MODELLING OF FURNACES AND COMBUSTION SYSTEMS

(670) - (*) - SIMULATION OF GRANULAR FLOW AND HEAT TRANSFER IN THE BULK BED OF ROTARY KILNS

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Rotary kilns are widely used in industries for the homogeneous thermal treatment of granular material. As the kiln rotates around the axis direction, the bulk bed undergoes both axial and transverse motion. The homogeneous distribution of the bed material in the kiln enables the particles to fully exchange heat with the flame, the hot gas and the kiln wall, then the bulk bed can obtain a uniform temperature and product quality. Therefore, the heating performance of rotary kilns is closely related to the movement of particles. However, the particle motion in the kiln is affected by many parameters like the kiln design, the operating conditions and the material properties.

In this study, a mathematical model for the transverse thermal bed mixing is presented by coupling the DEM (discrete element method) with the heat transfer mechanism inside the bulk bed. Besides, the heat convection between particles and process gas is considered and evaluated by a DEM-CFD (computational fluid dynamics) coupling model. The models are validated with experiments in a batch operated indirectly heated rotary kiln with an inner diameter of 0.6 m. The particle mixing behavior is analyzed under various drum filling degrees (10 – 20%) and different rotational speeds (1 – 6 rpm). To study the granular flow, the parameters in terms of dynamic angle of repose, particle velocity and the number of particle revolutions are presented. Moreover, during the mixing process, the temperature profiles of solids at different axial, radial and circumferential positions are analyzed to investigate the particle heat transfer behaviors. As a final result, this model can optimize the operational process of the rotary kiln, provide theoretical guidance for industrial production, and ensure product quality.

Palavras-chave : Rotary kilns; Heat transfer; Granular mixing; Numerical simulation