MODELLING OF FURNACES AND COMBUSTION SYSTEMS

(687) - NUMERICAL STUDY OF BIOMASS COMBUSTION IN AN INDUSTRIAL GRATE-FIRED BOILER

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The tightening of the environmental regulations in the last decades has motivated the improvement of accurate design techniques to optimize the combustion process, new technologies and simultaneously control pollutant emissions to the environment from biomass combustion. Furthermore, as biomass combustion is a complex process that involves several phenomena, it is necessary to obtain more insights into the conversion process.

In this sense, numerical simulations appear as a helpful tool since they allow us to model real and complex physical phenomena and, therefore, enable us to reproduce the behavior virtually. In the specific case, biomass combustion inside industrial boilers can be used to study and visualize how they work with graphical contours. In this way, numerical simulations have the advantage of limiting the risks and costs of direct experiments. It also enables us to test several scenarios to optimize and validate industrial boilers' final design or operating conditions in a more straightforward manner.

The present paper presents a preliminary development of a 3D transient numerical model for the combustion of forest residues particles in an industrial grate-fired boiler to characterize the combustion inside the equipment. This model used the eXtended Discrete Element Method, advanced simulation technology for multi-physics applications, consisting of a coupling between the discrete element method and computational fluid dynamics. This approach considers the solid biomass particles as discrete elements interfaced via heat, mass, and momentum transfer to the surrounding gas as a continuous phase.

To perform the numerical simulations, the nominal operating conditions in a specific industrial vibrating grate-fired boiler were used, and data about the plant's performance from meters installed on the combustion chamber and other places, along with the flue gas and water/steam circuit, were collected during a 12 days experimental campaign to validate the model.

The developed model proves to be a valuable tool to predict biomass conversion, and it can be used to obtain more knowledge about the combustion in a grate-fired boiler. With this work, the approach used to develop the numerical model was validated with data collected in the boiler and, in the future, parametric studies to investigate the influence of fuel properties, combustion air, and grate movement in the combustion process will be performed to understand how it is possible to improve the combustion efficiency and reduce the pollutants emissions. Consequently, the results will contribute to industry-academic collaboration applying scientific research to understand and improve the performance of an industrial boiler.

Palavras-chave : Biomass, Boiler, CFD, Combustion, Modeling