Characterization of Bio-Degradable Municipal Solid Waste (MSW) for WTE Technologies for Sri Lanka

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(158283D)

Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa
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Thesis/Dissertation submitted in partial fulfilment of the requirements for the degree Master of Engineering

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Declaration of the candidate and the supervisor

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   (Dr. M.M.I.D. Manthilake)
2. .....
   (Dr. H.K.G. Punchihewa)

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Abstract

Currently the mixed municipal waste as well as the source segregated household and commercial waste from eight local authorities is disposed at the Karadiyana waste-processing site. A small fraction of the source-segregated waste is processed as compost. All of the mixed waste is land filled. While the landfill is a managed landfill it does not meet the modern standards for a landfill by any measure. The environmental externalities due to open dumping caused by the site are palpable.

The main objective of the present study is 'Selection of the waste to energy (WTE) conversion options based on composition of short-term bio-degradable portion of Municipal Solid Waste (MSW) available at dump sites under Municipal Councils of Sri Lanka'.

Data collection survey has been conducted at dump sites in, Kurunegala and Kandy Municipal Councils to find out the condition of Municipal Solid Waste, especially bio-degradable portion, dump data and waste data to propose suitable WTE conversion technology for each dump site. An analysis was conducted using Case Studies on physical and chemical composition of MSW in Sri Lanka and the results are presented in the report. Karadiyana W2E Project was considered as a case study to get real time data.

It is observed that the mixed waste collected in shopping (polythene) bags is causing many issues in both sites such as methane formation in bags, odour, leachate, landslides in the dump site. Composting of old dumps at the sites is practiced as a solution for waste reduction. Cleaning and sorting is done manually creating a lot of problems.

Gohagoda dump site is well managed separating plastics and polythene for recycling and bio-degradable for composting. Due to natural wind circulating through the dump odour is considerably reduced compared to Sundarapola site. In contrast to this, Sundarapola dump site shows negative operating conditions with insufficient and disorganized waste management practices.

The result revealed that the feasibility of the WTE conversion technology, in the form of a community owned power generation plant, bio-gas generating facility or composting facility operated on thermo-chemical and bio-chemical energy conversion of MSW. But it is an attractive option for Municipal Councils to reduce its long term stagnation of MSW at dump sites. In other words, if Municipal Councils implement this project, it would be an ideal solution where both the Municipal Council and the related community are benefited.

Sorting of waste at the source need to be established and collected separately. Waste Management Authority (WMA) needs monitoring all the dump sites in the country and regulates their operation. Waste auditing scheme is recommended for Waste Management Centers (WMC) while awarding 'Star' ratings for best waste sorting practices at the source.

Keywords: municipal solid waste, short-term bio-degradable waste, waste composition analysis, Karadiyana W2E Project, waste to energy, waste management centers, composting, anaerobic digestion, waste auditing scheme.

TABLE OF CONTENT

LIST OF FIGURES

Page

LIST OF FIGURES

Page

LIST OF FIGURES

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

LIST OF ABBREVIATIONS

Abbreviation	Description
$°C \cdot min^{-1}$	Centigrade per minute
3D	Three Dimensional
AD	Anaerobic Digestion
ASP	Aerated Static Pile
ASTM	American Society of Testing Materials
BM	Bio Methanization
BOD	Bio Chemical Oxygen Demand
CC	Chemical Conversion
CFL	Compact Fluorescent
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon dioxide
CRDF	Carbonized Refuse Derived Fuel
CSTR	Continually Stirred Tank Reactor
$dm^3 \cdot h^{-1}$	Cubic decimetre per hour
DTG	Degradation Thermo-gravimetric
EOL	End-of-Life
Eq.	Equation
EU	Europe
FAS	Free Air Supply
FBI	Fluidized Bed Incineration
Fe	Ferrous
FV	Fuel Value
GJ/t	Giga Joule per ton
H_2	Hydrogen
HCl	Hydrochloric
HDPE	High Density Polyethylene
HHV	Higher Heating Value
IWP	Integrated Waste Plant
JICA	Japanese International Corporation Agency
kcal/kg	kilo calories per kilogram
$kcal/Nm^3$	kilo calories per Newton percubic meter
KDU	Kotalawala Defence University
kJ/kg	kilo Joule per kilogram
kJ/m^3	kilo Joule per cubic meter
KMC	Kurunegala Municipal Council
kWh	kilowatt hour
L&YW	Leaf and Yard Waste
LCV	Lower Calorific Value
LTBD	Long Term Bio Degradable
MBI	Mass Bed Incineration
MC	Municipal Council/ Moisture Content
MJ/kg	Mega Joule per kilogram

LIST OF ABBREVIATIONS

Abbreviation	Description
MJ/Nm^3	Mega Joule per Newton per cubic meter
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
Mt	Metric ton
MW	Mega Watt
N_2	Nitrogen
NCV	Net Calorific Value
NO_x	Nitrous Oxide
NSWMSC	National Solid Waste Management Science Centre
O_2	Oxygen
PHI	Public Health Inspector
PM	Particulate Matter
R&D	Research and Development
RDF	Refused Derived Fuel
SD	Standard Deviation
SO_x	Sulphur Oxide
SSO	Source Separated Organics
STBD	Short Term Bio Degradable
SWM	Solid Waste Management
TGA	Thermo-gravimetric analysis
TPD	Tons per Day
TPY	Tons per year
TS	Total Solids
USEPA	United States Environmental Protection Agency
VS	Volatile Solids
WMA	Waste Management Authority
WMC	Waste Management Centre
WTE	Waste to Energy
WWTP	Waste Water Treatment Plant

LIST OF APPENDICES