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Earthenware Clay as A Base Material For Ash Glaze

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Abstract

This research explores local clay located at Kota Kinabalu, Sabah using line blend formula for producing glaze. This study aims to document the basic introduction of earthenware clay that is in Sabah as a basic material in producing glaze. The method used is a qualitative method and carried out a test process at the ceramic studio, Universiti Malaysia Sabah. The formula used is the line blend formula. The line blend formula is an approach that applies a combination of one or two natural ingredients to obtain glossy, satin, and matt effects. A total of six research samples that have been carried out in the ceramic studio by applying the technique of combining earthenware clay (EC) and wood ash (WA) in different ratios using firing temperatures ranged from bisque firing (800℃, cone 014) to glaze firing (1260℃, cone 6). The results of the study found that the six samples showed different effects in terms of the surface and color of the glaze. This study is an indicator that is easy to use to produce glaze. The research findings show that the production of glaze using clay as the basis is the understanding and technical use of earthenware clay as the main material, the preparation of clay and adjustments for glaze using clay found in Sabah is effective in the creation of ceramics. This study hopes to inform and serve as guides to students how to produce a good and consistent ash glaze formula for ceramic creation.

Keywords: Earthenware, Ash, Glaze, Clay, Line Blend Formula

Introduction

Clay is the oldest known ceramic material. Prehistoric humans discovered the useful properties of clay and used it for making pottery. Clay, a naturally occurring material, composed mainly of fine-grained minerals, become plastic in presence of water, and become hard when dried or fired. Many categories have been studied about clay since ancient times. According to Muhamad (2010) and Saraswati (2011), the use of clay began to be known since humans began to be good at farming activities where the use of clay is the main medium in the production of ceramic products. This is because, residents used to need equipment to use their daily needs such as cooking and storing food ingredients. This clay was formed without any special tools, then humans began to present some types of tools that can be used in

ceramics. The experience and knowledge of this community then gave them a **Error! Hyperlink reference not valid.**wide development in the aspect of daily use until now (Muhamad, 2010:5,6).

Clay is created by natural forces and is contained in nature and can be described as a plastic material that undergoes erosion and decomposition on the surface of the earth continuously. In igneous rocks, silica, and alumina, the two main elements are important elements of clay (Ayob, 2021). Yaacob and Jusop (1982) also stated that each type of soil has its own mineral content. However, each clay has a variety of different contents in various types of clay, including earthenware clay, kaolin, stoneware, ball clay, fire clay, and porcelain.

According to Ayob, (2021), primary and secondary are two types of clay group based on geological formation. The nature of primary clay is pure in colour and structure because less of interaction with other foreign bodies which are found in their place of origin. While secondary or sedimentary clay is highly plasticity since mixing with an organic and inorganic matter before it reaches bay transported by rain. Furthermore, under pressure and distance make secondary clay have variety in colour (Hommel, 2013). Sedimentary clay would come out with tan, brown, cream, or ruddy color before and after being fired.

Uses of natural product have become an important aspect in the ceramic industry and to optimize reduce the consumption of natural resources. In this study, the researcher took pottery type soil in a nearby location in Kota Kinabalu. Among the locations of clay taken is at the latitude scale of 6.0487 and longitude 116.1509 (refer Figure 1). The clay taken from the location that has been specified, the researcher will look at the plasticity rate to see if the clay can be shaped or not. A simple test to see the flexibility and toughness of the soil is to make a roll of wet clay on the finger. Make sure the clay is consistent and not too dry or too soft and wet. If the coils are excessively cracked, the clay may not be very plastic and not suitable for forming.

If seen from the definition of plastic, the characteristics of clay mixed with sufficient water content will give the soil structure that can be formed and can be maintained after drying. According to Worrall (1986), clay that is easy to form is categorized as sticky where this type of clay is found in rocks. Research on plasticity began with Coulomb's study in the 18th century (Smith, 2010) on the stability of clay. Diversity in the processing of clay-based materials is a basic material because it defines the technical parameters to change the ceramic mass to a specific shape by applying pressure (Moore, Bowness, & Read, 1965). According to Peterson (2008) plasticity refers to how flexible the clay or clay body is. The plasticity of any given clay is greatly affected by the clay's particle size, water content, and aging. It is also known as "*the quality or state of being plastic especially the capacity to be forming or changed*". It is very important in ceramics because it works in relation to the clay's ability to form without any tendency to crack.

(i) (ii)

Figure 1: Location of clay have been taken near in Kota Kinabalu

Clay may be defined as an earthy mineral substance, composed largely of a hydrous silicate of alumina, which becomes plastic when wet and hard and rock-like when fired. In the researcher's observation, the soil taken is secondary soil which is earthenware clay. This earthenware clays are easily molded into a form, retain when dry, and they become hard and lose their plasticity when subjected to be heat in bisque firing (800 ^{O}C, cone 015). Earthenware clays are plentiful in nature and often have good plasticity. The presence of various forms of iron oxide and other impurities can make raw clay grey, green, ochre, red, or brown-colour, and fire to a buff to orange colour.

Glaze Material

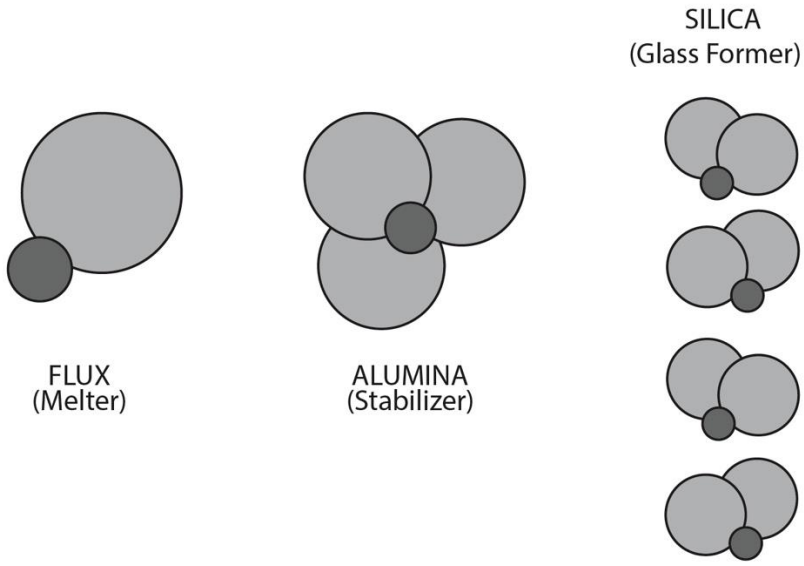


Figure 2 : The composition of glaze formation

Refer to Figure 2, the main ingredients used in glaze is silica, which is present in the form of ground flint or quartz. The most common glass former is silicon dioxide or silica. The melting point of silica is too high to melt in a kiln, so fluxes are added to reduce the melting temperature. For this reason, flux is added to the glaze mixture to lower the melting temperature of mineral compounds like silicon dioxide in pottery glazes. It is important to note that fluxes act as impurities lowering the melting point of silica. Some examples of fluxes used in glaze are bone ash, and oxides of potassium, sodium, calcium, and zinc (Bloomfield,

2018). These flux helps to strengthen the glaze and makes it more stable. Silica and flux sources are necessary components in producing glaze. If used together, the result will be too runny jelly. To increase the viscosity of the liquid powder so that it does not go directly to the surface of the clay during firing, alumina oxide which is natural aluminium needs to be added to the formula as a stabilizer. Aluminium oxide is used as a stiffening or stabilizing agent which prevents the molten glaze from running off the pottery surface. The stiffener helps the glaze stay in place while the pottery is in a vertical position.

Silica is an important material in the formation of glass which is also known as gemstone. Most glaze have a high silica content and have unique properties and are not easy to impregnate when cooled after the melting process. Instead, it remains in a state of randomly arranged molecules called glass. Chemically, silica is silicon dioxide, SiO2 and is one of the most abundant materials in the world. In its most natural crystalline state, it is known as quartz and the melting point of silica is so high that it is about 3100^{o} Fahrenheit (1700^{o}C) and this single substance is enough to form a glaze layer. Earthenware clay, however, the melting point of the clay is about 2000^{o} Fahrenheit (1093^{o}C). While clay stoneware and porcelain melting maturity between 2250^{o} Fahrenheit and 2400^{o} Fahrenheit (1238^{o}C-1315^{o}C). Therefore, pure silica cannot be used alone on the clay surface (Nelson, 2002).

A compound that lowers the melting point of another compound is called a flux. Flux is an oxide material, which is used in glazes and ceramic bodies to lower the high melting point in glass, usually silica and alumina (Daly and Greg, 1995). Flux functions by lowering the rate of partial or complete dilution. Many chemicals will readily combine as a flux with silica to form a glassy matrix that melts much lower than pure silica.

Refractory materials help form gels that are stronger and will hold up better than normal use as well as stabilize the melt of gels. Glaze is produced only with a mixture of silica and flux; this combination will generally be quite soft and quite watery. Alumina works to stabilize it by making it harder when fired and more viscous. At once this alumina serves to prevent the liquid from melting excessively. The main source of alumina is the chemical composition of clay sources. Clay contains silica, alumina, and water molecular bonds. The presence of feldspar consisting of silica, flux, and alumina as well as some dyes can cause a refractory effect in glaze.

Clay As Glaze

The three most used as a clay body is earthenware clay bodies, mid-fire stoneware clay bodies, and high-fire stoneware clay bodies. Clay is arguably one of the easiest rock derivatives to process and use for a glaze. According to Linda (2018), clay contains aluminium oxide (alumina) and silica. China clay, ball clay or bentonite can be used as glaze materials. Clay also helps to suspend the heavier ingredients in water in the glaze bucket, preventing them from settling. Alumina is found in clay, together with silica (a clay molecule is made of one alumina to two silica and two water molecules).

Each of these different clays are composed of different types and amounts of minerals that determine the characteristics of resulting a ceramic. When heated to high temperatures, clay also partially melts, resulting in the tight, hard rock-like substance known as ceramic material. It will often melt on its own but, when it does not melt a high flux ash can be added (Forest, 2013).

Balancing the Two Basic Ingredients of Glaze

Clay and ash combinations are probably the most common starting point for experiment. There are several ways to calculate the glaze formula such as a comparison of glaze composition ratios. In this study, the researcher used the *line blend formula* approach to produce glaze using earthenware clay and as the basic ingredient in the glaze. The line blend mixture table 1 is used as a glaze formula calculation with the main composition as follows.

Table 1

Weight percentages of Earthenware Clay (EC) and Wood Ash (WA) using Line Blend Formula Calculation

Sampel (%)	1	2	3	4	5	6
EC	-	20	40	60	80	100
WA	100	80	60	40	20	-

The line blend formula was introduced by Cerv, (2016) as one of the material synthesis methods that is easy to apply in glaze production. This formula suggests a method of mixing one, two, three or four variations to get and compare the effect variety on ceramic surfaces. New surface effects these variety of ceramics is determined by the content and material variations applied by the researcher.

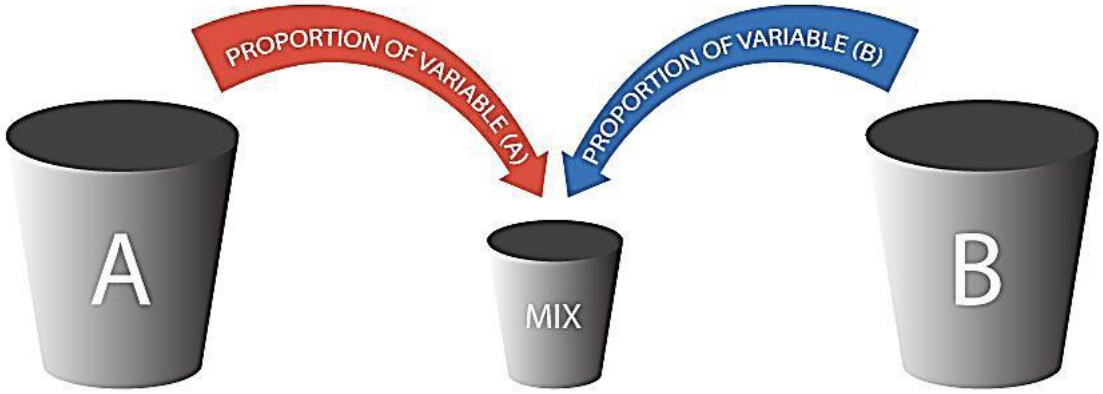


Figure 3 : Line Blend Formulation
Source: Michael Cerv (2016). http://mikepottery.blogspot.my/. (Accessed on June 2, 2017)

Figure 3 shows the mixture of ingredients A (portion of variable A) and B (portion of variable B). Material A is earthenware clay (EC) and material B is wood ash (WA). The two substances are mixed or synthesized for get glaze by using a certain ratio that has been set. Using this line blend formula is easy understood and can be applied easily to get glaze compared to using other formulas that require a mixture of six or seven specific types of material. The material used in this study is a type of earthenware clay (EC) and wood ash (WA). The selection of this material is based on the mineral content found in the material, without using a mixture of other chemicals. Based on the line blend formula, this study is carried out using two types of material, namely clay and wood ash. In this study, the researcher has carried out work in a ceramic studio based on several series. The first series is to prepare clay and wood ash, the second series is the process of mixing materials, namely clay and wood ash. Next, the third

series is forming a sample, fourth drying the sample and the fifth is the burning process according to the temperature which is scheduled. This study involved six samples using one materials synthesis techniques. The synthesis of the material consists of a mixture of clay and wood ash applied to the surface of earthenware clay samples. Results the analysis is as in Table 1 (1 to 6), while the variation of the study findings on the change and reaction of the sample by using a temperature of 1260 Celsius through electric kiln.

Preparation of Local Clay and Natural Materials


(i)


(ii)


(iii)


(iv)


(v)


(vi)


(vii)


(viii)


(ix)


(x)


(xi)

Figure 4 : (i), (ii), (iii), (iv), (v), (vi), (vii), (viii), (ix), (x) and (xi) Clay preparation process and clay samples

About 80 percent (%) of the earth's surface contains clay. There is a good chance that there is local pottery clay close to the dwelling. Some of the best places to find clay include

riverbanks, ditches or at construction sites. The researcher surveyed the raw materials around the selected location (refer Figure 1). Second, dry the raw material in the yard. In addition, the raw material should be dried in a sunny area because the heat of the sun makes it easy to handle. Lastly, burning WA material into ash. Figure 4 shown the preparation of this clay powder is intended for the combination of materials which are earthenware clay (EC) powder and wood ash (WA) that will be used to produce glaze. Figure 4 (vii) is the drying process of clay on the plaster bag. This plaster bag serves to absorb excess water. The researcher dried the clay from the plater bag to be left under the sunlight to completely remove the excess water content in the soil. The clay needs to be dry so that it is easy to grind. Figure (ix) the process of grinding the soil is done using a blended or better known as a grinding machine. The clay will be ground into a fine powder. Figure (x) where the process of pouring ground powder by using a sieve that will filter foreign matter or ground that has not been completely ground. Figure (xi) shows ground powder that has been finely ground and placed in a closed container.


(i)


(ii)


(iii)


(iv)

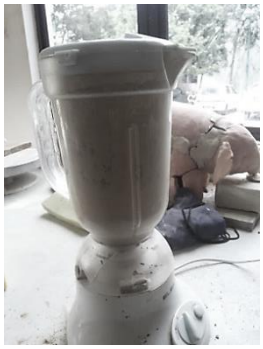

(v)


(vi)


(vii)


(viii)


(ix)




(x) (xi)

Figure 5: (i), (ii), (iii), (iv), (v), (vi), (vii), (viii), (ix), (x) and (xi) Ash preparation process

Figure 5, there are several techniques for burning raw materials, such as outdoor burning, burning in a steel box, burning in a brick kiln, and burning in a ceramic kiln. Raw materials must be burned in an oxidizing atmosphere. In this study, the researcher used an electric kiln to burn to ash at a temperature of 800°C because the electric kiln has a temperature display. If there is no ceramic kiln, it can be fired using other techniques. The researcher washes the ashes. Ash washing was carried out using the process shown in the approach of Rogers (1991). A large container is half filled with ash, then filled with water and mixed until well mixed. The ashes are then allowed to settle, and the debris and excess water are carefully poured off. This procedure is repeated several times, before being sieved through a 40-mesh sieve (Metcalfe, 2008).

Findings

This chapter discusses the results of a study on the reaction of two types of ash mixtures using the line blend formula. There are 6 samples consisting of one type of clay body which is earthenware clay using one technique which is dipping technique. 6 samples will be taken to be used as research analysis. Descriptive research is a research method that is used to find the most extensive knowledge of the research object at a certain time. It also aims to explain or describe a situation, event, object, or everything that is related and can be explained with the use of numbers or in the form of words. The researcher will analyse the sample using a descriptive approach in the form of written data from the aspects of special effects, colour and texture found on the surface of the sample (refer Table 2).

Table 2
Sample of EC and WA using Line Blend Formula Calculation

Sample	1	2	3	4	5	6
Front						
Back						
Ratio	EC:- WA:100	EC:20 WA:80	EC:40 WA:60	EC:60 WA:40	EC:80 WA:20	EC:100 WA:-

Table 2 shown the materials used in this study produce a matte effect and satin over different surfaces. The samples show that the colour turn to red-brown and green on the surfaces. Samples 1,2 and 3 give a glossy and satin effect but for samples 4,5 and 6 give a matte effect. Using this line blend formula is easy to be applied to produce glaze. Materials used by researchers have natural mineral content without combined ingredients other chemicals. These materials are successfully burned at combustion temperatures 1260 Celsius by using an electric kiln. A simple combination of ingredients can be used to reduce the rate of wastage of mineral content from nature. Next, the diversity of natural materials in Sabah potentially used to produce glaze. Therefore, the application of soil powder clay and various natural materials as the production of glaze on the surface ceramics need to be explored as a guide for ceramic creation.

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