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Determination of Thermal Properties of Compost Bulking Materials by Using Various Methods

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Determination of Thermal Properties of Compost Bulking Materials by Using Various Methods

Abstract
Thermal properties of compost bulking materials affect temperature and biodegradation during the composting process. Well determined thermal properties of compost feedstocks will therefore contribute to practical thermodynamic approaches. Thermal conductivity, thermal diffusivity, and volumetric heat capacity of 12 compost bulking materials were determined in this study. Specific heat was measured by a differential scanning calorimeter. Transient heat dissipation and steady-state gradient methods were used for thermal conductivity and diffusivity measurements. Thermal properties were determined at varying bulk density, particle size, and water content. Thermal conductivity and volumetric heat capacity showed a linear relationship with moisture content and bulk density, thermal diffusivity showed a nonlinear relationship. Since the water, air, and solid materials have their own specific thermal property values, thermal properties of compost bulking materials vary with the rate of those three materials by changing water content, bulk density, and particle size. The degree of saturation was used to represent the interaction between volumes of water, air, and solids under the various combinations of moisture content, bulk density, and particle size. The first order regression models developed in this paper represent the relationship of degree of saturation versus thermal conductivity and volumetric heat capacity well. Improved knowledge of the thermal properties of compost bulking materials can contribute to improved thermodynamic modeling and heat management of composting processes.

Keywords
thermal properties, compost bulking materials, thermal conductivity, thermal diffusivity, volumetric heat capacity

Disciplines
Bioresource and Agricultural Engineering

Comments
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Abstract. Thermal properties of compost bulking materials affect temperature and biodegradation during the composting process. Well determined thermal properties of compost feedstocks will therefore contribute to practical thermodynamic approaches. Thermal conductivity, thermal diffusivity, and volumetric heat capacity of 13 compost bulking materials were determined in this study. Specific heat was measured by a differential scanning calorimeter. Transient heat dissipation and steady-state gradient methods were used for thermal conductivity and diffusivity measurements. Thermal properties were determined at varying compaction (1, 1.3, 1.7, 2.5, and 5 times uncompacted bulk density), particle size (ground and bulk), and water content (0, 20, 50, 80% of water holding capacity and saturated condition). The resulting thermal properties of compost bulking materials can be used to develop heat transport models for design of more optimal temperature control in composting systems.

Keywords. thermal properties, compost bulking materials, thermal conductivity, thermal diffusivity, volumetric heat capacity.