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Abstract ID : **456**

Numerical Analysis of Interaction between a Reacting Fluid and a Moving Bed with Spatially and Temporally Fluctuating Porosity

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The purpose of this study is to propose a numerical approach that combines low computational costs through the use of high computing efficiency, allowing the realistic use of the design with a sufficient result's accuracy for industrial applications to investigate biomass combustion in a large-scale reciprocating grate.

In the present contribution, a Biomass combustion chamber of a 16 MW geothermal steam super-heater, which is part of the Enel Green Power "Cornia 2" power plant,is being investigated with high-performance computing methods. For this purpose, the extended discrete element method (XDEM) developed at the University of Luxembourg is used in an HPC environment, which includes both the moving wooden bed and the combustion chamber above it. The XDEM simulation platform is based on a hybrid four-way coupling between the Discrete Element Method (DEM) and Computational Fluid Dynamics (CFD). In this approach, particles are treated as discrete elements that are coupled by heat, mass, and momentum transfer to the surrounding gas as a continuous phase. For individual wood particles, besides the equations of motion, the differential conservation equations for mass, heat, and momentum are solved, which describe the thermodynamic state during thermal conversion. The grate system has three different moving sections to ensure good mixing of the biomass parts and appropriate residence time. The primary air enters from below the grate and is split into four different zones. Furthermore, a secondary air is injected at high velocity straight over the fuel bed through nozzles. A Flue Gas Recirculation is present and partly injected through two jets along the vertical channel and partly from below the grate.

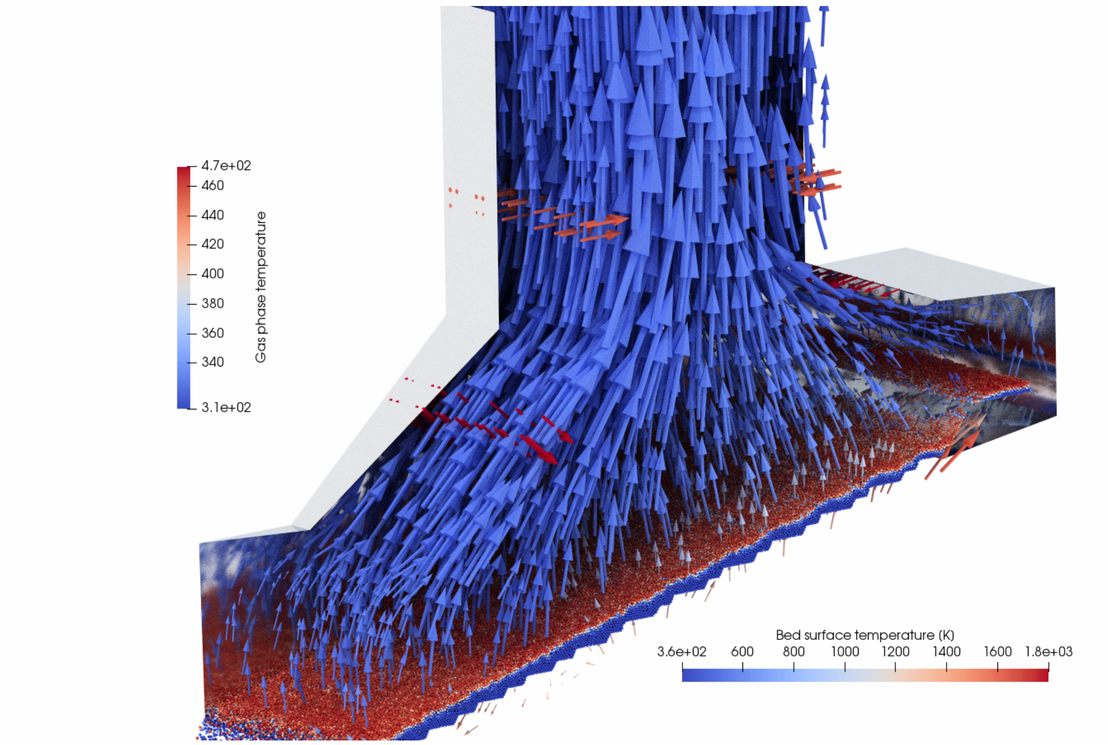

Figure 1: Velocity arrow, bed surface and gaseous phase temperature

The numerical 3D model presented is based on a multi-phase approach. The biomass particles are taken into consideration via the XDEM Method, while the gaseous phase is described by CFD with OpenFOAM. Thus, the combustion of the particles on the moving beds in the furnace is processed by XDEM through conduction, radiation and conversion along with the interaction with the surrounding gas phase accounted for by CFD. The coupling of CFD-XDEM as an Euler-Lagrange model is used. The fluid phase is a continuous phase handled with an Eulerian approach and each particle is tracked with a Lagrangian approach. Energy, mass and momentum conservation is applied for every single particle and the interaction of particles with each other in the bed and with the surrounding gas phase are taken into account. An individual particle can have a solid, liquid, gas or inert material phases (immobile species) at the same time. The different phases can undergo a series of conversion through various reactions that can be homogeneous, heterogeneous or intrinsic (drying, pyrolysis, gasification and oxidation).

Our first results are consistent with actual data obtained from the sampling of the residual solid in the industrial plant. Our model is also able to predict gas flux behaviour inside the furnace, particularly the flue gas recirculation on the combustion process injection.

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