Renewable and Sustainable Energy Reviews 52 (2015) 142–154

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

A comprehensive review on operating parameters and different pretreatment methodologies for anaerobic digestion of municipal solid waste

Siddharth Jain [a,b,*], Shivani Jain [c], Ingo Tim Wolf [a], Jonathan Lee [a], Yen Wah Tong [a]

[a] NUS Environmental Research Institute, National University of Singapore, #02-01, T-Lab Building, 5A Engineering Drive 1, Singapore 117411, Singapore
[b] Department of Mechanical Engineering, 4-9 Mechanical Engineering Building, University of Alberta, Edmonton, Alberta, Canada T6G 2G8
[c] Department of Mechanical Engineering, Quantum Global Campus, Uttarakhand Technical University, Uttarakhand, India

ARTICLE INFO

Article history:
Received 1 June 2014
Received in revised form
20 May 2015
Accepted 21 July 2015
Available online 7 August 2015

Keywords:
Biogas
Anaerobic digestion
Operating parameters
Pretreatment
Municipal solid waste

ABSTRACT

Municipal solid waste (MSW) management is becoming a serious issue in all over the world. Anaerobic digestion (AD) is one of the technologies to convert that waste into useful form of energy. But megacities like Singapore having limited resources, cannot fulfill the cow dung or other animal manure requirements in AD. Therefore there is a need to study critically the operating parameters and also the pretreatment technologies available for treating the substrate so that one can get the maximum output with limited input. To fulfill the need, the present paper deals with the review of various operating parameters and their effects on AD. This paper also reviews different pretreatment methods including mechanical, thermal, chemical and biological methods to improve the effectiveness of AD of MSW.

Contents

* Corresponding author at: Department of Mechanical Engineering, 4-9 Mechanical Engineering Building, University of Alberta, Edmonton, Alberta, Canada T6G 2G8.
E-mail address: arthjain2001@gmail.com (S. Jain).

http://dx.doi.org/10.1016/j.rser.2015.07.091
1364-0321/

1. Introduction

MSW amount from societies has increased over the last few years, out of which, food waste contributes a considerable fraction. The food waste generated annually in Singapore was 542,700 t in 2006 and reached about 570,000 t in the year 2008 and 680,000 t in 2011 [1]. Food waste management is a challenge faced by any developing nation as untreated and unmanaged food waste creates odor, hygiene concerns and cause adverse environmental impacts [1–3]. Singapore is a highly populated, industrialized city with limited land area. Semakau Landfill is Singapore's only landfill for waste disposal which is also going to be filled completely in the next few years. Singapore's offshore landfill accepts only inert wastes that are inorganic. Therefore, almost no MSW is sent to the landfill and the majority of MSW is directed to incineration plants [2]. The remaining 10–15% is sent for recycling via AD, followed by composting of the digestate material. But incineration also produces high amount of ash which again has to go for landfilling. Also lots of energy and cost are incurred in transporting the waste to incineration plants, therefore an idea has come into picture to digest the food waste anaerobically in decentralized manner so that on one side we can reduce the amount of ash generated through incinerator and on the other side the heavy investment in transportation can be reduced. AD is considered as the most effective method for the treatment of MSW [3]. In view of the increasing demand of the anaerobic digestion technology, the present paper reported the different aspects of AD along with the factors affecting the digestion process and different approaches/digestion systems.

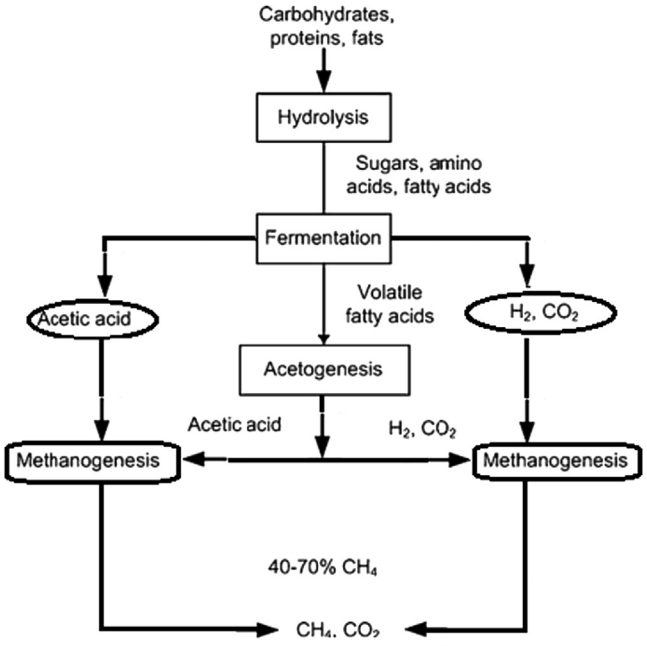

Fig. 1. Flow diagram of AD process [57,59].

Pretreatment of substrate is the necessary step nowadays to accelerate the AD and to obtain suitable by-products. A number of review papers have been published in the recent past on different pretreatment technologies, specially focused on pretreatment of wastewater sludge. The present paper has also attempted to report the different pretreatment technologies and their effect on AD of MSW.

2. Anaerobic digestion (AD)

AD is a method to decompose organic matter with the help of variety of anaerobic microorganisms under anaerobic or oxygen-free conditions. The end product of AD includes biogas (60–70% CH_4, 30–40% CO_2 and rest being the impurities) and an organic residue. This technology has been successfully implemented in the treatment of agricultural wastes, food wastes and wastewater sludge due to its capability of reducing chemical oxygen demand (COD) and biological oxygen demand (BOD) from waste streams and producing renewable energy [4–7]. AD processes are classified based on operating parameters and reactor design such as based on continuity it is batch versus continuous, based on operating