effects imparted only by raw materials on the

ware surface. Take for instance a glaze which specifies on opacifier that is different to obtain in an area, it means that an alternative opacifier must be sort with necessary calculation carried out so as to enable it fit the composition.

How about a middle or high temperature glaze that uses magnesium carbonate, it is necessary to do the calculation that will substitute it for talc or donomite as a source to get magnesium. This alternate material need test fired to see if the more expensive magnesium carbonate is justified. If not, it could be considered. The same goes for frits, expensive stains and oxides .If the material is expensive, that usually a signal that the supplier does not stock large amounts or that it is shipped or imported from some distance away. Therefore glaze calculations also make possible the following;

a) Easy comparison of Glaze
b) Quick Alteration of Glaze
c) Glaze Substitution
d) Trying out of New Material

Easy Comparison of Glaze

Since the proportion of oxides present in any glaze composition determines the exact behavour of the glaze as the melting and surface quality, it will ordinarily be very difficult to determine while a particular glaze behave the way it does except there is a basic for comparing the oxides one can only make guesses but when calculating in formula, one can see at a glance the relative amounts of oxides present in the glaze and make intelligent comparism.

Quick Alteration of Glaze

In replacing such expensive materials for less expensive and readily available ones, proper analysis of both materials need be carried out through considering the molecular weight in glaze calculation.

If alternation is between glaze colour, it is logical to use the same proven glaze and stain to achieve the desired colour unfortunately, it is not just a matter of putting stain in any clear glaze and getting the desired colour because while some colour systems like cobalt blue and chrome green are quite stable for diverse glaze types, others are sensitive to the chemistry of the glaze, this therefore require some amount of calculation to resolve, it is the reason why a glaze calculation is needed to develop a good transparent glaze recipe base, which makes allowance for as many of these to be possible. In order to also improve on the appearance of glaze or glaze body fitness, glaze calculation is one best way to make for easy modification especially when altering large quantity of glaze. Calculation will easily bring out the necessary quantity of material needed to transform the glaze into the desired characteristic.

Glaze Substitution

Glaze Calculation is useful in making replacement of materials in glazes should one material be too expensive or unavailable. Substituting by trial and

error would lead to a waste of time, material and energy. The understanding of the replacement and a few minutes of calculation saves one a lot of troubles and worries.

Trying out of New Material

When experimenting or trying out new materials especially with known chemical compositions, glaze calculation will make the introduction of such material easy by providing us with the exact amount needed to achieve the same goal.

Recommendation

New computer programs as Insight and Hyper-Glaze that make glaze calculation more interesting should be taught and made available to help out ceramist with glaze calculation

More light should be thrown on approach toward establishing good glaze by using glaze calculation to the advantage of the potter.

Conclusion

Getting a good base glaze with the right specific gravity and viscosity, the right clay content, flux and thioxotropy requires some testing and proper ceramic calculations to accomplish.

Some of such glaze calculations which have come to improve the quality of Glazes in ceramic productions includes

i. Finding of molecular weight
ii. Conversion of percentage glaze recipe to batch recipe.
iii. Finding the unity formula of a glaze.
iv. Conversion of glaze unity formula into a recipe.
v. Brongniart's formula calculation which involves the weight of the glaze and specific gravity of the solid it contains, the weight of dry materials it contain in the measure before it can be calculated.
vi. Calculating empirical glaze formula etc.

When there is a systematic application of these formulae and calculations, it goes a long way at transforming the quality of not only the glaze but of the materials to be used and the wares to be sold.

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