

DEPENDENCE OF THERMOPHYSICAL PROPERTIES OF CLAY ON CONCENTRATION OF SOME HEAVY METALS

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ABSTRACT

This paper presents the relationship between thermo physical properties (thermal conductivity and thermal diffusivity) and heavy metal concentration of some surface clay from six local governments in Ibadan, oyo state, Nigeria. An atomic absorption spectrometer (AAS) was used in analyzing the concentration of heavy metals present in each sample by measuring the intensity of external radiation absorbed by the atom produced from the same sample at a wavelength characteristic to that element. A transient measurement technique was used to determine the thermal conductivity and thermal diffusivity. Thermal conductivity of each sample was compared with the concentration of heavy metals present in the sample. Based on the results obtained from AAS, Manganese has the highest concentration in all the samples. It was followed by Zinc and the least was lead. The values of temperature, time and their respective measured thermal conductivity were highly correlated; with correlation coefficients between 0.9 and 1.

Keywords: Thermal Conductivity, Heavy Metals, Atomic Absorption, Wavelength, Intensity.

INTRODUCTION

The weathering of parent rocks and the decomposition of organic matter form soils. The fact that soil is so fundamental in life; it has been studied intensively for more than a century. Clay, one of the major types of soil is primarily formed by precipitation. The term, clay, is applied both to materials having a particle size of less than $2\mu\text{m}$ and to the family of minerals that has similar chemical composition and common crystal structural characteristics. Kaolin is the fine white clay found in the most weathering zone (Velde, 1995). The fact that clay soil allows the flow of heat energy when there is temperature difference; the knowledge of soil thermal properties are necessary in understanding mass and energy exchange process. The conductivity of the soils therefore depends majorly on the moisture condition of soils (Usowicz, 1993), the metals present in the soil (Alloway, 1995), the Soil cation exchange capacity (Rhoades, 1982), Soil pH (Koch and Merinenko, 1983), Soil organic matter (Gerriste and Van Driel, 1984), and clay content (Korte et al., 1976). The practical and useful relationship between heavy metal contents and the thermal conductivity and thermal diffusivity of the surface clay soil has however received very little attention. The main objective of this study is to investigate the relationship between thermo physical properties and heavy metal concentration of some surface clay soil from regions in Ibadan, Oyo state, Nigeria. In this work, greater emphasis was placed on surface heat distribution in clay soils and how the presence of heavy metals affects it.

MATERIALS AND METHODS

The clay used in this study was obtained from different local government in Ibadan, oyo state, Nigeria. Code $S_1 - S_{10}$ were used to represent collection point in the ten selected areas, as shown in Table 1. Sample preparation included air -drying, crushing by mortar and pestle, passing through a 1mm mesh sieve and distilled water. Analysis of the digested samples was performed using Atomic Absorption Spectrophotometer. The following elements were analyzed; Aluminium, Al, Lead, Pb, Zinc, Zn, Chromium, Cr, Copper, Cu, Arsenic, As, Cadmium, Cd Nickel, Ni, and Manganese, Mn. During the digestion experiment, one gram of each sample was weighed into a Teflon beaker while 10ml of conc. Nitric acid (HNO_3) was added and heated. About 70% of the mixture was allowed to dry off and 10ml Hydrofluoric acid (HF) was added to the mixture, followed by direct heating to about 20% total volume. A 5ml Perchloric acid (HClO_4) was then added and the whole mixture was allowed to dry by evaporation. 1ml of Nitric acid was then added and allowed to boil and latter transferred to a 25ml standard flask filled to the mark with distilled water (Akinyemi et al., 2006) the results obtained are showed in Table 2. A Nickel-Chromium wire was used as the heat source. The temperature was measured with a k-type thermocouple probe centered at the base of the sample clay slab at an interval time of 30s up to 150s. The probe passed through a hole under the insulating box stuck with glass wool (Middleton, 1993). The K-type thermocouple was connected to a digital multimeter (AVD890G). The thickness of the slab was measured using micrometer screw gauge and