Discrete Element Modelling of a charging program in a scaled bell-less top blast furnace model

Tamoghna Mitra*, Henrik Saxén

Thermal and Flow Engineering Laboratory, Åbo Akademi University,
Biskopsgatan 8, FI-20500 Åbo, Finland
E-mail: tmitra@abo.fi, hsaxen@abo.fi
web page: www.abo.fi/institution/en/varmeteknik

ABSTRACT

The burden distribution in the ironmaking blast furnace plays a significant role for achieving smooth operation under low coke rate and high utilization of the reducing gases in the process [1]. The burden distribution is controlled in a blast furnace with bell-less top charging equipment, i.e., with a rotating chute, the operator chooses a charging program by adjusting material dumps and chute angles. The charging program consists of a sequence of layers of coke and “ore” (in practice sinter or pellets), which differ largely in density, size and shape: The pellets are more than four times heavier, their shape is spherical by contrast to the irregular shape of coke, and their diameter is only about one fifth of that of coke. In the practical operation, it is almost impossible to directly monitor the layer formation and burden descent in the furnace. Furthermore, different complex phenomena associated with blast furnace charging, such as particle segregation, coke-ridge collapse and mixed layer formation make this even more difficult to predict the burden distribution.

In this work, Discrete Element Models (DEM) for a few typical charging programmes in a furnace section were developed using an open-source code, LIGGGHTS [2] and a commercial alternative, EDEM [3]. The coke particles were treated as spherical and as clumped spheres, and their effect was studied. The results were then compared with experiments performed using a 1/10 scaled model of an actual blast furnace charging system. The general behaviour of the particles showed good correspondence with experimental results. In addition, some effects like coke-ridge collapse which are difficult to quantify in experiments were studied using the models. The effect of coke-ridge collapse on the actual and perceived porosity from experiments is also discussed.

REFERENCES

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[3] DEM Solutions Ltd. EDEM, http://www.dem-solutions.com