PRODUCTION OF REFRACTORY CRUCIBLES USING CERAMIC RAW MATERIALS FROM SOME SELECTED STATES IN SOUTH WEST NIGERIA

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ABSTRACT

There is a high demand in the metallurgical, glassmelting, alchemical, chemical laboratories and among local jewelers for refractory crucibles that can withstand high temperatures. Unfortunately refractory crucibles seems not to have witnesses the desired development in Nigeria despite its potentials at helping in maximizing the ceramic raw materials potentialities, reduce dependency on importation of ceramic wares and provide job for the teeming unemployed Nigerian youths. This research is therefore aimed at developing refractory crucibles using ceramic composition from the available ceramic raw materials from some selected states in South Western Nigeria. The study is hinged on the objectives at identifying the source of ceramic raw materials that can be used for the production of refractory crucibles from some selected parts of South Western Nigeria; assessing the chemical and physical properties of the local ceramic raw materials using X-ray Fluorescence Spectrometer (XRF); producing refractory crucibles using slip casting method; and carrying out standard refractory tests such as drying and firing shrinkage, water absorption, thermal shock resistance and refactoriness on the locally produced crucibles. The production of refractory crucibles was carried out using experimental procedures by analyzing selected raw materials sourced using two selected locations in South West Nigeria. Chemical analysis was carried out on the locally sourced ceramic raw materials using X-ray Fluorescence Spectrometer (XRF). Five different body compositions were formulated using quadaxial blend of 36 recipes and are labeled as samples A, B, C, D and E respectively. The crucibles were produced after preparing and mixing raw materials using slip casting. They were dried and fired in a gas kiln above 1300°C for 6 hours. The result of the standard tests carried out on the locally produced refractory crucibles showed drying shrinkage between 5.26% - 11.11%, firing shrinkage between 2.78% - 5.56%, total shrinkage between 10% - 15%, water absorption between 0.36% - 0.72%, density between 0.3g/cm³ - 0.46 g/cm³ and compressive strength between 1.43N/mm² – 1.65 N/mm². All the five crucible samples show good response to thermal shock and maintained their refactoriness above 1300°C. Crucible sample A which consists of 10% Ikere Ekiti ball clay, 50% Ikere Ekiti kaolin, 30% Ikere Ekiti calcined kaolin and 10% Awo quartz was observed to have given the best composition for the production of refractory crucibles. The drying shrinkage, firing shrinkage, total shrinkage, water absorption, density and compressive strength values of crucible sample A are 8.11%, 5.41%, 12.5%, 0.37%, 0.46g/cm³ and 1.65N/mm² respectively. The result showed that quadaxial mixture of ceramic raw materials compounded from Ikere Ekiti ball clay, Ikere Ekiti kaolin, Ikere Ekiti calcined kaolin and Awo quartz can be used for the production of refractory crucibles. The locally produced refractory crucibles can be used for melting substances that have their melting points below 1300°C.
CHAPTER ONE

1.0 INTRODUCTION

Ceramics, according to Jones (2014), is a word derived from the Greek word “keramos” whose original meaning was “burnt earth”. This nomenclature was applied traditionally to earthenware objects produced by the molding and subsequent firing of moist clay at low temperature to form hard, dense solids. Adindu, Moses, Thaddeus and Tse (2014) defined ceramics as solid compounds, usually inorganic and non-metallic crystalline materials, manufactured by heat treatment that are formed by the application of heat and sometimes heat and pressure, comprising at least one metal and a non-metallic elemental solid (NMES) or a non-metal, a combination of at least two NMESs and a non-metal.

Ceramics once referred purely to pottery which involved forming a clay body into objects of a required shape and heating them to high temperatures in a kiln. This firing process removes all the water from the clay and induces reactions that lead to permanent changes. Today, ceramics are referred to as inorganic and non-metallic materials with a wide range of useful applications. This is as a result of their useful properties which include very high hardness and strength, good electrical and thermal insulation, good erosion and corrosion resistance and high temperature stability, among others. (Woodford, 2015).

According to Matse (2015), ceramics offer many advantages compared to other materials: they are harder and stiffer than steel (this is the reason why ceramic refractory furnaces and crucibles are employed in steel production), more heat and corrosion resistant than metals and polymers and are less dense than most metals and their alloys. More importantly, ceramic raw materials are both plentiful and inexpensive. (Matse, 2015). From times immemorial in history to the present times, ceramics has helped tremendously in sustaining human lives so much that it is difficult to think of an area of human’s existence that has not been touched by ceramics. It is almost impossible to visualize a world inhabited by humans without ceramics.

The technology and applications of ceramics have catapulted man from the ancient primitive technology to the present highly improved technology seen in the world today and there are yet much more to see. Many are the wonders of ceramics in the modern world, increasingly making life easy for man and helping tremendously to improve his survival
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