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Lecture #2



13:00 CET



UNDERSTANDING AND PREDICTING TEMPERATURES IN MUNICIPAL SOLID WASTE LANDFILLS

There are reports of landfills, permitted to accept municipal solid waste (MSW) and other non-hazardous wastes, exhibiting temperatures in excess of 80 – 100 °C in the U.S.. These temperatures are well above values typically associated with MSW landfills, which are reported to range between 40 and 65 °C, and generally below 55 °C.

Landfills exhibiting elevated temperatures over a large area are referred to as elevated temperature landfills (ETLFs). ETLFs have unique characteristics and challenges, including substantial changes in the composition and quantity of landfill gas (LFG) and leachate, fugitive gas emissions, rapid waste subsidence, and in some cases, elevated liquid and gas pressures. These conditions, alone or in combination, may affect the waste containment system - engineered barriers (liners and covers), gas and leachate collection infrastructure, and the physical stability of the waste mass.

The objective of the research to be presented was to develop a mathematical model to predict heat generation, transport and accumulation from biological and chemical reactions that occur in MSW landfills. Initially, a batch reactor model was developed to identify an appropriate mathematical approach for the representation of heat generation sources including aerobic and anaerobic biological reactions, anaerobic metal corrosion, acid-base reactions, ash hydration and carbonation, and pyrolysis. The model predicted a temperature of about 55 °C for MSW only. The inclusion of ash hydration and carbonation, and Al corrosion resulted in temperature rises of 14 and 26 °C in 10 years, respectively. The landfill temperature and reactant concentrations do not vary spatially in a batch reactor model which represents an important limitation in representing landfills.

To better represent the temperature evolution in landfills, a multi-physics transient 3D finite element model has been developed to simulate spatial variations in waste properties and concentrations of materials that contribute to heat accumulation such as ash, oxygen, and aluminum. This model developed simulates liquid-gas-heat coupled reactive transport and landfill-relevant heat generating reactions while accounting for conductive heat transfer, convective heat transport as well as heat removal mechanisms including leachate collection, gas extraction, evaporation, the impacts of waste disposal strategy, and boundary conditions. Model simulations illustrate the effects of boundary conditions and landfill geometry, as well as the effects of ash disposal in the center and at the edge of a hypothetical landfill. Finally, the model has been applied to a southeastern landfill exhibiting elevated temperatures.



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Dr. Morton A. Barlaz is Distinguished University Professor of the Department of Civil, Construction, and Environ. Engin. at North Carolina State University. He received a B.S. in Chem. Engin. from the University of Michigan and an M.S. and Ph.D. in Civil and Environ. Engin. from the University of Wisconsin in 1988. He joined NC State in 1989 and served as Department Head from 2010 - 2022.

He has been involved in research on various aspects of solid waste since 1983 including biological refuse decomposition, methane production, the fate of hazardous wastes in landfills, policies for the long-term management of landfills, and factors contributing to heat generation and accumulation in landfills. He is also recognized for his research on the use of life-cycle analysis to evaluate emissions associated with alternate solid waste management strategies.

Dr. Barlaz is the author of over 150 peer-reviewed publications and has made hundreds of presentations at conferences throughout the world.

Dr. Barlaz served as co-Editor-in-Chief of Waste Management from 2018-2020 and has served as co-chair of the Global Waste Management Symposium since 2008.

He was awarded the Gordon Maskew Fair Award by the American Academy of Environ. Engin. and Scientists, both the Perry L. McCarty Founders' Award and the Frederick George Pohland Medal by the Association of Environ. Engin.and Science Professors (AEESP), the Richard I. Stessel Waste Management Award by the Air & Waste Management Association and is a Fellow of the American Society of Civil Engineers, AEESP and the American Association for the Advancement of Science.