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MODELLING THERMAL AND FLUID-DYNAMIC PHENOMENA IN THE COMBUSTION CHAMBERS OF INCINERATION PLANTS

Fausto Arpino[a], Michela Costa[b], Nicola Massarotti[b,c*,§]

[a] Università degli Studi di Cassino e del Lazio Meridionale, Cassino, Italy
[b] Dipartimento di Ingegneria, Università degli Studi di Napoli "Parthenope", Napoli, Italy
[c] Istituto Motori del Consiglio Nazionale delle Ricerche, Napoli
[§]Correspondence author. Fax: +39 081 5476777
Email: massarotti@uniparthenope.it

ABSTRACT

Waste incineration, even though at the bottom of the waste hierarchy below reduction and recycling, is still today an critical technology for Waste Management in developed countries. In the near future, also in developing countries may adopt it, especially if some of the common issues of the technology are properly tackled.

The costs and complexity of these systems is evidently related to the emissions management and control, and it represents one of the main concerns in waste incineration. In order to reduce the overall environmental impact of incineration plants, it is very important to control combustion and treat its products, including recovery of energy form the process. For this reasons, it is extremely important to be able to model thermal and fluid dynamic phenomena that occur in the in the combustion chambers of incineration plants. Numerical modelling has become a relevant part of the design, operation and control of waste-to-energy plants. However, the phenomena involved are very complex even with the aid of advanced computational tool available today. Many approximations are needed to obtain a simulation of these phenomena and in most cases, for full scale problems, it is not possible to validate the results also due to difficulty of measuring the quantities of interest.

This work presents the main approaches for the simulation of combustion chambers of waste to energy plants, developed by the author and his colleagues over the last ten years, together with the results obtained for different Waste-to-Energy plants that process waste derived fuel in Italy.

The combustion chambers of these plants have been modelled, and the thermo-fluid-dynamic fields have been compared to the measurements available for these plants.

The results mainly concern the velocity and temperature distributions in the vertical channels of these plants, with the concentration of the species produced in the chambers. The simulations also allow to predict the temperature and residence time of the combustion products in the first vertical channel of the plants. The effects of the boundary conditions and modelling approaches used on the fluid-dynamic and temperature field in this part of the channel has been analysed. The results show the need for proper validation of these type of simulations.