ANALYSIS AND DEVELOPMENT OF HIGH RATE COMPOSTING SYSTEM USING MUNICIPAL SOLID WASTE IN SRI LANKA

By

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Abstract

Municipal solid waste has become a major problem in every country in terms of public health and environmental damage. As a developing country, Sri Lanka too faces the same challenge not only by public health and environmental damage, but also in finding an affordable yet effective technology, which is socially and economically acceptable. Municipal Solid Waste (MSW) is qualitatively heterogeneous. Therefore, it is difficult to find a unique solution for proper treatment. I.e. The solution is always an integrated one, which consists of sorting, biological/thermal/chemical treatment, recycling and land filling. However quantification and characterization of solid waste in a given area are important factors prior to selecting suitable technology. Therefore, it is required to find waste quantity, composition, density, moisture content, annual rate of waste generation and calorific value of waste etc in a given area. In Sri Lanka, moisture content and organic fraction are reasonably high and lack of high thermal value materials in solid waste stream, have lead to an overall low calorific value of MSW. The general practice for handling the MSW is low rate composting systems. Most have been failed due to poor process management, lack of knowledge of proper operation (feedstock formulation, process control, end point indicators), poor product quality, long lead-time, weaker community participation and lack of public awareness. In all systems existing at present bad odor and leachate are unsolved issues. These systems have largely been controlled by default rather than by design. Thus, losing the public confidence on composting is inevitable.

Properly engineered composting systems require to monitor and control of key parameters such as aeration, C/N ratio of feedstock, pile temperature, moisture content and particle size. The broad objectives of the research were, a detailed review of solid waste management practices in Sri Lanka and process of composting, Identification of composting strategies & evaluation of systems, and design of a high rate in-vessel composting system. During the design, it was considered to maintain the optimum environmental conditions for higher rate of decomposition by microbial activities, aeration demands, and required moisture content throughout the process. The main component of the model is a rotating drum reactor, which is operated under the thermophilic temperature conditions. The rate of decomposition at thermophilic temperatures is much higher (low residence time) than the mesophilic temperatures. A shredder could be used for size reduction of incoming feed in order to determine the optimum particle size. As source separation is very poor in Sri Lanka, this research addresses the possibility of using a semi-mechanized waste segregation device at the secondary stage. Special care was taken to control the odor and leachate of the system. On the other hand, the confidence on low rate windrow / static pile composting among the people have been lost due to the process mismanagement. Therefore, the design offers to have an energy optimized semi mechanized system in which minimum labor contact with the waste occurs.

The reactor is operated by a feedback control system, in which real-time monitoring of critical parameters are done. Based on the existing value and the set point (optimum value for each parameter: moisture and aeration), the control action is taken. Further, intermittent rotation of the reactor facilitates the proper temperature distribution inside, particle size reduction and uniform porosity throughout the mixture while reducing the energy consumption faced by the continuous operated system. Sensor

setup at different heights of the reactor monitors the temperature and moisture content along the axis of the system. It has been observed that moisture is the limiting factor, when the temperature feedback control system is used in the composting. However, real-time monitoring of the moisture content avoids this difficulty. Further, weak pathogen inactivation is a major drawback found in most of the manually turned systems. Intermittent rotation and temperature feedback control system ensure the proper temperature distribution across the reactor and mixes the matrix properly in order to subject to uniform temperature throughout the mass. The modular basis helps for easy movement and it consumes less space compared to the windrow system. According to the national database on solid waste in Sri Lanka, 88% of Local Authorities collects less than 10 Tons per day. This shows the possibility of use of modular units in areas, where space is limited. Close monitoring of the critical parameters of the system helps to maintain optimal decomposition rates while ensuring consisted product quality during the decomposition.

Since organic farming is a growing area in export-oriented agriculture (Tea, vegetables) in our country, this research helps to produce a good soil conditioner (with consistent finished product) using MSW while solving a major environmental problem. Tea plantation companies put special attention to identify the requirements of quality standards for the production of famous 'Ceylon Tea'. Hence as a part of this work, analysis of the critical parameters of the compost, manufactured by different organizations in the country that use solid waste as the substrate was carried out. It is important to match composting quality and the particular plantation requirement to develop a sustainable market for the compost produced using MSW. This has been particularly lacking in the Sri Lankan market with the compost producer hoping to realize a good price for anything that is produced; an expectation that had not been realized.

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Declaration

This thesis is a report of research work carried out in the Department of Civil Engineering, University of Moratuwa, Sri Lanka, between December 2000 and February 2002. The work included in the thesis in part or whole has not been submitted for any other academic qualification at any institution.

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