Ain Shams University
Faculty of Engineering
Design and Production Engineering

A Study of the Potentiality of use of the Palm Midrib in Charcoal Production

A Thesis submitted in partial fulfillment of the requirements for the degree of Master of Sciences in Mechanical Engineering

(Design and Production Engineering)

By

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Cairo, Feb.5, 2018

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Statement

This thesis is submitted in partial fulfillment of requirements for the degree of Master of Science in Design and Production Engineering, to Faculty of Engineering, Ain Shams University. The work included in this thesis was carried out by the author, primarily at the laboratories of the Design and Production Engineering Department, Faculty of Engineering, Ain Shams University. No part of this thesis has been submitted for degree or qualification at any other university.

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Thesis Summary

The objective of this study utilizes the residues of palm midrib to produce charcoal with satisfactory environmental, medical, and industrial applications. Choosing the palm midrib residues is based on its distribution all over Egypt and availability for Egyptian farmers. The study objective was achieved by passing with some steps. The first step prepared the samples, where used the two types of palm midrib samples Baladi and Siwei, then divided the palm midrib into five parts (top, middle, base, knee, and end), according to the dimension of the inner reactor.

The second step is to design and manufactures a pyrolysis reactor(test rig) to produce charcoal. The third step is carbonization cycle process for the samples of palm midrib ten parts with quantity for all part, where the carbonization cycle process steps according to food and agriculture organization (FAO) standard.

The four-step is experimental analysis for twenty samples of palm midrib ten parts (row material before carbonization) and palm midrib ten parts (after carbonization) in labs according to American society for testing and materials (ASTM) standards. The experimental analysis divided into proximate analysis such as (moisture content, ash content, volatility matter content, and fixed carbon content), ultimate analysis such as sulfur, and calorific value(also known as heating value or a specific value).

Finally, After comparing the results of the experimental analysis for samples of Baladi and Siwei palm midrib parts (after carbonization) to FAO standard values. The potentiality of production of charcoal from Baladi and Siwei palm midribs with satisfactory properties has been proven. The procedure charcoal is suitable for environmental, medical, and industrial applications. According to FAO, the best samples are the middle part of palm midrib in Baladi, followed by the top, base, knee, and end. According to FAO, the best samples are the top part of palm midrib in Siwei, followed by the base, middle, knee, and end. The whole Baladi palm midrib could be utilized realizing the calorific value is 86% of the FAO standard. The whole Siwei palm midrib could be utilized realizing the calorific value 88% of the FAO standard. The designed reactor in this work could serve as a model for the production of charcoal from palm midribs in the village conditions.

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Nomenclature

ASTM	American Society for Tooling and Materials
FAO	Food and Agriculture Organization
ARC	Agriculture Research Center
GHG	Greenhouse gas
CV	Calorific Value
FC	Fixed Carbon
VM	Volatile Matter
AC	Ash Content
SC	Sulfur Content
MC	Moisture Content
KJ/Kg	Kilo Joules per Kilogram
g	gram
Temp.	Temperature
min.	Minute
N2	Nitrogen
CO2	Carbon dioxide
CO	Carbon Monoxide
H2	Hydrogen
3D	Isometric
A	Weight of the used sample
B	Weight of the sample after heating
C	Weight loss
D	Moisture content
X	Weight of the capsule, cover and ash residue
Y	Weight of the capsule and cover
Z	Weight of the sample to be analyzed
BaSO4	Barium sulfate

M	$BaSO_4$ precipitated
N	$BaSO_4$ correction
O	Tested sample weight
13.738	The percentage of sulfur atomic weight the molecular weight of barium sulfate.
cm	Centimeter
L	Liter
ha	hectare
Yr.	Year
t	Tonnes

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Chapter 1

Introduction

The charcoal is the black carbon and ash residues, which come from animal or vegetation substances by removing water and volatile matter during slow heating in the absence of oxygen by pyrolysis process.

Charcoal marketing shapes, the first lump charcoal is low ash, high calorific value, and ability to be used in many applications, the other briquette charcoal is high ash, medium calorific value, and ability to used in low energy applications.

The charcoal applications are environmental, medical and industrial. The environmental applications are using the charcoal in soil amendment is considerably required, because it increases the carbon concentration in soil and reduces the emissions of green carbon gases.

The medical applications with activated carbon mean that the carbon structure of the charcoal has a pore in low volume to do absorption of chemical substances. It acts as filters and has excellent health and medical benefits.

The industrial applications have required the sulfur at low levels as much as possible to avoid environmental effects, the ash content at high to realize the most significant energy consumption, the stable pore structure, and chemical compatibility. Almost smokeless, because of its low ash content and chemical stability.

Suggested Plan of Work