IMPORTANT INFORMATION FOR TEACHING INDUSTRIAL CERAMICS IN TERTIARY INSTITUTIONS IN NIGERIA

Soyinka, G. K.;. Ahuwan, M. A and Sullayman, A.
Dept. of Industrial Design,
Yaba College of Technology, Yaba Lagos

Abstract

The teaching of ceramics in Nigerian schools has been only from the tertiary institutions. This makes thorough impartation of pottery and ceramic knowledge somewhat condensed by teachers, therefore subjecting such exercise to be a rushed short - cut of knowledge impartation without making room for adequate experiences, ideas and diverse knowledge(implied and applied) by teachers. Production in ceramics includes preparations and use of various clays and glazes which are taught to students because it is considered necessary prerequisite to the student ceramist further training. Therefore the student is made to understand the import of levigation of clays to remove impurities, calcinations of rocks and other ceramic raw materials in preparing and condition them for use in production of various wares. This process of taking the student through different rudimentary preparation stages of various pottery and ceramic materials is considered vital to the student potter's training. Should it therefore not be considered a grave omission, should the teaching of ceramics continue without equipping the student with the ample knowledge of how an important ceramic material such as gypsum plaster is produced for use in ceramics? A focus on the aspect of using raw gypsum for processing plaster of Paris and its use in ceramic production is the focus of this study.

Introduction

There are various types of moulds; the plaster of Paris mould appears to be the type common with most ceramic mass production. Ceramic moulds are made from plaster of Paris processed and produced from gypsum. It was developed in Montmartre France around 1770, which gave rise to its name plaster of Paris. The discovery revolutionised mass production by slip casting, gypsum is a rock or natural mineral that is mined from the earth, usually referred to as hydrous calcium sulphate or ($CaSO_4.2H_2O$). When gypsum is exposed to heat treatment, 75% of water loss is recorded to change to hemihydrates ($CaSO_4.½H_2O$). In other word; gypsum + heat = plaster (and ¾ water which evaporates). The making of plaster is done by grinding gypsum, and then heating it until the chemically-bonded water partially evaporates from 100 degree centigrade to about 180ºC.

It is evident from past studies that gypsum is available in Nigeria. Researchers and writers alike have tried to establish this fact from their findings. Examples of such reports can be found with the Ministry of Solid minerals Development 2000, and Mohammed-Sani, 2002. According to Akpakip, (1993), moulds may come in various forms but the medium which can best be adapted for ceramic production is gypsum plaster. This is so because moulds made from plaster have the ability or tendency to absorb large quantity of water from casting slip, thus making it a cheap and reliable medium for ceramic production that cannot for now be substituted with other media.

Generally, moulds may be produced using other media such as metal, cement, wood, earthenware, silicone gel, polyvinyl etc. (Sullayman, 2006, Akomolafe, 1991). Moulds of different types are often used to execute both small and large projects. These could work well for non-clay processes and allied disciplines but not with ceramic mass production due to the peculiarity of its production. This may be due to the fact that most ceramic productions use clay in wet state (plastic or slurry) or such materials (ceramic bodies) that form or dry on plaster moulds. An exception is when

other mechanical processes like dust / granular pressing, isostatic pressing, tape casting, and rain pressing, etc are involved.

However, the fact remains that whether mould is made in a single one piece, two-piece, three-piece or multiple-piece form, its production helps in replicating art, craft or other industrial products exactly, either in the relief or three – dimensional ceramics. In other words, to attain accuracy, uniformity in weight, size and spotless finishing, mould making and its usage are desirable. Akpakip, (1996) worked on using gypsum in the area of plaster of Paris production.

Schools that Offer Ceramics / Pottery in Nigeria

Ceramic art or design is taught in most institutions offering Fine and Industrial Art or Industrial Design in tertiary institutions available in Nigeria. These schools in no specific order or mention, include among many others, Ahmadu Bello University, Zaria; University of Benin, Benin; University of Nigeria, Nsukka; Federal University of Technology, Akure; University of Lagos, Akoka, Lagos; University of Uyo, Uyo, Akwa Ibom State, Abubakar Tafewa Balewa University. Other schools are various Polytechnics and Colleges of Education in Nigeria that time and space will not permit mention of all.

Brief background on Gypsum and Anhydrite

Several studies have been carried out on both the physical and chemical environment that favours natural formation of gypsum and anhydrite, the replacement of one mineral rock by another. Anhydrite is a mineral very like gypsum but without the water of crystallisation, and with chemical formula $CaCO_4$, it is found most frequently in evaporate deposits with gypsum. The name anhydrite was given by A. G. Werner in 1904 because of the absence of water of crystallization in contrast to the presence of water in gypsum. (en.wikipedia.org/wiki/Anhydrite) Based on these studies, many theories or concepts have been put forward in an attempt to try and explain the various thick deposits of gypsum found around the world. According to available literature, the formations of earthy or non-metallic minerals take a period of thousands and hundreds of years. However, it is assumed by some writers that the word gypsum is from the Greek word “gypso” meaning “chalk or plaster” Gypsum (or calcium sulphate) generally occur as sedimentary deposits and this is common in much of the geological records evident from literature. Gypsum is rampant among carbonate rocks especially dolomite and do occur in saline lakes. In fact, gypsum is commonly formed in the marine environment of sea-water as opined by Deer et al (1985), Palache, (1951), Wright et al (1985) and also around oxide portion of ore deposits. However, two of the three authors state that gypsum could be formed in volcanic environments associated with metamorphic rocks.

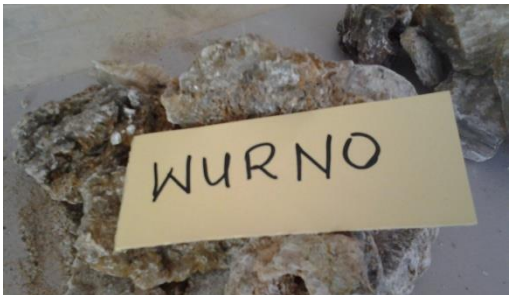

Fig.1 Sample of Gypsum from Dange, Sokoto Sokoto State of Nigeria.

Fig. 2 Raw Gypsum from Wurno,

Fig. 3 Raw Gypsum from Weppa, Agenebode-Edo State of Nigeria.

Basic Knowledge on Gypsum Plaster Production and Usage

Gypsum in its natural form also finds applications in the manufacture of hydraulic cements, ammonium sulphate fertilizer, sulphuric acid and soil reclamation for agricultural purposes. When crushed and calcined into powder form it is plaster of Paris and if enriched with additives like accelerators, retarders, fillers and binders, the use of gypsum are varied and extensive. The calcined gypsum or plaster of Paris is used in building / engineering / architecture, pottery, ceramics and orthopaedic medicine according to plaster grades. (British Geological Survey (BGS), 2006).

Locations of Gypsum in Nigeria

However in Nigeria, according to available publications, Ministry of Solid Minerals Development, (2000) and Mohammed-Sanni, (2002) gypsiferous shales are reported from the upper Cretaceous Dukamaje Formation and the Paleocene Dange Formation is available in the Sokoto area. The 1.46-million tonne gypsum deposit at Wurno also in Sokoto State is currently being mined by small-scale miners to supply the Sokoto cement plant. Other gypsum prospects are reported from Nafada/Bajoga in Gombe State, at Fika in Yobe State, Weppa area of Agenebode in Edo State, and at Guyuk/Gwalura in Adamawa State (Ministry of Solid Minerals Development 2000). Gypsum is a natural mineral which has the formula $CaSO_4.2H_2O$. Gypsum is a soft, transparent or translucent mineral composed of crystallized calcium sulphate ($CaSO_4$), found naturally primarily in sedimentary deposits. According to literature there is gypsum in Nigerian soil, Mohammed-Sani, (2002) claims there is in an occurrence of gypsum in Mutwe area of Yobe State, Nigeria. In yet another development, it is also stated by Aribisala and Adegbesan; in (Ministry of Solid Minerals Development 2000). The reserve estimate of the Sokoto phosphate deposit is about 5 million tonnes. The Raw Materials Research and Development Council

(RMRDC) has therefore set up pilot plants for the mining and processing of phosphate rock in Sokoto State (Ministry of Solid Minerals Development 2000). Mining is currently ongoing according to this source.

Uses of Gypsum Plaster

Gypsum is used for the manufacturing of various items e.g. wall boards, paper, paints, plasters, cement etc. According to Gypsum Recycling International (2007), in total 80 million tons of plasterboard, wallboard and dry wall is produced every year.

Many researchers and writers, USG, (2014), Naturesway Resources, (2014), British Geological Survey (BSG, (2006) including Mohammed-Sanni, (ibid) and Akpakip, (ibid) agreed that plaster usage could be multi – purpose for the production of plaster of Paris which can be used for diverse purposes, ranging from orthopaedic, dental, wall/roof spraying, plastering or decorations, and production of ceramic moulds for mass production purposes as presented by Environics, (2002) and Akpakip, (1993), supports the use of plaster of Paris in ceramic mould making for mass production, while Okojie, (1978) favours the use of plaster moulds for slip casting; Sullayman, (1991) used plaster moulds for jiggering and jolleying techniques and Lee et al, (2012), used plaster moulds for a modified slip casting methods as in the case of denture casting (Giordano and Mclaren, 2010). Therefore all agree on the use of plaster of Paris for ceramic mould making.

Ceramic production, it is described by various writers and researchers over the years, that it is tedious, strenuous and slow, Akinbogun, (1997), Kashim, (2002), Soyinka, (2015) and so on. Mass production of ceramic products otherwise understood as industrial ceramic production method, offers the ceramist the easier way of production. This is where the design, production and use of gypsum moulds are utilised effectively and the use of gypsum plaster powder is prevalent. For the student of ceramics to be well grounded in their chosen area of specialization, the knowledge imparted must be seen to be rich in all areas, namely materials, techniques, tools and equipments, production methods to mention but a few.

Knowledge and experience is needed for enriching all research work, teaching, professional practice, even for acquisition of knowledge in itself. For the sake that the graduate ceramist is the product and most time an extension of the tutor or teacher, it is best that they are sufficiently equipped with professional practical knowledge for all the above mentioned reasons. On this note, below are selected areas considered for the purpose of enriching students with basic knowledge on the use of plaster.

- Safety issues in working with Plaster of Paris in the Ceramic Studio.
- For the student of ceramics, physical identification and basic knowledge of raw gypsum may be important.
- The chemical representation of both the native or natural gypsum and what happens to gypsum before and after calcinations.
- Various plaster ratio mixes available from literature and the one suitable for use in ceramic practice.
- Important processes such as that of weighing plaster and water in correct ratio, mixing correctly and pouring in the right way for optimal mould making in ceramics.
- General procedures necessary to good plaster mix.

Many students of ceramic in Nigeria may not be able to identify natural rocks relevant to his/her field of study which powder he/she regularly uses. It is therefore necessary that in every ceramic section or everywhere this subject is taught, effort should be made such that a collective display of some of these rocks is available to the student both to examine and be familiar with.

Plaster is produced when raw gypsum is ground or crushed to powder is placed in a heated enclosure like kiln or oven for a period ranging from three to six hours. During this time, plaster is monitored and stirred to avoid local overheating. When calcinations is done the powder is poured on to a dry open space to cool, after which, it is wise to pour produced plaster into dry airtight container for sieving before future usage. The chemical representation of natural gypsum is $CaSO_4 \cdot 2H_2O$. This indicates the presence of calcium sulphate with two molecules of water. With calcination process, a change is recorded according to Soyinka, (2015), $CaSO_4.½H_2O$, it indicates a loss of 75% of the two molecules of water of crystallization remaining about 25% or ¼ of the two molecules. This change is temporal as plaster returns to its rock like nature with an introduction of water to calcined gypsum plaster. The unique ability of plaster mould to absorb water or liquid makes it a very important material to ceramic mass production.

It is important to know that with the production of plaster, there is need to protect it from moisture and water, otherwise plaster is quick to absorb back earlier driven out water and return back to the rock like nature it was when it was in the native or natural state. For this reason, plaster must be placed in a plastic airtight container.

There are various ratio mixes suggested which are considered suitable for ceramic mould making, however Akpakip (1993) and Soyinka, (2015) posit the use of 70/100 and 75/100. Plaster is usually stable at 100 while water could be varied. It is important that plaster is first weighed out before water to forestall premature setting of plaster. However, it is equally important that the student should note that it is correct to gently pour plaster into water and not otherwise.

A moment of slaking or “slaking time” should be allowed, usually a period of between two to about five minutes. This period of slaking allows plaster in water to dissolve sufficiently before mixing, with little or no lumps, making stirring easier and quicker, otherwise, stirring could become tedious and with multiple lumps. Stirring should be done first slowly and gently in a clock wise or anti clock pattern. “Marking” method is used to determine plaster readiness of pouring. This is reliable for some, the finger is used in marking the surface of plaster and if the surface remains marked even remotely, the mix is ready for pouring on to intended surface. Other method for determining plaster readiness is through time check. It is usually agreed that plaster should be ready between eight to twenty five minutes.

An example of three - piece mould

Plaster should also be poured slowly, smoothly and evenly, not in a hurried manner. Once the plaster surface hardens, the finishing work on the mould should begin. All containers should be promptly washed when plaster has been poured to avoid plaster sticking to the container making it impossible to wash off.

Tools for plaster work

Benefits of Teaching Industrial Ceramics in Schools

Teaching of industrial ceramics is the course the exposes both students and teachers to the practicality of mould making and use. It also draws their interests towards material study and examination. The long term benefit being that apart from throwing and hand building techniques, the industrial ceramist is trained respect set targets and work persistently to meet it. Among many other benefits is that producing bigger moulds may not be such big challenge, because in this case mould making is already part of the ceramist and therefore establishing confidence at work.

In conclusion, above discussed issues in industrial ceramic design and practice is aimed at closing the gap of detailed and constructive teaching in schools offering this course, thereby enriching students' knowledge/ curriculum in tertiary institutions in Nigeria. Working with plaster of Paris demands that these ethics of practice and proper plaster use is taught to students willing to excel in the study and therefore develop in the practice of ceramic design and art for the masses. There may be need to focus on other areas of study in ceramics so that study of the course in

tertiary institutions in Nigeria could be the better for it. It is crucial in ceramics as in all profession that students go through a period of tutoring and mentoring such that should prepare them for proper foundational advantage in their chosen field of practice. Absence of expected knowledge may result in none preparedness of graduate potters who may not acquire expected professional confidence in the field, could become much eager to do anything for survival after graduation rather than practice ceramics design as a choice profession.

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