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ScienceDirect

Procedia Environmental Sciences 35 (2016) 749 – 755

Procedia Environmental Sciences

International Conference on Solid Waste Management, 5IconSWM 2015

Design, Fabrication and Experimentation of a Small Scale Anaerobic Biodigester for Domestic Biodegradable Solid Waste with Energy Recovery and Sizing Calculations

Jyothilakshmi R.[a,*], S.V.Prakash[b]

[a] *Assistant Professor, Department of Mechanical Engineering, MSRIT, Bangalore, Karnataka, India*
[b] *Professor and Head, Department of Mechanical Engineering,CMRIT, Bangalore, Karnataka, India*

Abstract

Biogas digesters are used to produce methane gas and the size of the digesters are commonly bigger in size. People who live in poor conditions and are familiar with the uses and the advantages of using methane gas wants to have a biogas digester at home for replacing the cooking gas as the ever increasing price of cooking gas is adding to their woes. Being in the densely populated city, Bangalore, the problem of domestic waste management is highly inefficient. There is a need for an efficient method to tackle this problem. Both the problems can be met with a residual clean energy output in the form of biogas through a portable bio-digester which can be installed and moved at any place in every house with the help of minimum resources. The project involves the developing and analysis of the body shape of the digester to make it be more efficient to produce methane gas. It mainly concentrates on the economic aspect and will also concern about the structure strength, durability, ergonomic factor, convenience and flexibility of usage in different weather conditions. All the specifications must be verified to avoid materials and fund wasting. Overall process to design, develop and fabricate this digester required the skills of designing and fabrication and used all the basics knowledge of Static, Industrial Design and Manufacturing Technology.

The objective of this project are:

- To fabricate a portable bio-digester to be used in all weather conditions.
- Consideration of economic and ergonomic factors with maximum efficiency in production of methane gas through domestic waste.

Peer-review under responsibility of the organizing committee of 5IconSWM 2015

* Corresponding author.
E-mail address: jyorthirswamy@gmail.com

Peer-review under responsibility of the organizing committee of 5IconSWM 2015
doi:10.1016/j.proenv.2016.07.085

Keywords: Bio-digester, Domestic Waste Management, Biogas, Household Bio-digester;

1.0 Introduction

One of the main environmental problems of today's society is the continuously increasing production of organic wastes [1]. In many countries, sustainable waste management as well as waste prevention and reduction have become major political priorities, representing an important share of the common efforts to reduce pollution and greenhouse gas emissions and to mitigate global climate changes [2]. Uncontrolled waste dumping is no longer acceptable today and even controlled landfill disposal and incineration of organic wastes are not considered optimal practices, as Environmental standards hereof are increasingly stricter and energy recovery and recycling of nutrients and organic matter is aimed.

Production of biogas through anaerobic digestion (AD) of animal manure and slurries as well as of a wide range of digestible organic wastes, converts these substrates into renewable energy and offers a natural fertilizer for agriculture [3]. At the same time, it removes the organic fraction from the overall waste streams, increasing this way the efficiency of energy conversion by incineration of the remaining wastes and the biochemical stability of landfill sites [4].

AD is a microbiological process of decomposition of organic matter, in the absence of oxygen, common to many natural environments and largely applied today to produce biogas in airproof reactor tanks, commonly named digesters [5]. A wide range of micro-organisms are involved in the anaerobic process which has two main end products: biogas and digestate. Biogas is a combustible gas consisting of methane, carbon dioxide and small amounts of other gases and trace elements. Digestate is the decomposed substrate, rich in macro- and micro nutrients and therefore suitable to be used as plant fertilizer.

The production and collection of biogas from a biological process was documented for the first time in United Kingdom in 1895 (METCALF & EDDY 1979). Since then, the process was further developed and broadly applied for wastewater treatment and sludge stabilization. The energy crisis in the early '70s brought new awareness about the use of renewable fuels, including biogas from AD. The interest in biogas has further increased today due to global efforts of displacing the fossil fuels used for energy production and the necessity of finding environmentally sustainable solutions for the treatment and recycling of animal manure and organic wastes [6].

Biogas installations, processing agricultural substrates, are some of the most important applications of AD today. In Asia alone, millions of family owned, small scale digesters are in operation in countries like China, India, Nepal and Vietnam, producing biogas for cooking and lighting [7]. Thousands of agricultural biogas plants are in operation in Europe and North America, many of them using the newest technologies within this area, and their number is continuously increasing. In Germany alone, more than 3.700 agricultural biogas plants were in operation in 2007.

2.0 Design and Fabrication

2.1 Components Required

- Digester tank,
- Inlet for feeding the kitchen waste,
- Outlet for the digested slurry,
- Gas collection and storage system.