ANAEROBIC SLUDGE DIGESTER PERFORMANCE IMPROVEMENT BY ADDING ORGANIC MUNICIPAL SOLID WASTES

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Dedication

This thesis is lovingly dedicated to all the close, special and beautiful people in my life. A special dedication to my supportive parents and wonderful sisters 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 November 2011 to August 3013.

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: - ---/-- /2013

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

Name: - ***MOSTAFA AHMED ABD EL-SATTAR***

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ABSTRACT

Name*:* MOSTAFA AHMED ABD EL-SATTAR AHMED
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Faculty: Faculty of Engineering, Ain Shams University.
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Abstract:-

The technical feasibility of the co-digestion of primary sewage sludge (PS) and food wastes as an organic fraction of municipal solid waste (OFMSW), in the context of typical Egyptian solid waste, was evaluated through this study. A pilot unit with 1.5 m3 net volume, simulates dynamically and geometrically full scale digester, was erected in El-Berka wastewater treatment plant, Cairo, Egypt. The digester worked under routine natural operating conditions and was daily fed through pulsing feeding. The study was operated in four stages each with different mixing ratio of PS to OFMSW 95:5, 90:10, 80:20, and 70:30 by volume, respectively. The unit was operated in mesophilic temperature, under minimal mixing conditions, and at retention time of 30 days, and the functioning of the digester was assessed by calculating the efficiencies of solids destruction and chemical oxygen demand (COD) removal. The digester was capable to work optimally under the mesophilic temperatures, without using any temperature adjustment devices. The results showed increase in solids destruction and COD removal efficiencies with increasing the portion of the food wastes in the influent mixtures. The TS, TSS and VSS destruction efficiencies reached 76.4 %, 82.1 %, 93.4 %, respectively, and the total and soluble COD removal efficiencies reached 70.1 % and 85.3 %, respectively. The optimum mixing ratio was of 80 % PS to 20 % OFMSW. It was also noticed that there was a need for pH adjustment through the process.

SUPERVISORS

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LIST OF ABBREVIATIONS

AD	Anaerobic Digestion
ADS	Anaerobically Digested Sludge
BOD	Biochemical Oxygen Demand
C/N	Carbon to Nitrogen Ratio
COD	Chemical Oxygen Demand
DS	Dry solids
FSS	Fixed Suspended solids
HRT	Hydraulic Retention Time
MSW	Municipal Solid Wastes
OFMSW	Organic Fraction of Municipal Solids waste
OFSUW	Organic Fraction of Solid Urban Wastes
PCOD	Particulate Chemical Oxygen Demand
PS	Primary Sewage
RAW	Raw Primary Sewage Sludge
SCOD	Soluble Chemical Oxygen Demand
SGP	Specific Gas Production
SRT	Solids Retention Time
SW	Solid Waste
TCOD	Total Chemical Oxygen Demand
TDS	Total Dissolved Solids
TS	Total Solids
TSS	Total Suspended Solids
TWAS	Thickened Waste Activated Sludge
VFA	Volatile Fatty Acids
VS	Volatile Solids
VSS	Volatile Suspended Solids
WAS	Waste Activated Sewage
WWTP	Waste water treatment plant

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CHAPTER I
INTRODUCTION

1.1. GENERAL

According to the Egyptian Environmental Affairs Agency (EEAA) studies, it was estimated that nearly 1.5 - 2 million tons of dry sludge and 15 – 16 million tons of municipal solid waste is generated annually in Egypt. Organic wastes constitutes about 50 – 60 % of the generated municipal solid waste. Conventional municipal solid waste management has focused primarily on disposal, with little or no emphasis on preprocessing or resource recovery alternatives. While sewage sludge management, in contrast, has involved extensive sludge treatments and beneficial use practices.

The rapid urbanization in the major Egyptian cities directly contributes to waste generation, and improperly managed wastes pose a risk to human health and environment and also increase greenhouse gases' emissions, which contribute to climate change. Consequently, a severe need for finding out efficient and sustainable waste treatment methods and management techniques was created.

Several studies and research projects stated that the Anaerobic Digestion is considered to be one of the most reliable waste treatment techniques to mitigate for climate change. As the process occurs naturally, in the absence of oxygen, as bacteria break down organic materials and produce biogas. The process reduces the amount of material and produces biogas, which can be used as an energy source.

Moreover, co-digestion is of considerable technical interest, since it allows the use of existing installations in wastewater treatment plants that could potentially reduce capital and operating costs. Other benefits of co-digestion include: dilution of potential toxic compounds, improved balance of nutrients, synergistic effects of microorganisms, increased load of biodegradable organic matter and better biogas yield. An additional advantage of the process is the obtaining of a valuable sludge which can eventually be used as a soil amendant after minor treatments.

1.2. STUDY OBJECTIVES

The present study has been designed with the following objectives:

- To investigate the effect of the anaerobic co-digestion of the sewage sludge and the organic municipal solid wastes, as well as the factors that affect the performance of the co-digestion process.
- To find out the optimum mixing ratio of primary sewage sludge and food waste as an organic fraction of municipal solid waste
- To evaluate the technical feasibility of the process in the context of typical Egyptian solid waste.

1.3. SCOPE OF WORK

The study program was prepared to achieve the study objectives and was divided to two main parts, theoretical and practical. The first step of the theoretical part included collection of data for the literature review for the digester including all parameters affecting its efficiency.

This was followed by the practical part, for which a continuous feeding pilot unit, chosen to be dynamically and geometrically similar to a full scale digester, was erected in El-Berka wastewater Treatment plant, Cairo, Egypt, to investigate the effect of the anaerobic co-digestion of sewage sludge and organic municipal solid wastes. Different mixing ratios of primary sewage sludge and organic municipal solid waste were tested to find out the optimum mixing ratio.

While the second step of the theoretical part included analyzing and discussing the results and findings obtained from the practical work in order to identify conclusions and recommendations.

1.4. THESIS ORGANIZATION

The thesis consists of six chapters in addition to abstract, Arabic summery and references.