Optimal Solid Wastes Mixture for the Production of Solid Fuel

A Thesis
Submitted To Faculty of Engineering
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in Civil Engineering

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Dedication

This thesis is dedicated to those who contributed to educating, raising and supporting me to be able to accomplish in this picture.

A special dedication to

MY SUPPORTIVE PARENTS

and to

My wonderful
Sisters and Relatives

and finally
special dedication to

MY LOVELY WIFE AND HER MOTHER

for encouraging me to complete this work and for always being there for me.

STATEMENT

This dissertation is submitted to Ain Shams University, Faculty of Engineering for the degree of M.Sc. in Civil Engineering.

The work included in this thesis was carried out by the author in the department of Public Works, Faculty of Engineering, Ain Shams University, from October 2013 to December 2016.

No part of the thesis has been submitted for a degree or a qualification at any other University or Institution.

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others

Date: - ---/-- /2017

Signature: - ----------------

Name: - ***Maged Abdallah Hussieny Mahmoud***

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ABSTRACT

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Abstract:-

Municipal Solid Waste (MSW) in Egypt is generated in huge amounts and has become one of the most serious current environmental problems. Egypt is suffering from waste disposal problems and fuel shortages. In a way to partially solve both waste and energy problems, some types of waste can be utilized as alternative fuels (AFs) in energy intensive industries such as cement industry. With limited fossil fuel resources and high energy costs combined with the fight against climate change and mismanagement of wastes, AF represents a real substitution to conventional fuels. This study aims at the determination of optimum mix of non-hazardous MSW to be utilized as AF.

Survey on different types of waste in the Egyptian market, their availability and applicability to produce AF is conducted, and eight SW materials are selected: rice straw, cotton stalk, olive pomace oil, used tires, wood, paper, plastics, and dried digested sludge. Waste analysis is carried out on each type of waste to determine their characteristics: calorific value (CV), moisture content (MC), density, and gas emissions.

The optimum AF mix is determined based on technical and financial evaluations. Technical evaluation is based on the maximization of CV, and minimization of MC, density, and gas emissions; whereas financial evaluation is based on the market price of SW material. The optimal mix is found to be: rice straw (22.36%), wood (19.04%), plastics (24.25%), cotton stalks (17.90%), and used tires (16.45%). The optimum mix is found to have CV of 5353 cal/g, moisture content of 1.90%, and density of 330.70 kg/m3.

Economic feasibility study is conducted for an AF plant with production capacity of 50 ton/d. The study considered capital, operation and maintenance costs with NPV of 38,647,565 EGP. At a proposed selling price of 1500 EGP/ton, the plant can achieve IRR of 29%, B/C ratio of 1.163, and payback period of 4 years.

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Key Words:

Municipal Solid Waste, Solid Fuel, Solid Recovered Fuel, Refuse Derived Fuel, Cement Manufacturing, Economic Feasibility Study

TABLE OF CONTENTS

LIST OF FIGURES

List of Figures

LIST OF TABLES

LIST OF ABBREVIATIONS

AF	Alternative Fuel
DOE/EIA	Department of Energy/Energy Information Administration
JCEE	Egyptian-German Joint Committee on Renewable Energy, Energy Efficiency and Environmental protection
EIA	Energy information administration
IMF	International Monetary Fund
USGS	U.S. Geological Survey
BP	British Petroleum Corporation
EGAS	The Egyptian Natural Gas holding organization
ENCC	Egyptian national competitiveness council
CEO	Chief Executive Officer
EPAs	Environmental protection agencies
WBCSD	The World Business Council for Sustainable Development
RDF	Refuse Derived Fuel
EEAA	Environmental Affairs Agency
EIAs	Environmental Impact Assessments
MSW	Municipal Solid Waste
ERF	Energy Rich Fraction
MBT	Mechanical Biological Treatment
C&D	Construction and Demolished
MRF	Materials Recovery Facilities
BMW	Biodegradable Municipal Waste
ABT	Anaerobic Biological Treatment
SRF	Solid Recovered Fuel
MPT	Mechanical Physical Treatment
NCV	Net Calorific Value
CV	Calorific Value
ERFO	European Recovered Fuel Organization
NIR	Near Infrared Spectroscopy
SW	Solid Waste
FAO	Food and Agriculture Organization
NSWMP	National Solid Waste Management Programme
GIZ	*Gesellschaft für Internationale Zusammenarbeit*
WWTPS	Wastewater Treatment Plants
ENCPC	The Egypt National Cleaner Production Centre
ASTM	American Society for Testing and Materials
NPV	Net Present Value
ROI	Return on Investment
B/C	Benefit To Cost Ratio
CC	Capital Costs