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INNOVATIVE GAS-FIRED FACILITY FOR CURING *Laccosperma opacum* AND *Laccosperma secundiflora* (RATTAN SPECIES) IN GHANA

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Abstract- Rattan is an excellent material for many applications in art and craft. However, untreated rattan is a vulnerable material for fungus and insects, which affect product durability and the resultant market value of its products. A high temperature facility for oil-curing of local rattan species in Ghana was designed and built with locally obtainable raw materials, such as locally composed low density bricks, locally composed kiln mortar and locally manufactured gas burners rated at 160 kilo joules. This innovative oil-curing gas-fired facility is a solution to the poor oil curing methods adopted by local craftsmen, industry and some research institutions that work with rattan species in Ghana. Conflagration box component of the facility enhancing utmost heat maintenance is specially built to keep the tub temperature high for effective removal of waxy layer and gummy substances, resulting in remarkable reduction in moisture content of the rattan and eventual full treatment against fungus and insect infestations.
Keywords- bricks, craftsmen, density, fungus, insects, kiln, moisture, mortar, oil-curing, rattan, retention, temperature.

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Introduction

Rattan has a long and well-established tradition as a basketry material and complementary material to bamboo in Ghana. This material is widely used in many forms for useful products like fruit containers, furniture, lampshades, bags, paneling and bead making. An important factor, which limits the use of rattan, is its durability. Rattan is subject to attack by pest and fungi. This reduces the expected life of the rattan. Studies done on rattan species by Gnanaharan and Mosteiro (1997) affirm that because rattan is not toxic, it serves as a ready food source for a variety of organisms. They observed that the considerable quantity of waxes in rattan makes it attractive to borers and pests [2]. They also claim that soluble sugars form the principal nutrients for degrading organisms and that removal of wax from rattan will significantly reduce the risk of decay.

The essential step involved in oil-curing is to keep the rattan stems immersed in an oil medium (diesel) just below boiling point for a certain amount of time, ranging 5-10 to 30-40 minutes, depending on the species and diameter of the rattan in hand [2]. They explain that during this process, waxy materials like, gum and resins will be dissolved and removed, alongside with the moisture from the rattan.

The Department of Integrated Rural Art and Industry (DIRAI), at the Kwame Nkrumah University of Science and Technology (KNUST), teaches students to produce works of art in rattan; unfortunately, the department lacks the facilities for giving curative treatment to rattan. The oil-curing facilities used by some industries to improve the quality and life expectancy of rattan species that could be adopted by the DIRAI are not environmentally friendly, because of the use of wood fuel. These oil-curing facilities are deficient in the use of energy and pose health hazards to users in their operations.

In this paper, environmentally responsive and innovative high temperature tub, a locally resourced oil-curing facility with the capability of curing *Lacosperma opacum* and *Lacosperma secundiflora* rattan species is presented. The innovation functions with little or no health hazards, well organized in the use of energy and fueled by Liquefied Petroleum Gas (LPG).

Materials and Methods

The technique adopted to fabricate the gas fired oil-curing facility is basic and consists of four main components: the tub, firebox, LPG, and a temperature indicator. The set-up is simple to comprehend and user friendly.

The Tub

A rectangular tub and a fitting lid fabricated from mild steel plate, 2 mm thick, by arc welding, measured 120 cm in length, 50 cm in width and 60 cm in depth. The rectangular tub would accommodate 60 pieces of rattan species approximately 3 cm in diameter and 100 cm in length. The cover is necessary to prevent or minimize the escape of vapor and gas during curing.

The Firebox

The second component is the firebox, a fabricated metal frame that also measured 120 cm in length, 50 cm in width, 60 cm in depth and 20 cm above ground level, supports the mild steel tub. The firebox is a high temperature withholding, low-density bricks compartment lined with special high temperature insulation material for maximum energy utilization. The low-density bricks composed from local earthenware clay (*Mfensi* clay) and sawdust, as appropriate material for accommodating heat for kilns and similar projects where heat preservation is required [3,4]. Several experiments conducted determined the optimum volume of clay, the principal material and sawdust required to mix well with water and sodium silicate to mould the low-density bricks. The sodium silicate served as deflocculant for reduction in apparent viscosity and the drying time [5]. The 5 cm x 7.5 cm x 15 cm-moulded bricks were air dried and fired to 1100 degrees Celsius. This temperature was necessary for the appropriate tensile and compressive strengths of the bricks as well as the total burning of the sawdust to create the multitude of air cells required for the retention of heat during the oil-curing process. Table 1 shows the results of moisture absorption test made on the burnt porous low-density bricks.

Table 1- Moisture Absorption Test showing the Properties of the 5 cm x 7.5 cm x 15 Low-Density Bricks

Percentage of True porosity	40
Density in g/cm3	0.889
Crushing strength in kg/sq cm.	60
Maximum service temp. in °C	1100
Average mass of each brick in grams.	500

The mortar for laying the bricks was composed from locally available raw materials based on earlier successful studies on mortar preparations by Steiner *et al.,* 2010. Table 2 shows the constituent materials and their required mass for the preparation of the mortar used for this project. First, the low-density bricks neatly secured with the composed mortar lined the base tray of the firebox frame.

Table 2- Composition of Local Mortar

Mortar Material	Required Wt./ Vol.
Local plastic clay	30 kg
Flint or builders sand	15 kg
Sodium silicate	1 lit.

Next came the four walls of the firebox and the creation of burner and exhaust holes in the walls. After construction, the inner parts of the firebox were painted with deflocculated slip and allowed to set three days. This secured the walls from thermal pressure. Finally, ceramic fiber was used to line the rim of the firebox in order to prevent heat loss when the tub is mounted on the firebox during the firing and curing process. Fig. 1 shows a setup of the complete facility.

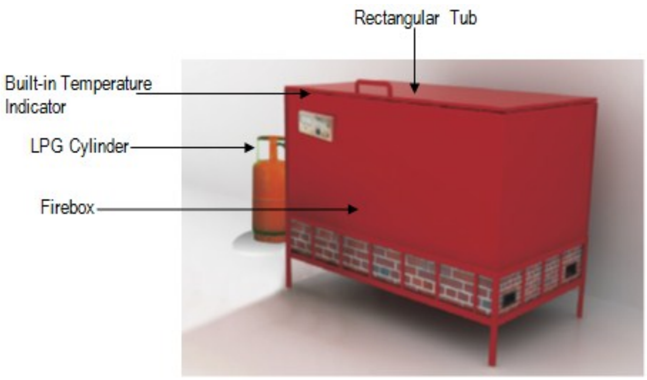

Fig. 1- Innovative Gas-Fired Facility for Curing Rattan Species

Operation

The tub of the facility was half-filled with a mixture of kerosene and diesel in the ratio of 1:1 and fired to a temperature of 110 degrees Celsius, which is just below its boiling point of 120 degrees Celsius. The rattan oil curing started with the primary preparation and processing of the freshly harvested rattan. After cross-cutting to the required lengths, the hard silica saturated epidermis was deglazed. Firing at 160 kilo joules, bundles of *Laccosperma opacum* and *Laccosperma secundiflora* rattan species were gently lowered into the hot oil with the aid of hooks. A galvanized metal mesh was then placed on them to keep them submerged.

Thirty minutes of continuous boiling completed the oil curing treatment for the rattan in the tub. The rattans in the tub were hooked, allowed to drain, cleaned of oil with rugs and were stacked in bundles standing to air-dry, ready for use. The volume of LPG used was dependent on the quantity of oil and rattan used in the oil curing treatment.

Results and Discussions

Samples of *Laccosperma opacum* and *Laccosperma secundiflora* rattan species boiled in the tub and those that have not been oil boiled were exposed to termites for six weeks. The third and fourth days of this exposure period, water was deliberately sprinkled on and around the ground where the samples were exposed to the termites. The sample pieces were gradually covered with termite mound three days after the sprinkling of water. The rattan samples were not fully covered; the mud had covered only part of the pieces by the seventh day. The presence of mud around the samples was evidence of the presence of termites on the pieces. The uninterrupted termite mounds built up for five to eight days. There was proof of uninterrupted movement of termites to and from one sample piece to another. After the third week, it was observed that, parts of the mounds created around the pieces had given way, making visible more than a few pathways of the termites as they moved about in different directions. It became visible that the samples that were not oil boiled were thoroughly termite infested. On the other hand, the rattan samples that were oil boiled were not termite infested. A second samples test result after three months showed the same response from the termites.

The study has sufficiently demonstrated that when *Laccosperma opacum* and *Laccosperma secundiflora* rattan species are oil boiled, as shown in Fig. 2, the likelihood of insects to plague the material is nonexistence. There was improvement in colour, attributed to a change in state of the rattan. The facility has also addressed two environmental issues: the use of charcoal or fuel wood was avoided because the burning of these materials contributes to the depletion of our forest covers; smoke which form as a result of incomplete combustion contains harmful pollutants that can trigger coughs, runny noses, headaches and eye and throat irritation [1]. Liquefied Petroleum Gas on the other hand is environmentally friendly. The firebox has also enhanced the rate of curing methods adopted by local craftsmen, industry and some research institutions that use fuel wood in open space by 40 %.

Fig. 2- Oil Cured Rattan after Six Weeks Exposure to Termites.

Conclusion

The curing facility for the different rattan species by boiling in oil comprises the boiling tub and the firebox. After the first curing cycle, the time taken for the rattan to be brought to temperatures close to boiling point was shortened because the oil remained hot after first boiling. The firebox was able to house the flame produced by gas burner rated at 160 kilo joules and very little heat was lost. Consumption of LPG is very low – about 2.0 to 2.5 kilograms for the initial firing and extremely low as 0.5 kilogram for subsequent firing. The ceramic fiber, which lined the edge of the firebox, prevented loss of heat between the firebox and the tub. These have confirmed the quality of locally sourced materials processed for the construction of the firebox. Effective curing or protection of this versatile craft material, against fungus and insects, especially in areas where longer durability is necessary, can result in immense social and economical benefits, which would facilitate employment potential in Ghana.

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