

PALM KERNEL OIL CAKE AS AN ALTERNATIVE TO EARTH RESISTANCE-REDUCING AGENT

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Abstract

This paper presents a study on Palm Kernel Oil Cake (PKOC) as an earth resistance-reducing agent. The PKOC is a derivative of palm kernel nut after extraction of oil. Significant earth resistance reduction is obtained by means of replacing soil within 'critical resistance area' of an earth electrode with the PKOC. The properties of PKOC as an earth resistance-reducing agent is investigated. Among the important properties considered are moisture content, moisture holding capacities, pH (acidity) level, and its resistivity. The paper presents and discusses the techniques in the PKOC application and reports the results achieved which demonstrate effectiveness of the PKOC.

Keywords: *Palm Kernel Oil Cake, Earth Electrode, Critical Resistance Area.*

Introduction

The term earthing is defined as the connection of a conductor or frame of a device to the general mass of earth. Earthing plays an important role in generation, transmission and distribution for safe and proper operation of any electric installation. In many of the applications of earthing, low earth resistance is essential to meet electrical safety standards. However, in certain soils, it has been extremely difficult to obtain and maintain a satisfactory earth resistance values. As a means of reducing the earth resistance, a chemical treatment and other methods are used. In most developing countries, materials used as earth resistance-reducing agents are often imported. As a result, the cost of backfills for lowering earth resistance value is very high. In a study to determine the most effective method of installing low resistive earth electrode, majority of the standard methods were rejected for practicality or cost reasons [1]. To reduce cost

and save scarce foreign exchange for other projects, there is the need to find cheaper local materials as close substitutes to the imported materials. Palm kernel oil cake (PKOC) is an organic material which provides a low resistance when used to backfill around earth rods. Where chemicals are used, electrolyte such as sodium chloride, magnesium sulfate, copper sulfate, magnesium chloride, calcium chloride, ammonium chloride, or the like, is injected into the soil surrounding the earth electrode to reduce the earth resistance. When this method is applied, the soil shows an extremely favorable earth resistance for some period after the treatment. However, the chemicals are carried away by surface run-off water and subsoil water during rainfall, and the effect of chemicals lasts only for a period ranging from several months in an extreme case to 3 years at the longest, the mean effective period being about 2 years [2]. Accordingly, the chemical treatment must be repeated after a certain period. However, such repeated treatments, maintenance, and inspection are very difficult in remote and deserted places [2]. Also questions regarding environmental impact of these chemical remained unanswered. Others have raised concerns about ground water contamination from the chemicals [1].

In most soils, organic matter accounts for up to 10% of the soil mixture [3]. Organic material

plays an important role in soil structure. It acts as a cementing agent to bind soil particles together. Thus, the organic nature of the PKOC makes it a promising candidate in the earth resistance-reducing agents. The PKOC does not only appear to possess the necessary electrical properties, but is environmentally and economically friendly material.

A natural method of reducing earth resistance will be replacing all soil in the effective resistance area with the PKOC. However this method may not in general make sense economically. For this to be realistic, it will be necessary to limit the backfill to the area very close to the earth rod and judged to be accounting for a substantial percentage of the total earth resistance. The area is referred to as critical resistance area and its radius as critical resistance radius. In this paper, the characteristic of PKOC is investigated and its effectiveness as a backfill in critical resistance area to lower earth resistance is demonstrated by field test data. It is therefore the principal objective of this paper to provide an improved and cost-effective method of reducing earth resistance by use of PKOC.

Methodology

Chemical properties of the PKOC were tested in a Soil Research Institute. The chemical properties were compared with other earth

resistance-reducing agents. Parameters determined were total nitrogen, carbon, phosphorus, potassium, calcium, magnesium, and pH (acidity). Organic carbon was determined using the modified Walkley and Black method [4] Total nitrogen was determined by the modified Kjeldahl digestion and distillation method.

Sodium and Potassium were determined by taken 5ml of 1:1 nitric acid concentrate + perchloric acid, 5ml of concentrated sulphuric acid and 1g sample PKOC mixed in a digestion flask and placed on electro-thermal heater for an hour. When sample became clear, it was left to cool then 50mls of distill water was added to the sample volume; a concentrate of Sodium and Potassium was read on a flame photometer after calibrating the instrument with known standards. The concentrate of the unknown is extrapolated from the standard curve

Moisture content of the PKOC was also examined. Moisture content was assessed by taking a PKOC sample at a depth of about 0.3 meter and putting it in a plastic bag immediately. The sample was then weighed and dried to constant weight in the oven at 70°C. The weight of the dried sample was taken and the difference was expressed as a percentage, with the result being the PKOC's percent moisture by weight [5]

A water- holding-capacity test was carried out by equilibrating a known weight of the cake (20 g) with a known volume of water at various time duration.

Resistivity was measured by the Frank Wenner's method [6]. Earth resistance values were recorded using the DET5/4R Digital Earth Tester applying the Fall-of –Potential method or the so-called “62%” rule [6, 7].

To determine the effectiveness of the earth resistance reduction technique, a 100% PKOC was applied as a backfill in a critical resistance radius of earth electrode at selected sites and resistance behavior at the sites monitored over period of three years.

Result and Discussion

Table-1[(a) and (b)] shows chemical composition of PKOC as compared to other backfills. Major parameters identified to contribute significantly to the high electrical conduction of the PKOC are carbon, moisture content and low acidity level. The chemical analysis and moisture characteristics show that PKOC consists of relatively large conductive carbonaceous aggregate 56.22%. This demonstrates the ability of the PKOC to hold its moisture contents for a considerable period and absorbs moisture from the surrounding soil even in the degraded state. According to [8],

high electrical conductivity of carbon based materials is observed above 14% of carbon concentration. Further increase in carbon concentration beyond the critical concentration region (>24%) causes marginal change in conductivity.

The moisture content of the palm kernel oil cake (air- dried) was 14.2%. Results indicated that moisture holding content increased with time from an initial level of 240 to 260%. This means that the kernel oil cake can absorb moisture about two and a half times its weight. It is our believed that the charge carriers in PKOC are ions in the moisture plus the ions provided by the slightly acidity of the PKOC. Additionally, the PKOC conducts by means of free electrons in the carbon, the same as a metal does, even when dry.

Table-1: Chemical composition of PKOC as compared to other backfills

Sample Parameter	% Composition				
	PKO C	LEC Crystal activator	LEC GAF	Coke	Marconite
Carbon	56.22	3	4.45	3.9	0.51
Nitrogen	46.86	0.04	0.14	0.68	0.05
Crude Protein	30.25	0.25	0.88	4.25	0.31
Calcium	0.32	0.16	0.84	0.16	0.08
Magnesium	4.48	0.12	1.92	0.32	0.07
Phosphorous	0.42	Trace	0.2	0.003	0.081
Potassium	.57	1.43	0.42	0.02	Trace
Moisture	240.2	11.53	191.72	56.69	62.5
Sodium	0.002	40.50	1.43	-	-

(a)

Sample Parameter	PKO C	LEC Crystal Activator	LEC GAF	Coke	Marconite
pH 1:1	5.34	-	7.76	5.62	5.55
Ph 1:2.5	4.76	9.53	7.65	-	-

(b)

Moisture content is one of the controlling factors in earth resistance because electrical conduction in soil is essentially electrolytic. Electrolytic conductivity increases at a rate of approximately 1.9% per °C increase in temperature. The moisture characteristics of the PKOC eliminate the need to use moisture retentive materials such as silica gel and resins of a lignin type or a urea type. It is the most probable that the moisture property contributes significantly in making the PKOC a good material for earth resistance- reducing agent.

Acidity level (pH) of the PKOC was found to be 5.13. Soil pH is a measure of the acidity or alkalinity of a soil. A pH below 7.0 is acidic and above 7.0 is alkaline.

Electrode corrosion is high at pH levels above 7.0. High pH levels affect durability of earthing system and could result in safety threat to both personnel and equipment. The durability of an earth electrode backfilled with PKOC can be expected to be high due to its relatively low acid content.

Application Technique of PKOC

Test was conducted at three different sites not far from each other. A plot of resistance R against distance x for the three rods used for the study is shown in Fig. 1. The rods are 0.5-, 1- and 1.4-m long and each has a diameter of 14 mm. The resistance is expressed as a percentage of the total earth resistance. The distance is also expressed as a percentage of the length of rod l .

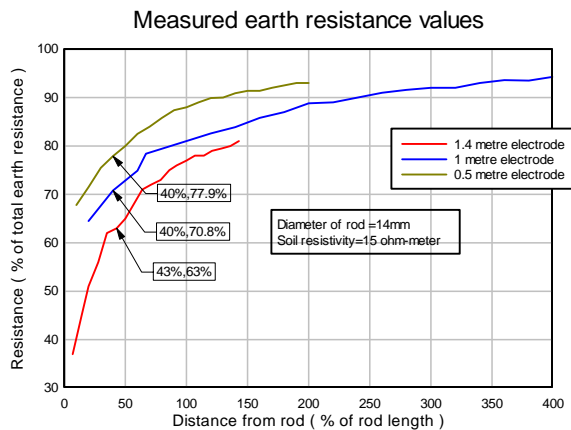


Figure-1: Earth resistance measurement as a function of distance from electrodes

It is observed that the resistance curves begin to saturate around 40% distance from the rods. Thus the 40% distance becomes a good proposition for the critical radius. This radius will be used as critical resistance radius for the study.

Field Validation

To determine the effectiveness of the earth resistance reduction technique, the 1-m electrode was driven into a soil of resistivity 300 ohm-m. At this resistivity, earth resistance of 236-ohms was measured. The soil within the critical resistance radius of the 1-m electrode (0.4-m) was removed and backfilled with PKOC of resistivity 5.7 ohm-m.



Fig 2: Application demonstration of PKOC on the field

As a result, the resistance dropped to 62.54 ohms representing a percentage reduction of over 73%.

PKOC has been applied at seven selected sites with different types/texture of soil. Average soil resistivity values and moisture content at the sites are presented in Table. Figure-3 shows test results at these sites over a period of 3 years. The results show an average earth resistance improvement of about 50%. It was noted; see Fig-3, that the PKOC was very effective in high resistive soil with low moisture content. Percentage change in earth resistance value over 3 years with PKOC application in high resistive soil was over 80%.

This significant change is attributed to seasonal changes of climate and rainfall is indirectly extending the cross sectional area of substantially negligible. the earth electrode by the PKOC, ability of the PKOC to absorb moisture and the presence of charge carriers in the form of ions in the slightly acidity of the PKOC.

Table-2: Soil Resistivities and Moisture contents at 7 sites of investigation

	Substation B15	Top-timbers	G.Gate	Chief's P	Tano-Odum	Berebe-T	Unity Oil
Average Resistivity ($\Omega.m$)	6653	5200	570	5499	5125	550	4500
Moisture Content(%)	1.2	1.9	2.1	1.2	1.5	2.4	2

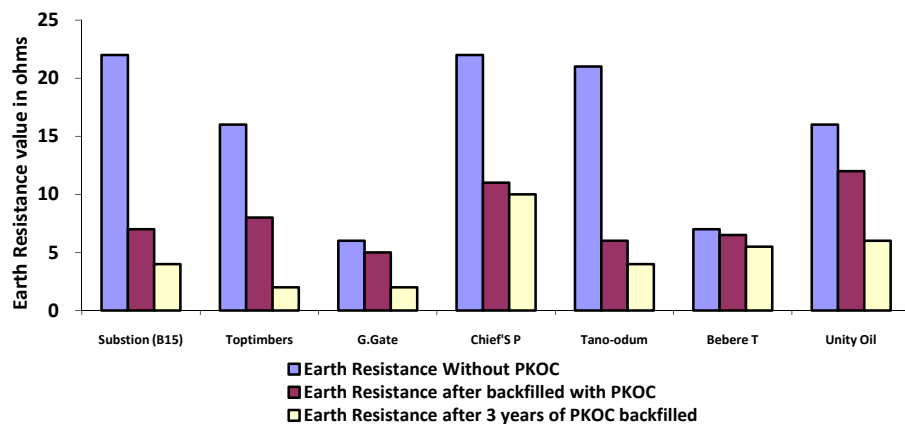


Fig-3: PKOC Application, Sites monitored for 3years

Conclusion

The study has so far shown that the PKOC provides and maintain an excellent earth resistance-reducing effect for a long period of time. The PKOC is quite stable with resistance to acids and alkalis, and are able to maintain permanently earth resistance-reducing effect substantially without being lost by rainfall. As a result, fluctuation of earth resistance due to

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