12th North American Waste to Energy Conference
May 17-19, 2004, Savannah, Georgia USA
NAWTEC12-2232

Modeling of Solid Waste Flow and Mixing on the Traveling Grate of a Waste-to-energy Combustion Chamber

MASATO NAKAMURA AND N. J. THEMELIS

Earth Engineering Center, Columbia University
500 W 120th Street, 918 Mudd
New York, NY 10027
Tel.: (212) 854-2142 e-mail: mn2028@columbia.edu

Keywords: mass burn, moving grate, mixing, Martin grate, Markov Chain, mathematical modeling, combustion, municipal solid wastes, waste-to-energy, WTE

Abstract

Mixing of the highly non-homogeneous municipal solid wastes (MSW) on the traveling grate of mass-burn combustion chambers assists the combustion process in waste-to-energy (WTE) facilities. A matrix-based Markov chain model was developed to simulate particle flow and mixing as the solid waste particles travel over a reverse acting Martin grate. The model was used to project the pathway of a solid waste particle over a time series, in the bottom layer of the bed that is in contact with the bars of the grate. Further analytical and experimental work is planned in order to develop this model to a useful tool for designing future moving grate systems and increasing the combustion efficiency of existing WTEs.

1. Introduction

Simulation of the physical and chemical processes in moving beds is used widely to study combustion and other chemical reaction phenomena in gas-solid systems. Three general types of mathematical models are used for investigating the transport and chemical reaction phenomena in mass burn combustion chambers: Computational Fluid Dynamics (CFD), bed models, and stochastic models. CFD models simulate the fluid flow, heat and mass transfer, and reaction phenomena in the combustion chamber above the traveling grate by solving numerically the continuity and energy conservation equations and the Navier-Stokes equations (conservation of momentum). Numerical bed models of solid waste combustion have been developed since the early 1970s [1]. More recently, Yang, Swithenbank et al at Sheffield University [2] developed a two-dimensional program, called the Fluid Dynamic Incinerator Code (FLIC). FLIC is graphically interactive and is widely used by WTE engineers to simulate the physical and chemical transformations involved in the drying, volatilization and combustion processes on the grate; however, the combustion process is modeled using typical or average data such as composition, particle size, density and heating value, even though MSW is a very non-homogeneous fuel [3]. Stochastic models, such as the one described in this paper are relatively new, although some researchers have suggested combining mixing models of the traveling bed with experimental work [4].