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Using Singularity Theory to Analyse a Spatially Uniform Model of Self-Heating in Compost Piles

Thiansiri Luangwilai
Australian Defence Force Academy

Harvinder Sidhu
University Of New South Wales

Mark Nelson
University of Wollongong, mnelson@uow.edu.au

Xiao Dong Chen
Monash University, dong.chen@eng.monash.edu.au

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Abstract
Fires at industrial composting facilities, such as those storing industrial waste products like municipal solid waste (NSW) and landfills are fairly common. In most cases these are manageable and such incidents are not destructive enough to attract attention beyond these facilities. However, over the years there have been a few notable devastating fires at such facilities.

In each of these industrial processes there is an inherent increase in temperature as a consequence of the biological activity. Indeed such a temperature increase is one of the goals of the composting waste. Elevated temperatures of the order of 70-90 degrees celsius have been documented within a few months (or even a few days) of forming the compost pile. Although the basic theory of spontaneous combustion relating to organic materials is well understood, there has been very little work undertaken with regard to the mechanism for fires involving biological self-heating.

In this work we formulate and investigate a uniformly distributed mathematical model (based upon Semenov's theory) for the thermal response of cellulosic materials in compost pile. The model consists of mass balance equations for oxygen and energy equations. The model incorporates the heat release due to biological activity within the pile. Biological heat generation is known to be present in most industrial processes handling large volumes of bulk organic materials. we utilize dynamical systems theory, in particular singularity theory, to investigate the generic properties of the model, as well as to determine the critical sizes of the compost piles under various conditions.

Keywords
analyse, theory, singularity, piles, compost, heating, self, model, uniform, spatially

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