OIL KILNS IN THE PRODUCTION OF CERAMICS BY NIGERIAN CERAMISTS

ETUOKWU, A. O.
Department of Fine and Applied Arts,
Niger Delta University,
Wilberforce Island, Bayelsa State
Email - etuokwucharles@gmail.com

Abstract
Oil fired kilns has become very popular nowadays as a result of the readily available oil to power it. This enables the potter to fire his kiln whenever he wants to; as against the electric kiln whose firing is determined by the epileptic power supply presently experienced in Nigeria today. The benefits of firing a finished clay work to the desired temperature in the kiln is immeasurable, as the real beauty and value of any clay work can only be appreciated when it is successfully fired in the kiln. This implies that the kiln and the art of firing it successfully is a very important aspect in the processing of ceramics. This paper therefore emphasizes the benefits in the fabrication of oil kilns for the production of ceramics as one method which can complement modern ceramic kilns. It therefore encourages the design and building of oil kilns for the processing of ceramic wares, which could be achieved by using locally made insulating bricks to line the walls of the kiln.

Introduction
The firing of a ceramic ware is the final stage in ceramic processing. It is the make or break of a ceramic piece. It is that which makes a piece of clay work to be qualified to be called a ceramic piece. The potter's craft would not exist without the knowledge of the action of fire on ceramic ware; neither is the ware complete without going through the firing process. As Peterson and Peterson (2003) declare "If work is to stay within the traditional ceramic vocabulary, firing must be considered from the start".

Firing ceramic wares in oil kilns is a very exciting and fascinating experience. The thundering, the rumbling and the musical roaring of the fire and the kiln at peak temperature, as the fire battles with the wares inside the kiln makes it even more fascinating. More than half of the fun and pleasure in the production of ceramics lies in the firing. This is true, particularly in oil-fired kilns, where various artistic effects could be achieved on the wares by the reduction firing process.

Presently many pottery studios use oil kilns because oil price is still affordable and readily available to power them (the kilns). Firing oil kilns gives very interesting and encouraging results in ceramics. "The atmosphere can be easily controlled, and a very rapid advance of heat is possible if desired" (Rhodes 1973). The firing of clay wares to the desired temperature is the most important in the processing of ceramic wares, and this has always been the challenge of the potter. Until a piece of clay work is fired, it can hardly be referred to as ceramics.

The firing of a loaded kiln is usually advanced slowly for the first one or two hours, for the safety of the pots. This is because advancing the heat too rapidly could bust or crack the pots. In this demonstration, a forced air pressure burner system is used. The burner which works in conjunction with air pressure tank is regularly controlled by the potter. (See plate1).The size of the firing chamber determines the number of burners required to power it.

The Need for Machinery Fabrication

The non-availability of necessary ceramic equipment and their cost has necessitated the need for the fabrication of vital ceramic equipments like the kiln. Kiln construction is a job that involves some engineering experience, and it is carried out by the potter in collaboration with the engineer, to balance creativity, beauty and functionality (Bony, 2005). Again the readily available oil (kerosene and diesel) has made potters to think of the oil kiln more than other types of kilns; hence the oil kiln is gaining a lot of popularity among potters. With the oil available the potter can afford to fire his wares any time he chooses to work, as against the electric kiln which is entirely dependent on the discouraging, frustrating and epileptic power supply presently experienced virtually all over Nigeria, or the gas kiln where the cost of gas is very much on the high side.

The potter living in the heart of the city may not find it easy to lay hands on fire wood for his wood fired kiln, neither would those living in the suburb be comfortable with the local laws prohibiting the felling of trees, where they would have procured the quantity of wood required to fire their wood burning kiln. All these make the oil fired kiln a preferred and popular option for firing ceramic wares. The aesthetic value of the finished works in the electric, gas, or wood kilns may all be very brilliant but in my experience, I have been favoured in the manipulation of the oil kiln, more particularly in the reduction and oxidation firing processes. The ease with which the burners are manipulated to achieve the desired effect on the wares is immeasurable, and the end result of the ceramic works from such processes is fantastic.

The Production of Insulating Bricks for Kiln Construction

Bricks are very important when considering building a kiln. There are basically two types of bricks required for the construction of a kiln. They include the light insulating and the dense refractory bricks. Very efficient light insulating bricks can be made with a mixture of kaolin and saw dust at a 50:50 aggregate. This is mixed with just enough water to make a stiff mixture to be pressed with a mould. Some little sodium silicate could be added to the mixture to give it strength. Odu, Nwoye, Ameh and Nnamchi (2013), has suggested a blend of clay and rice husks as appropriate materials for the production of light-weight insulating ceramic brick. A wooden mould is constructed for the brick moulding. The standard size for insulation brick for kiln building is 23cm x 11.5cm x 6.5cm. So the mould should be constructed to this size.

The light insulation bricks will be used for the inside lining of the kiln which includes the three side walls, the floor, the roof arch and the door; while the dense refractory bricks will be used for the fire chamber, the burner ports, the flue and the chimney as well as the back-up walls.

The Brick Composition

The composition for the bricks could be as follows:

1. **The light insulating bricks**
   Kaolin--------50 parts
   Saw dust------- 50 parts
   Total-------- 100 parts
2. **The dense refractory bricks**
   Kaolin----------50 parts
   Ball clay--------20 parts
   Sand----------20 parts
   Saw dust--------10 parts
   Total----------100 parts

An addition 1% of sodium silicate to each of the compositions and enough water to make a stiff mixture is necessary. The clay/saw dust mixture is allowed to age for at least two days and the brick making could commence. After the bricks have dried sufficiently, they are fired to the highest temperature that the proposed kiln is likely to be fired to. Bricks for kiln building are usually made with kaolin or fire-clay, as these are the materials that can withstand the higher temperatures required.

Overview of the Firing Process

Ceramic firing has been a serious menace in the production of ceramic wares particularly at the studio level as well as at the cottage ceramic industrial capacity. As a result many ceramic studios have folded up since their clay work could not be fired at the end of the day. This is discouraging. The electric kiln which would have been the easy way out in the firing of these wares has not been a complete solution to this challenge. This is due to the following reasons:

1. The equipment is expensive to purchase where available,
2. The opportunity of using the electric kiln effectively to fire the wares has been made impossible due to the epileptic power supply in Nigeria today.

Of the other fuel burning kilns like the gas kiln and the wood burning kiln, the oil kiln seems to be the preferred option. Again this is as a result of the following reasons:

1. It is expensive to run a gas burning kiln because of the expensive nature of gas,
2. The local laws guiding the natural forest reserve may prohibit the felling of trees, thereby making it difficult for the potter to afford the quantity of wood required for the regular firings of his kiln.

With these challenges the potter takes to oil as a better option for firing his ceramic wares.

The Down-draught Kiln

Firing a down-draught oil kiln gives a more even temperature distribution within the kiln chamber. With the opening or closing of the dampers, oxidation or reduction firing is made more successful. Gregory (2005: 13) posited that "A down-draught kiln works on the principle that the heat is introduced at the base and deflected up into the crown of the chamber then passes back down to the collecting flue at the bottom linked to the chimney". This agrees with the views of Green (1972) when he says: "The principle of the downdraught kiln ensures that the flame is kept within the kiln for a longer period – it travels almost twice the distance inside". He went further to add: "therefore higher temperatures are easily reached with only a fractional increase in the quantity of fuel consumed" (ibid). (See figure i).

The Up draught Kiln

In the up-draught kiln the fire is introduced at the bottom of the kiln and flows fast out through the chimney, thereby having very little impact on the settings. The temperature distributions in the chamber are never even. The fire tends to flow towards a less dense area, thereby making such area over fired, while the densely packed area remains under fired.

It is better therefore to fire a downdraught kiln to achieve a more even temperature distribution in the chamber. Cardew (1979) declares that in the case of a downdraught kiln "the product of combustion leaves the chamber at or below ground level where their heat can be more conveniently utilized". He went further to say: "Above all, temperature differences automatically adjust themselves. Downdraught kilns therefore, have a very even distribution of temperature both in a vertical and in a horizontal direction" (ibid).

Preparing the Kiln for Successful Firing

Before loading the kiln, the inside should be cleared of possible pieces of broken wares or similar objects from previous firings; and possibly given a light coating of kiln wash. The batts are also dressed and equally be given a light coating of batt wash if necessary. The burner ports and the fire box compartments should be attended to as these are the areas that are mostly exposed to intense heat. Cracks in such areas should be mended and given a kiln wash too. You will also need to check through the flue to ensure that it is through to enable easy and better pull of draught.

The burners should be serviced thoroughly before firing. This is to ensure that there are no dirt in the pipe line, particularly the coil and the nozzle areas of the burners. To service the burner, simply open the nozzle and blow air through the coils with the month, or flush through with water, to ensure that it is clear of dirt or obstructions which could block the coil or nozzle at the peak of firing. Check through the hose and the pressure tank and ensure there are no leakages. If all these have been taken care of then the kiln is ready for firing.

The method of loading the kiln is dependent on the type of firing to be carried out. In a bisque firing the green wares are free to touch each other. In so doing the lighter wares could safely be loaded on the heavier and larger wares; whereas in gloss firing, wares are carefully loaded such that they do not touch each other.

Firing the Kiln

After loading the kiln the burners are positioned in the burner ports. Some

combustibles like pieces of wood are introduced into the burner ports against the coils of the burners. This is ignited to heat up the coils of the burners. The burner is opened a little to admit some kerosene to the coils of the burners.

As soon as the coils get heated up, they are charged and the spray of kerosene in mist form starts; and the firing has started. At the first time, the firing should be left at a very low pressure for the safety of the wares inside the kiln; most especially when it is bisque firing. This should be carried up to at least one or two hours. The pressure could be increased after this preheating hour by introducing more air into the tank and/or increasing the fuel flow to the burners by opening the ball-gauge valve of the burners the more. The firing is noisy but musical and fascinating.

The firing lasts for about four to six hours, depending on the intended temperature. It is advisable that the kiln operator stays around throughout the firing period because of the inherent danger in working with necked fire. Again the burners and the fire need to be attended to regularly. The oil pressure tank should be located a reasonable distance away from the kiln – at least 5 to 6 meters (15 to 20 feet) for safety reasons.

A soak period of about thirty minutes to one hour may be necessary towards the end point of the firing, when the wares are almost matured enough. This is carried out by keeping the heat impute almost at a standstill, whereby the temperature rise would be extremely slow. Another approach to this soaking is by closing all the bungs (the spy hole, the burner pots and the damper) at the end of the firing; that is as soon as the burners goes off. This should be left for about the same thirty minutes to one hour. By this the attained peak temperature of the firing would drop very slowly. This exercise is particularly necessary for glazes with peculiar problems like bubbling, blistering and pin holing. The fired kiln should be allowed to cool overnight before opening to unpack the stacked wares.

Findings

The firing of clay wares is the most important in the processing of ceramic wares from the local studio of the potter to the industrial level. Until a piece of clay work is fired, hardly can one refer to it as ceramics. This study therefore is of benefit in the following direction:

(i). It will impact positively on studio potters, as well as ceramic departments in colleges and universities and will further its creative development processes.

(ii). The presence of a good kiln in the ceramic studio will go a long way to enhance and ensure meaningful production, thereby encouraging effective use of materials machinery and equipment.

(iii) It will open up more challenges in research in relevant areas with regards to equipment and machinery development.

Conclusion

Operating high temperature kilns are inherently dangerous and hazardous; therefore one should be very conscious of the dangers involved working with fire, especially naked fire which the oil firing kiln and the burners produces. (See Plates 2a, 2b & 3). The kiln space should therefore be provided with fire fighting gadgets. Gregory (2005) advises that one should "… use adequate safeguards when attempting any of the activities….".

Patience is very important when firing the kiln, as one could easily be deceived at red heat, particularly inexperienced potters. Peterson and Peterson (2003) declare that "Firing is a mystical adventure; experience teaches". They went further to say; "Proper firing is tricky". Therefore, it is very important to fire kilns only when you can be present regularly within the firing period, to watch the development until the firing is over. At this point therefore the pyrometric cones, which is more reliable, or the pyrometer, which records the firing temperature, are extremely of importance and a necessity.

A successful firing demands the potter's attention to control the burners regularly, particularly oil kiln or gas kiln where naked flame is involved. As rightly pointed out by Peterson and Peterson (2003), he says, "…Intelligent firing of clay work must include controlling, managing, measuring and recording temperature and atmosphere throughout a firing". Kiln firing is dramatic, exciting and fascinating, especially at high

temperatures. This is what every potter aspires to attain and experience; and it is only patience that can take us there. Although Peterson and Peterson (2003) see "proper firing as tricky", I would consider it as a display of dexterity on the part of the artist potter. However, caution should be the watchword in firing any type of kiln to guide against fire hazards.

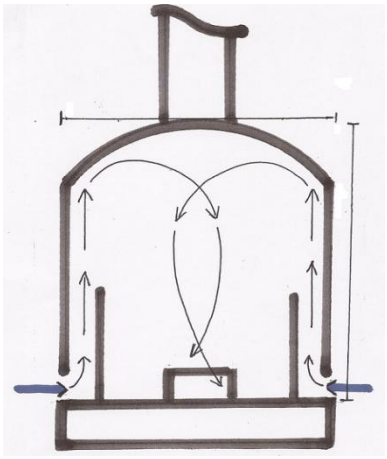

Figure 1: Down-drought Oil Kiln design showing heat flow in all directions to the flue



Plate 1: View of burner port at the early stage of firing



Plate 2a: Burner port at peak temperature during a night firing



Plate 2b: Spy hole port at peak temperature during a night firing



Plate 3: The researcher attending to the kiln during a firing



Plate 4: View of successful kiln load



Plate 5a: Successfully fired ware from oil burning kiln



Plate 5b: Successfully fired ware from oil burning kiln



Plate 5c: Successfully fired ware from oil burning kiln



Plate 5d: Successfully fired ware from oil burning kiln

References

Agberia J. T. (1993): *Design and Construction of a Gas-Fired Kiln for Ceramics Production.* Nigerian Journal of Technical Education. Vol. 10 No 1&2. Planning Division, National Board for Technical Education, Kaduna.

Bony A. (2005): *Design.* Edinburgh. Chambers Harrap Publishers ltd.

Etuokwu, A. (2012): *Design, Construction and Operation of a Multi-Fuel Firing Kiln for Ceramic Production;* A PhD Dissertation.

Fournier, R. (2000): *Illustrated Dictionary of Practical Pottery*. New York. Van Nostrand Reinhold Company Inc.

Gregory, I. (2005): *Alternative kilns.* Great Britain. A and C Black Publisher Ltd.

Leach, B. (1976): *A Potters Book*. London. Faber and Faber Ltd.

Norton, F.N. (1956): *Ceramics for the Artist Potter*. U.S.A. Addison Wesley Publishing Company Inc.

Odu J. N, Nwoye C. I, Ameh E. M, and Nnamchi P.S. (2013): *Production of Fireclay Insulating Bricks from a Blend of Clays and Rice Husks.* Ashakwu Journal of Ceramics. Vol. 10 June 2013.

Peterson, S and Peterson, J. (2003): *The Craft and Art of Clay*. London. Laurence King Publishing Limited.

Rhodes, D. (1981): *Kilns. Design, Construction and Operation*. Pennsylvania. Chilton Book Co.