

Energy and Resource Efficiency of the MOSAN Pyrolysis and Drying System

Treatment of Sewage Sludge and Fecal Waste Streams for Biochar Production

Graduate



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Problem: The Lake Atitlán basin in Guatemala is home to approximately 250,000 people, over 95% of whom belong to Indigenous Maya communities. Water quality in the lake is rapidly declining due to agrochemical runoff, insufficiently treated wastewater, and unmanaged sewage sludge. Although more than 15 wastewater treatment plants operate in the basin, most do not meet discharge standards, and none provide safe sludge treatment. Consequently, contaminated sludge containing pathogens, pharmaceuticals, PFAS, microplastics, and heavy metals is often stockpiled or illegally dumped. Since 2018, the organization MOSAN has been active in Santa Catarina to address these challenges. By developing a combined sludge-drying and pyrolysis system and implementing a collection system for household separation toilets, environmental pollution can be reduced. Pyrolysis converts sewage sludge and faecal matter into biochar, which is further processed and enriched to develop soil amendment for agriculture.

Approach / Technology: This study aims to evaluate and troubleshoot the sludge drying bed to resolve airflow and heat distribution issues, optimize and standardize key pyrolysis parameters to ensure consistent biochar quality, develop a simple quality control framework for input materials and biochar output, and monitor gas emissions to ensure safe operation and assess environmental impacts. Methodology involves evaluating normal production processes with respect to system stability and production limitations, assessing field measurement devices for use with sewage sludge and biochar, establishing an experimental baseline to evaluate system reproducibility, and conducting parallel testing of the pyrolysis reactor using different feedstock properties alongside drying system experiments. Pyrolysis tests focus on the effects of feedstock characteristics on biochar yield and temperature profiles, while drying tests analyse airflow and heat distribution under different system configurations.

Result: During the initial pyrolysis runs, insufficient chimney draft was evident from smoke escaping through multiple gaps in the system. Visual observations indicated that the chimney roof restricted the natural draft generated by the chimney effect. As shown in Fig. 2, removing the chimney roof improved natural airflow within the system; however, this measure alone was insufficient to ensure stable operation. Installing a ventilator further enhanced airflow by inducing a Venturi effect and creating sustained negative pressure in the system, which significantly improved exhaust gas removal and overall process stability. Nevertheless, as shown in Fig. 1, high exhaust gas inlet temperatures exceeding 400 °C in the drying bed still caused localized incineration of the drying material. Despite this limitation, the implemented measures improved

operational safety by reliably transporting flue gases and smoke through the chimney and enabled the use of the upper right drying chamber adjacent to the chimney. During improvements to the drying bed, several feedstock experiments were conducted. The results shown in Fig. 3 represent initial observations; additional experiments are required to generate sufficient data for statistically robust conclusions.

Fig. 1 Mosan pyrolysis and drying system (reactor, brick channels, drying chambers and chimney)
Own presentation

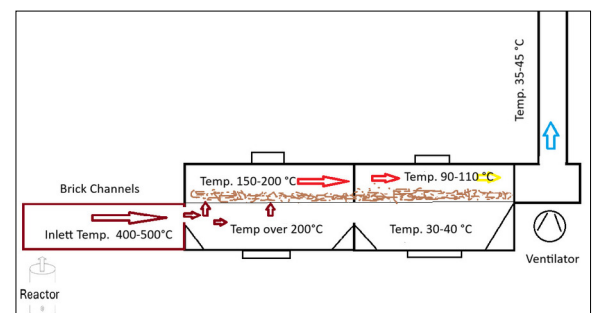


Fig. 2 shows the improvement in natural draught achieved by removing the chimney roof.
Own presentation

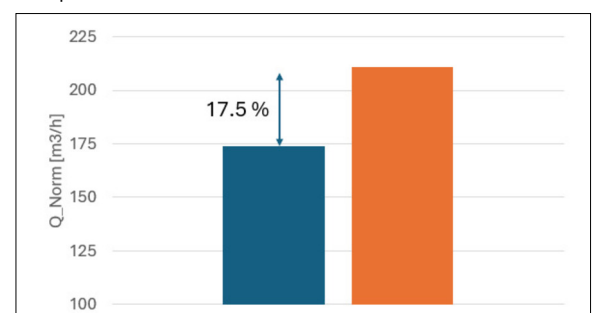
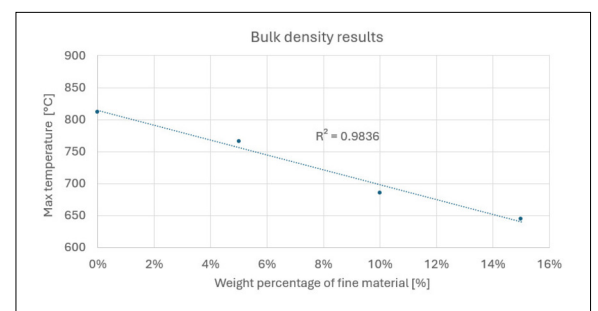


Fig. 3 indicates that higher bulk density reduces reactor temperature due to restricted air circulation.
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Subject Area

Thermal process engineering, General environmental technology, Air pollution control, Waste management and technologies