ABSTRACT

TRINIDAD CLAYS AS A POTENTIAL COMPONENT IN CLAY-GRAPHITE REFRACTORIES

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The potential of four Trinidad clays (the Longdenville, Carlsen Field and Cocoloco clays of central Trinidad; and the Devil's Woodyard mud volcano effluent) as a possible component in the production of clay-graphite refractories has been assessed. The formulation parameters include body composition that spanned the range 20 – 40 % graphite, firing temperature spanning the range 800°C – 1100°C and firing environment. The effect of each was assessed in terms of the attainment of combined optimum mechanical properties, physical properties and graphite retention on firing composites subject to atmospheric oxidation. In addition percolation theory was applied to describe the conduction properties of the clay graphite system. In accord with this model a critical or threshold value for conduction was found for a body composition of 15% graphite. The critical exponents relating the variation of the conductivity close to the critical value were in good agreement with the theoretical values for the three-dimensional percolation model with a conductor in a non – conducting matrix.

The raw materials were characterized by a number of techniques including X-ray diffractometry (XRD), Differential Thermal Analysis (DTA) and standard analytical chemical methods. Fabrication of test specimens used to assess mechanical properties, physical properties and graphite oxidation was by hydraulic extrusion. Based on fired properties, two of the clay-graphite compositional systems (the Longdenville and the Devil's Woodyard) exhibited encouraging potential as a component in clay-graphite crucible making. However, of these two the Longdenville system was found more suitable and singled out for in depth study.

In order to correlate microstructure-property relationships, scanning electron microscopy techniques (including secondary electron imaging, energy dispersive x-ray analysis (EDXA), and elemental dot mapping) were used to study selected fired samples in the Longdenville and Devil's Woodyard compositional systems. In addition, the thermophysical and thermomechanical properties (e.g. thermal conductivity, thermal expansion, thermal shock resistance) were studied using the flash diffusivity method, dilatometry, and air quenching from elevated temperatures.

A review of the firing environment and the detrimental effect it has on graphite retention, revealed that samples when fired buried in graphite were virtually unaffected by graphite oxidation, compared with relatively high graphite loss on firing in open air.

To assess practical thermal performance, model crucibles were fabricated after selecting the optimum processing parameters and body composition for the Longdenville system. Of these some were fired in air and others fired buried in graphite. Subsequent lead melt experiments in these crucibles showed that those buried in graphite when fired performed significantly better than those fired in air.