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Full Length Article

Scale effects and mechanisms ruling the onset of wastewater sludges self-heating

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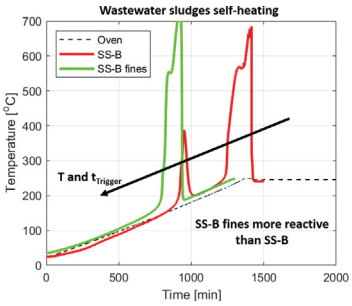
GRAPHICAL ABSTRACT



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ABSTRACT

We investigated the autoignition and self-heating of three different dried, wastewater treatment sludges of different origin and share of municipal and industrial waste water. We used a custom testing apparatus to study large (approx. 20 g) samples, where heat- and mass transfer limitations are purposely relevant, as in real scale applications. We tested different particle size distributions, applying heating rates between 0.1 and 6.0 °C/min. We proved that i) ignition can occur in more than one step, ii) the same solid behaves very differently by changing its particle size distribution and the applied heating rate, iii) the onset is controlled by physical processes, rather than chemical, iv) the hazard is determined (and can be controlled) by modifying the particle size, the bed structure and density. We conclude that the hazard of self-ignition and heating is largely controlled (thus manageable) by the physical properties of the solids and its packing, given that its reactivity in air is always sufficiently high, once appropriate (and common) environmental conditions are met. Consistently, the self-heating hazard assessment requires investigation at a representative scale, where physical processes have an appreciable impact. Conclusions obtained on sludges are expected to apply to any biomass, with comparable properties.

1. Introduction

The expanding interest in biomass exploitation as a C-neutral source of energy calls for deeper understanding of the threads in biomass treatment and manipulation. Here we address the spontaneous self-heating up to ignition. We focus on a largely available, specific type of

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