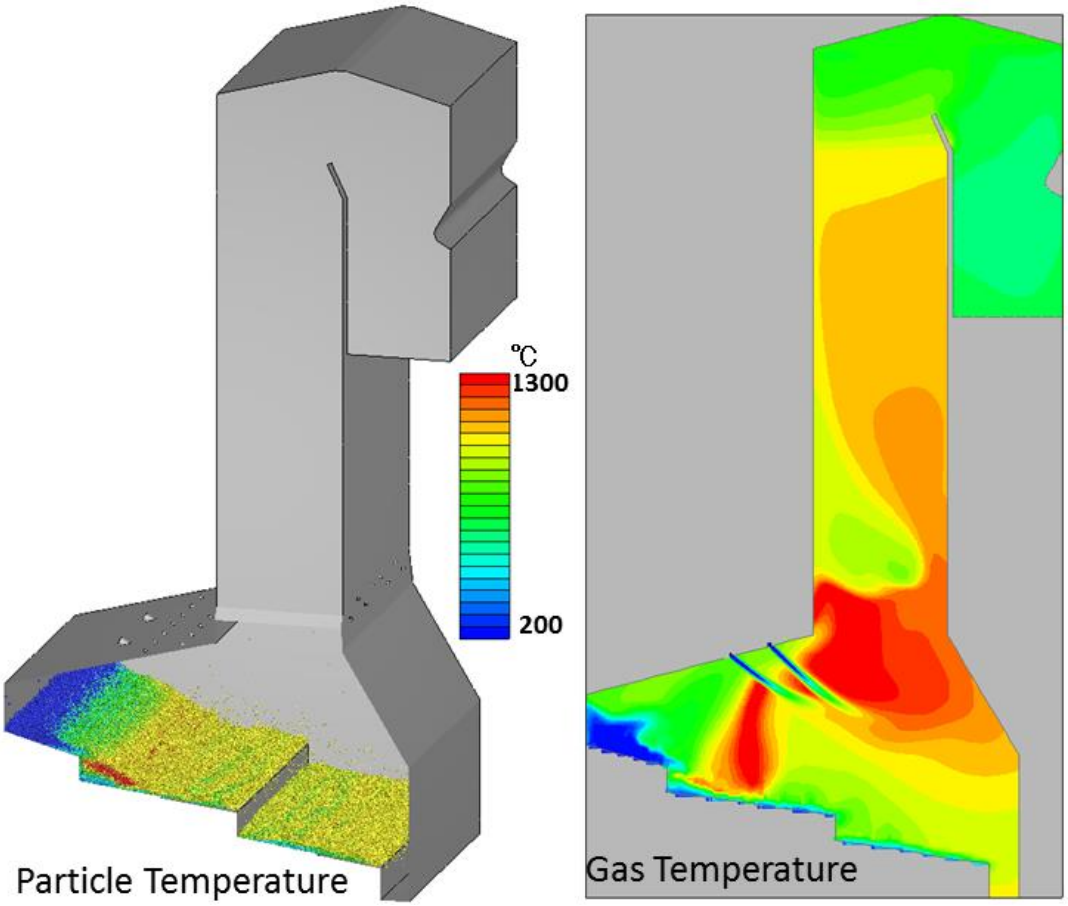
Combustion Simulation of Municipal Waste in Stoker Incinerator

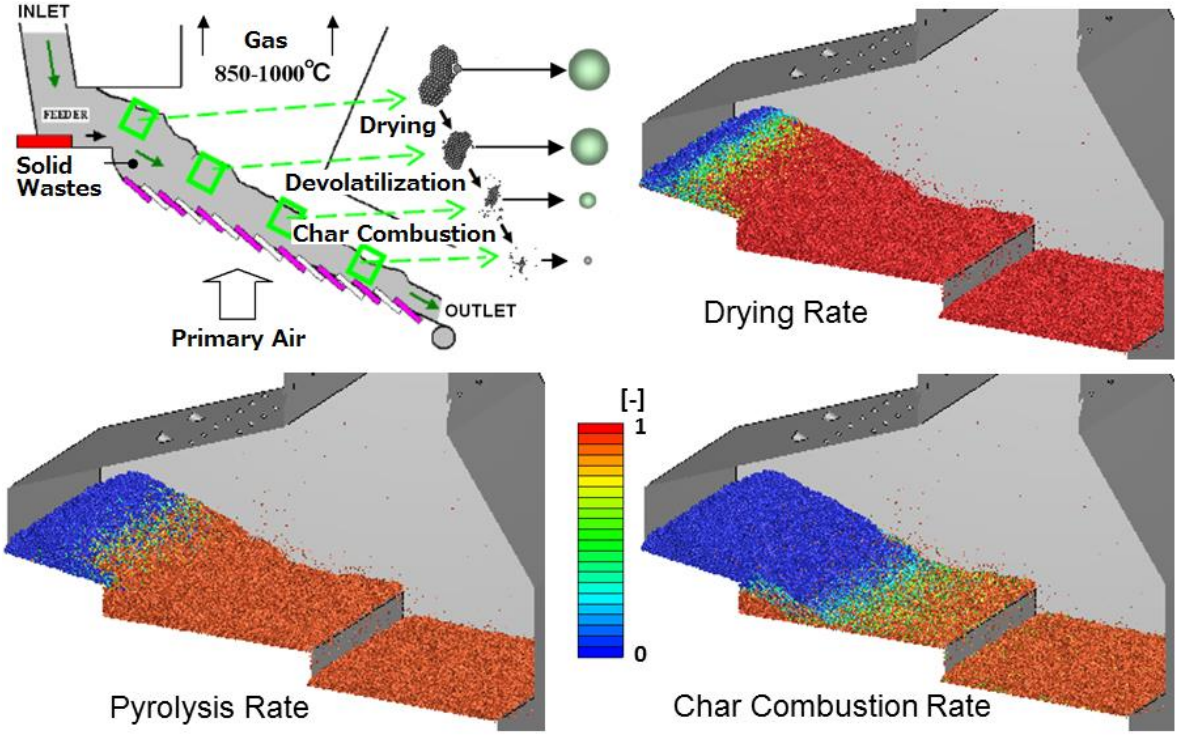
The municipal solid waste combustion process in a stoker-type incinerator with a capacity of 750 t/day, constructed several years ago in Guangdong Province, China, is numerically simulated. In the simulation, our originally developed "Representative Particle Model" [1, 2], which is a pioneer of the DEM (Discrete Element Method) based coarse-grained model, is used to simulate the behavior and combustion process of solid waste particles, coupled with the compressible flow of reactive gases and the radiation field. In addition, the combustion of solid waste particles is modeled in three stages: water evaporation, devolatilization (pyrolysis), and fixed carbon (char) combustion. Furthermore, each concentration component of reactive gases produced and extinguished during combustion process is also simulated such as Oxygen (O_2), water vapor (H_2O), carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4) and hydrogen (H_2).



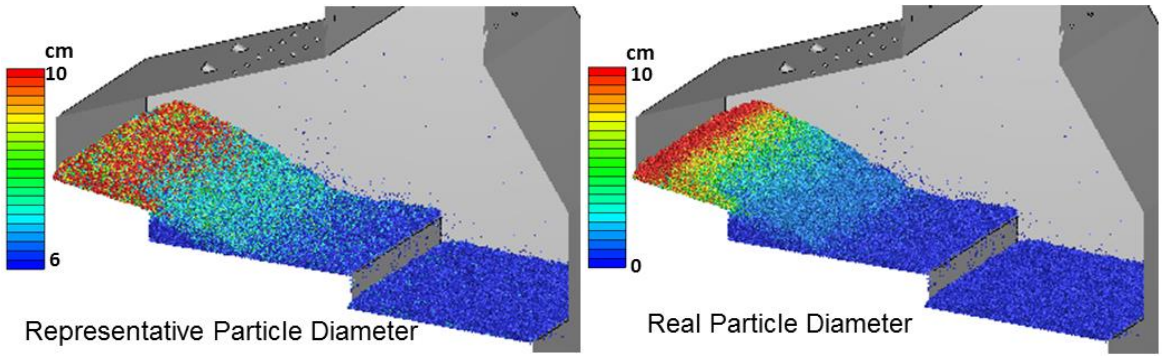
References

Takeda, H., Granular flow simulation by continuum model, J. Soc. Powder Technol., Japan. **40** 746-754 (2003)

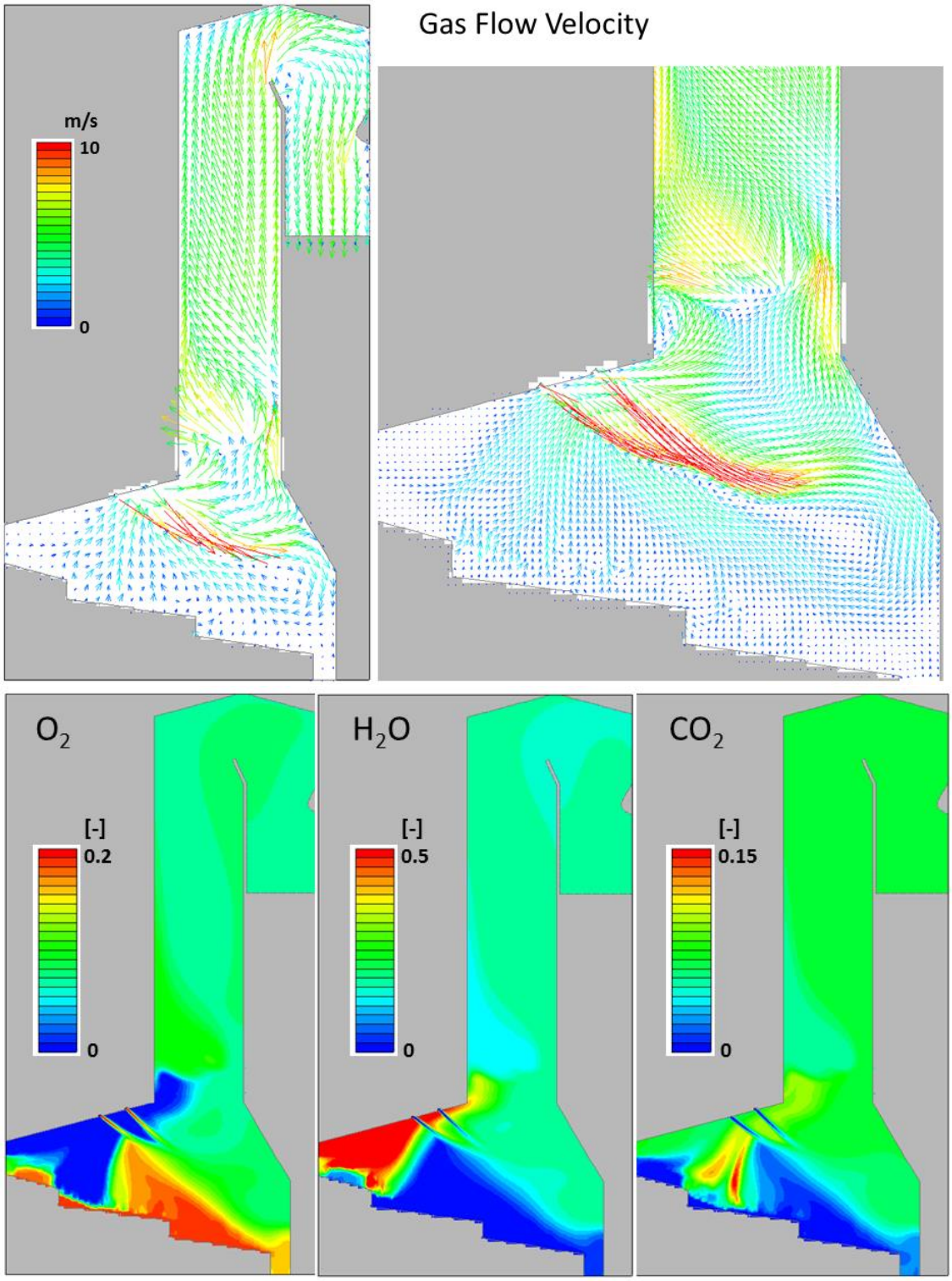
Takeda, H., Granular flow simulations in the industrial sector, J. Soc. Powder Technol., Japan. **50** 264-271 (2013)



The combustion process of solid waste particles is simulated in three stages: water evaporation, devolatilization (pyrolysis), and fixed carbon (char) combustion.



In the representative particle model, both the representative particle diameter (used to calculate the contact between particles) and the real particle diameter (the particle diameter of actual solid waste particles) change as the combustion progresses. The representative particle diameter is determined to reflect the particle volume decrease (mass decrease and density change). On the other hand, the actual particle diameter change is given as a simulation condition considering not only the change of the representative particle diameter but also the cracking of solid waste particles. In practice, the actual particle diameter distribution is specified at the time of waste particle generation and at the time of completion of combustion (when the particles are reduced to ash), and the intermediate stage is calculated by interpolation. Considering the actual particle diameter distribution at the completion of combustion and specifying it from the order of microns to cm as a simulation condition, the ratio of main ash to fly ash can be controlled indirectly.



Concentration (volume fraction) distributions of reactive gases. In addition to oxygen (O_2), water vapor (H_2O) and carbon dioxide (CO_2), concentrations of combustible gases such as carbon monoxide (CO), methane (CH_4) and hydrogen (H_2) are also simulated.