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Biodrying Process Efficiency: -Significance of Reactor Matrix Height

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Abstract

Waste to energy concept should become a reality to meet the critical issues faced by the solid waste management system of developing nations. Energy oriented municipal solid waste conversion technologies have the potential to reduce the bulk volume of the waste in addition to the refuse derived fuel production applications. In this scenario biodrying process is found to be the best option, where biological heat energy is effectively channelized for drying purpose so that the heavy moisture laden municipal solid waste is dried and its energy value is increased. This technology seemed to be promising specially in the case of developing nations where the heavy moisture content of the typical municipal solid waste is the major issue faced by the waste to energy conversion systems. In the present case study the effect of increasing the reactor matrix height and the resulting changes in the biodrying process output has been studied in a pilot scale biodrying reactor of 0.565 m^3 capacity for a period of 10 days. Two case studies were conducted on mixed municipal solid waste substrates with moisture content of 62.45 % and 66.4 % respectively. The reactor matrix height of first case study was kept at1.65 m, while that is increased to 2.0 m in the second case study. The constant air flow rate of 40 litre per minute was provided throughout the experiment for both case studies. During the second case study an air evacuation test has also been conducted on the 4^{th} and 5^{th} day of experiment to understand the temperature profile variations. Overall weight reduction of 26.32 % and 19.01 % along with average moisture reduction of 24.26 % and 15.98 % has been achieved in the first and second case studies

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respectively in 10 days of reaction. The volume reduction and bulk density increase was the maximum in the second case study with 43.5 % volume reduction and 53.01 % bulk density increase in achieved in 10 days of biodrying reaction. Comparing to that a lesser result has been obtained in 10 days of experiment in the first case study with a volume reduction of 35.1 % and bulk density increase of 27.58 %. Therefore increasing the reactor matrix height at a constant air flow rate has affected the biodrying process efficiency in terms of weight reduction and moisture reduction, but the volume reduction and bulk density increase were significant achievements.

Keywords: Biodrying; Reactor matrix height; Moisture content; Temperature; Weight; Volume; Bulk Density.

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1. Introduction

Biological drying is an auto-thermal process in which drying rates are augmented by biological heat released during on-site decomposing of the organic matter. Therefore, it offers an interesting alternative for waste management in terms of feasibility and cost. Biodrying leads to moisture reduction while maintaining the calorific value of the processed wastes so the wet waste is transferred in to solid 'fuel' that can be stored for the future use [1,2,3]. Landfill gas is approximately fourty to sixty percent methane (CH_4), with the remainder being mostly carbon dioxide. In absence of collection and treatment, methane landfills emissions represent both, a potential explosion hazard [4] and a strong environmental threat because CH_4 is a powerful greenhouse gas. Bio-drying is an MBT(Mechanical Biological Treatment) approach that exploits the biological reactivity of the waste in order to produce a material with an improved lower heating value due to the reduction in moisture. Either with or witout some post-treatment, this material can be considered as a solid recovered fuel (SRF), which can be used for energy production in industrial plants. The major advantages of bio-drying process are waste mass reduction, reduction of CH_4, CO_2, SO_2, NO_x emission and dust emission from waste lanndfills into the atmosphere [5].

Biodrying of mixed municipal waste is researched in Europe [1,2,6]; as well as in Poland [7,8,9,10,11]. In India no case studies have been reported in biodrying process and this study is innovative in the field of municipal solid waste treatment system of the country. The water content of municipal solid waste is very important factor affecting the combustion efficiency and hence in the waste to energy conversion processes [12]. Moisture loss of 50 % was reported in a lab scale study conducted on 240 dm^3 reactor using the organic fraction of municipal solid waste and plant structural material of high moisture content [11]. In biodrying process, about 63 % loss in the organic fraction weight was accounted for since the bio-dried mass can be considered equal to 37 % of the percentage of the organic component [13,14,15]. Initial Moisture content is known to be a critical parameter in the biodrying process because it influences the biochemical reactions associated with microbial growth and the biodegradation of organic matter during the process. Optimization of the biodrying process is essential since high temperature in biodrying process will result in increased metabolic reactions of microbes, but the slow diffusion of oxygen in to the water film surrounding micro-organisms decreases, whereas fast biodrying produced low biological stability [16]. The end product of biodrying process has high energy value and hence can be used as a replacement of coal for thermal energy generation [17,18]. In the present paper an innovative pilot scale biodrying reactor system was designed for treating the mixed municipal solid waste of high moisture content. Two case studies were conducted on the designed innovative biodrying reactor system to study the effect of increased reactor matrix height on biodrying process efficiency. The various parameters considered for process analysis the present study included weight reduction, detailed temperature profile formation along the reactor height, moisture reduction and bulk density increase.