Ain Shams University

Faculty of Engineering

Design and Production Engineering Department

Study of the Appropriate Conditions for the Production of Pellets as a Solid Biofuel from Agricultural Residues

A Thesis Submitted in Partial Fulfilment for the Requirements of the Degree of Master of Science in Mechanical Engineering

By

Mohamed Mohamed Abd ElHameed Abd ElWahaab

Supervised by

Prof. Dr. Hamed I. El-Mously

Dr. Iman M. Taha

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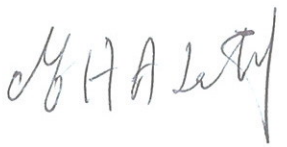
Examination Committee

The undersigned committee certify that they recommend to the Faculty of Engineering - Ain Shams University the acceptance of the thesis entitled "Study of the Appropriate Conditions for the Production of Pellets as a Solid Biofuel from Agricultural Residues", submitted by Mohamed Mohamed Abd ElHameed Abd ElWahaab, in partial fulfilment of requirements for the degree of Master of Science in Mechanical Engineering.

Names	Signature
Prof. Dr. Sherif Bahi Mahmoud Mosharraf Professor at the Faculty of Engineering, Al-Azhar University	
Prof. Dr. Mohamed Hazem Abd El-Latif Professor at the Faculty of Engineering, Ain Shams University	
Prof. Dr. Hamed Ibrahim El-Mously Professor at the Faculty of Engineering, Ain Shams University	

Date: 21st of August, 2014.

Statement

This thesis is submitted in partial fulfilment for the degree of Master of Science in design and production engineering, to the 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.

Mohamed Mohamed Abd ElHameed Abd ElWahaab

Signature:

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Date:

_____

Curriculum vitae

Name: Mohamed Mohamed Abd ElHameed Abd ElWahaab

Birth Date: 10-7-1984

Degree: Bachelor Degree in Mechanical Engineering

Discipline: Mechanical Power Engineering

University: Faculty of Engineering, Ain Shams University

Date of Receiving the BSc. Degree: August 2006

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Abstract

This work targets the investigation and studying of the appropriate conditions for the production of pellets as a solid biofuel from agricultural residues. Agricultural residues in Egypt have been studied and characterized in order to select the most promising and suitable raw materials for the purpose of bio-pellets production.

Agricultural residues have been characterized based on amounts, availability, geographic distribution, collection prices, current utilization methods and physio-chemical properties of the residues. Trading off between these parameters is based on a screening matrix; in which every factor affecting the production of pellets was weighted on a 0 to 100 scale and the highest score raw material was selected to produce pellet samples for factory tests and experimentations. Based on the screening matrix results, rice straw, cotton stalks, and sorghum stalks have been chosen for study.

Agro-pellet samples were produced from rice straw, cotton and sorghum stalks with different water and molasses concentrations. The associated quality parameters of the produced pellet samples in terms of calorific value, single pellet density, bulk density of pellets and mechanical durability index were measured and compared to the requirement of international standards for agro-pellets. International agro-pellet standards' lower limits are 12 MJ/kg for calorific value, 1.2 g/cm^3 for single pellet density, 600 kg/m^3 for bulk density and 96.6% mechanical durability index. A maximum water content of 10% and natural additives at a maximum of 2% is permitted. The results show that the produced agro-pellets well satisfy these international standards requirements.

Producing rice straw pellets with 1.1% water content (w.b.) will result in high quality pellets satisfying the requirements of international standards in terms of calorific value, single pellet density, bulk density of pellets and mechanical durability, their values were found to be 15.45 MJ/kg, 1.435 g/cm3, 717.5 kg/m3 and 99.904%, respectively.

Producing cotton stalks pellets with 1.95% water content (w.b.) results in high quality pellets satisfying the requirements of international standards in terms of calorific value, single pellet density, bulk density of pellets and mechanical durability.

Sorghum stalks require the addition of 1.6 % water in order to produce sound agro-pellets satisfying the international demands.

Generally, all agro-fibres doped with 2 % molasses proved to be successful agro-pellets. Despite the slightly reduced calorific value associated with the use of molasses, the use of this binding agent proved to be beneficial in terms of energy reduction along the pelleting process.

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