A Numerical Approach for Softening and Melting of Particles in Packed Beds

Wenjing Yang[1)], Zongyan Zhou[2)], Aibing Yu[2)], David Pinson[3)]

[1]Science and Technology on Combustion, Internal Flow and Thermal-Structure Laboratory, Northwestern Polytechnical University, Xi'an 710072, PR. China
[2]Department of Chemical Engineering, Monash University, Clayton, VIC 3800, Australia
[3]BlueScope Steel, P.O. Box 202, Port Kembla, NSW 2505, Australia
Presenting author: yang_wenjing@qq.com
Corresponding author: zongyan.zhou@monash.edu

ABSTRACT

The cohesive zone, where ore particles soften and melt into liquid, plays a significant role in determining the layer permeability and structure, hence the flow of gas and liquid in a blast furnace. In this paper, the softening and melting behaviour of particles, coupled with gas flow and heat transfer, is investigated by means of the combined approach of computational fluid dynamics (CFD) for gas phase and discrete element method (DEM) for solid phase. In connection with the previous experimental study, wax and glass particles are used to simulate ore and coke particles, respectively, and the particles are arranged in different alternative layers in a packed bed to simulate the furnace operation. The effects of different variables such as layer configurations and gas properties on the softening and melting of wax particles are examined. It is demonstrated that the layer thickness and position have an obvious effect on the layer deformation and permeability, and hence gas flow; improved gas flow can be achieved in multiple layer operations. The approach and findings should be useful to the establishment of a comprehensive picture about softening and melting behaviour of particles, and its effect on blast furnace operation.

Keywords: particle softening and melting, blast furnace, cohesive zone, discrete element method, computational fluid dynamics