

Distribution of Residence Times in Rotary Drum Composting and Implications for Sanitary Regulations

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Abstract

Rotary drum systems enable more efficient composting processing of organic wastes compared to static systems. Typical residence times (RT) in these systems range between 3-5 days on average. This short composting time expects to fulfill sanitary requirements as well as initial organic matter stabilization, reduction of phytotoxicity and destruction of weed seeds viability. However, a portion of the feed passes through a well-mixed drum in less than the theoretical RT which may not be sufficient to guarantee safety application of the end product. This study explores the distribution of residence times (RTD) along with the dynamics of other properties in a commercial rotary drum (Ecodrum™) during composting of calves manure and green waste. Two different 'tracers' were used, including short pieces of plastic tubing and lumps of raw organic mixture packed in nylon socks in which several species of weed seeds were incorporated. We distinguished between a transient stage, during which the drum is only partly occupied, and a steady state stage, when the drum is operated at optimal loading. We assumed 'approaching' steady state conditions based on temperature dynamics and the discharged volume per drum rotation. Starting temperatures inside the drum were close to ambient when the drum was fairly empty and then increased gradually up to 60-65°C when the occupied drum volume approached 50%. The distribution of all types of markers were close to normal. Under steady state conditions, the observed distribution suggests that the RT of 10% of the particles is about two-third of the mean residence time (MRT) whereas the RT of 1% of the particles will be only half of the MRT. Even shorter RT can be expected under transient conditions. These shorter RT coupled with non-thermophilic temperatures under transient conditions likely increase the risk of inadequate pathogens reduction. The viability of plant seeds that were incorporated with markers indeed showed some dependence on their specific RT. This study is the first to explore the issue

of RTD in rotary composting drums. The findings are valuable for risk assessments and the formulation of guidelines for safe utilization of rotary drum composting.

Keywords: Residence time distribution (RTD), Retention time (RT), Markers, Rotary drum; Rotation, Solid flow, Pathogen elimination, Weed seed viability

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