Journal of Engineering and Applied Sciences 2 (12): 1697-1699, 2007
ISSN: 1816-949X

Producing Insulating Refractory Bricks with Kaolin and Sawdust

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Abstract: This study was carried out to exploit kaolin and sawdust from local environs for the production of insulating refractory bricks, used in the construction of ceramic kilns, glass furnaces and gas-fired or electric ovens. Results of the study show that kaolin and saw dust mix in the ratio of 1:1 by volume is found suitable for producing good-quality insulating refractory bricks.

Key words: Kaolin, sawdust, insulating refractory bricks, ceramic kiln

INTRODUCTION

The term refractory means hard to fuse. Refractory materials are generally employed for the construction of furnace flues, crucibles, etc., used in high temperature operations because of their resistance to the corrosive action of gases and slag present therein (Rashidi, 1986). High temperatures are involved in the industries dealing with the treatment of ores and other materials for the manufacture of metallurgical, chemical, glass and ceramic products. As such, equipment used for the treatment of these materials must sustain the operating temperatures and other working conditions such as corrosive and load conditions. The objective of this research, is to find out if the mixture of Kaolin and sawdust can produce insulating refractory bricks that can be used in the construction of annealing ovens (used as backers for glass furnaces) and ceramic kilns-used by visual artists to fire works of art.

There are different types of refractory materials namely aluminosilicate, silica, dolomite, magnetite and chrome base, carbon, insulating, to mention just a few. However, this research focuses on insulating refractory materials. Insulating refractory materials are specially formulated to have a highly porous structure, low thermal conductivity and high thermal insulating properties suitable for minimizing heat losses and maximizing heat conservation in furnaces (Chester, 1973). Insulating refractory materials can be produced using fire clay mixed with specific quantity of combustible materials like a binding agent (Olson, 1975). Other materials that have insulating refractory properties are glass wool, slag wool, vermiculite and ceramic fibres. China clay is sometime used where very high-temperature refractory properties are required.

MATERIALS AND METHODS

The Kaolin used in this research was obtained from kankara village in Katsina state. Two wooden moulds measuring 31×25×6 cm and 52×32×6 cm were constructed. The sawdust was obtained from the wood workshop, ABU Zaria. Other materials used include a plastic bucket, a shovel, a large black polythene sheet, water and a ceramic kiln for firing.

Kaolin and sawdust, which formed the major raw materials used, were measured in the ratio of 1:1 by volume using a plastic container of 30 cm^3. They were thoroughly mixed together (dry mixing) on the floor using the shovel to break the large lumps of kaolin into finer particles. Water was added gradually and further mixing continued using the shovel until the desired viscosity of the mixed batch was obtained.

The mixed batch was covered with a black polythene sheet to prevent air from penetrating and also to facilitate the aging period (fermentation of the batch). The aging period may take up to 5-10 days before the desired texture is achieved (Ewule, 1988). However, for the purpose of this study, due to the change in climatic condition (harmmatan season) the aging period was extended to two and half weeks before the desired texture was achieved. After aging, the batch was ready for brick moulding.

Slab moulding: Before the brick moulding process commenced, a large polythene sheet was spread on the floor (to prevent the brick from sticking to the floor) and the moulds placed on it, ready for filling-in of batch mixture. The bricks were made by dipping the wooden mould in water before filling each mould with batch mixture and the top smoothened using a heavy metal iron slab to attain the desired levelness.

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Two different sizes of insulation brick slabs were produced. The bricks produced were left for a period of 2-4 week to harden up, after which they were lifted up, turned side ways or up-side-down for proper drying. It should be noted that if the bricks were not given much time to harden up breakage or even warping may occur (Norton, 1970).

After properly drying the bricks were ready for firing. By mixing fire clay with combustible materials and then firing at a temperature of 1000°C (Ewule, 1988), the sawdust burns and the products of combustion are expelled from the refractory body mass, resulting in a compact light product having the desired porous structure. Normally, the range of any refractory bricks is determined by its maximum service temperature (Chester, 1973). For instance, if a ware is to be fired to 1300°C to reach maturity, the brick has to be fired to a temperature of between 1300-1800°C to exceed that of the ware's temperature. This would thus enhance proper conservation of heat during firing. For the purpose of this research, the insulating bricks were expected to attain a temperature of 1280-1300°C (using ceramic cone 10) which is an advantage for the purpose required. After firing using a ceramic gas-fired kiln, at the temperature of 1300°C, the burners were put off, the kiln allowed to cool gradually and the insulating bricks removed ready for use.

RESULTS AND DISCUSSION

The fired bricks were observed to be white in nature (Fig. 1), light in weight, porous with high insulating properties and were able to withstand temperatures of between 1100-200°C, when used in constructing a top-loading electric oven (Fig. 2). Kaolin being a primary clay with a low shrinkage rate, it was observed that during the bricks' open-air drying process under shade, the shrinkage rate was minimal. No crack was observed since the drying process was gradual.

According to Rashidi (1986) the good properties of an insulating refractory material include low thermal conductivity, high and uniform porosity, reasonably good cold-crushing strength, a good PCE value to withstand the working temperature, light weight and a low apparent density of about 0.5 g cm^{-3}. Also Chester (1973) opines that a good fired insulating brick is best appreciated in the light of heat conservation and thermal efficiency of any modern furnace. The insulating refractory bricks made in this research were found to fulfil the conditions laid-out by Rashidi (1986) and Chester (1973).

Fig. 1: Showing one of the fire bricks produced. Notice its white colouration

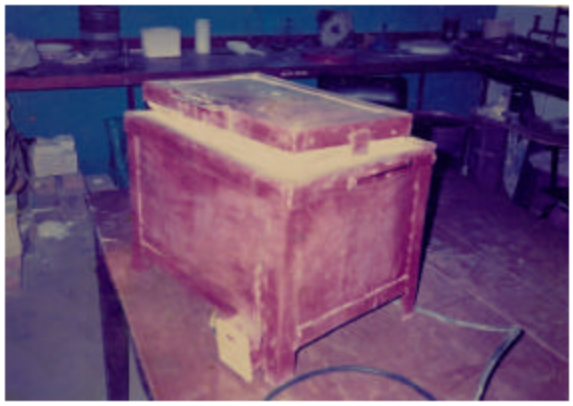

Fig. 2: Showing a top-loading electric oven constructed with insulating bricks made from sawdust and kaolin mixture

CONCLUSION

The mixture of kaolin and sawdust in the ratio of 1:1 by volume was found to be suitable for the production of good quality insulating refractory bricks. Since the bricks can withstand temperatures of 1000°C and above, they can be used for the construction of glass furnaces, ceramic kilns and electric or gas-fired ovens.

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