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New Development in EfW Boiler Process Modeling: Fully Integrated CFD Model

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ABSTRACT

This paper focuses on a Computational Fluid Dynamics (CFD) application to Energy-from-Waste (EfW) boiler systems, which are much smaller than utility boilers, but typically have more complicated design and performance issues due to the nature of their fuel: municipal solid waste (MSW). The majority of the commercially available CFD software packages have impressive capabilities in homogeneous flow modeling, which make them very suitable for gas fired boilers and with some reasonable simplifications to oil and pulverized coal fired boilers. But this is not the case for EfW boilers, especially mass-burn technology, where MSW combustion on the grate is the "heart" of the process. These boilers have two interacting phases: MSW burning on the grate and combustion products with entrained fly ash particles above the grate.

This challenge has been recognized from the very first applications of CFD modeling in the EfW industry. This paper describes several approaches to numeric modeling of MSW boilers. In the most successful cases, two different models have been built: one for the grate combustion and another for the homogeneous gas flow, with back-and-forth iterations between these two models. Such an approach has given Covanta Energy (Covanta) a good start in its CFD modeling program. A number of models have been built, tested and validated, resulting in several successful project executions. However, some serious limitations have been found in this approach as explained in this paper.

Recognizing these deficiencies, Covanta has recently made a new significant step in its CFD development program by creating an innovative, fully integrated CFD model that comprises solid fuel combustion on the grate, gaseous phase interactions above the grate, and the rest of the boiler. While this integrated model and its validation are still in progress, Covanta is moving forward on its application to on-going projects.

Key words: *Computational Fluid Dynamics, Waste-To-Energy boiler, radiation coupling, Discrete Phase Model*

Introduction

Over the last decade Computational Fluid Dynamics (CFD) models have become more widespread in the energy industry. Due to the combination of significant progress in CFD software capabilities and "user-friendliness," the tremendous boost in computational power of modern computers, and an increased number of highly educated, skilled and CFD-trained engineers, CFD process modeling has been spreading from academic institutions and research centers to many engineering firms and operating companies. CFD capabilities in temperature and flow pattern investigations, and in simulations of complex chemical reactions and heat transfer, are rapidly gaining more recognition and respect in the industry. A number of very successful CFD-based projects in Low-NO_x combustion, boiler modification, and air pollution control equipment optimization have proved the practical value of this engineering tool and its huge potential for future applications.

The majority of these CFD packages were originally developed for homogeneous (gas phase) flow modeling. It made them very suitable for gas fired boilers, and with some reasonable simplifications, to oil and pulverized