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Biodrying of Food Waste-Rich Municipal Solid Waste for Enhanced Incineration Efficiency

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Extended Abstract

Efforts to reduce the amount of waste sent to landfills are increasing within waste management. The challenges and high costs associated with constructing and operating new landfills have made energy recovery through incineration technologies, a significant alternative, particularly in developed countries, as these technologies can reduce the volume of municipal solid waste (MSW) by approximately 85-90% [1]–[4]. Given the high installation and operating costs of incineration, minimizing the moisture-content, and maintaining the energy content of the waste are crucial for achieving the desired quality of refuse derived fuel. Biodrying, a process that generates thermal heat through aerobic microbial activity, is currently recognized as a promising alternative for drying MSW due to its cost effectiveness and energy saving features [5]–[7].

Temperature is a crucial parameter influencing the water removal rate, biological activity, and energy efficiency in the biodrying process. As temperature increases during biodrying, it facilitates the evaporation of water within the waste matrix, transitioning it to the gas phase [8]-[9]. Since this temperature rise is driven by biodegradation, the food to water ratio in the waste composition becomes a significant factor.

The objective of this research is to determine the optimal artificially generated waste composition that accurately represents real food waste and to investigate the use of food waste as an energy source in the biodrying process. In this study, temperature and mass changes of waste in a 0.9 m^3 biodrying reactor were monitored over 7 days. Multiple trials were conducted by adding varying doses of bread waste (BW) and a bulking agent (BA) to lettuce, with each trial using approximately 95 kg of total waste. The trials, labelled A (BA-20%), B (BA-10%), C (BA-10%), D (BA-10%), E (BA-10%-BW-6.75%), and F (BA-10%-BW-9.00%), were aerated at rates of 2.5, 3.5, 0.3, 2.0, 1.9, and 2.4 m^3/kg, respectively.

Mass reduction (%) and the time dependent temperature profiles were recorded. In trials A to F, mass reductions were approximately 49%, 79%, 64%, 51%, 49%, and 37%, respectively. The maximum temperatures observed in these trials were 38°C, 41°C, 45°C, 40°C, 46°C, and 60°C, respectively. The mass loss at high airflow rates was primarily due to airborne moisture loss, indicating that the air-drying was the dominant mechanism rather than biodrying. The airflow rate per unit mass of waste proved to be a more significant factor than the amount of bulking agent (BA) used.

Using only green waste (GW) resulted in low heat generation potential, leading to drying that was driven by airflow rather than heat from biodegradation. When GW was used as the sole component of MSW matrix, the highest temperature increase was detected in trial C, where the lowest aeration flow rate was applied. In trials E and F, where BW was added to the food-waste matrix, the highest temperature increase (60^{o}C) was achieved in trial F on the second day of the process. These results align with existing scientific studies on the biodrying of MSW [10]–[12]. It was concluded that adding 10% BW to GW is necessary to simulate food waste effectively in biodrying studies.

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