Analyses of Dust Emissions at Transfer Points: Comparison of Two-Way Coupled DEM-CFD Simulations and Industrial Implementations

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Abstract

The reduction of dust emission is an issue in various sectors and especially crucial in the conveying technology. Continuous bulk material flow processes, like in transfer points, are one of the critical topics according to dust emission. Therefore, the results of the investigations based on full-scale simulations and industrial implementations are presented within this paper.

Previous research work describes the prediction of dust by simulation. Examples can be found on transfer chute design e.g. by Goniva et al. (2012) [1], Chen et al. (2012) [2] and Katterfeld et al. (2010) [3]. A further option is the estimation of dust emissions according to the guidelines of VDI (VDI 3970) [4]. These guidelines employ e.g. the speed of out flowing air to give a rough estimation of the emitted dust.

This paper deals with a two-way coupled combination of the approaches of the Discrete Element Method (DEM) and Computational Fluid Dynamics (CFD), which is utilized to visualize the diffuse dust emission at a full-scale transfer point. The implementation of dust particles within the simulation is achieved by the method of Discrete Dust Particles (DDP), which was developed by the Chair of Conveying Technology and Design Methods (Montanuniversität Leoben) and presented in previous publications [5, 6]. The following figures (Fig. 1-3) illustrate several results of simulation analysis. Figure 1 presents the DEM simulation result of a transfer point option with DDP (red) and Figure 2 furthermore shows a comparison of the maximum air velocities. The emitted DDP of the different transfer point designs are opposed in Figure 3. The simulations provide qualitative estimations of dust emission and are used to develop improvements in transfer point design. These improvements are subsequently implemented at a representative transfer point at the steel plant of VoestAlpine Stahl Donawitz GmbH in Leoben, Austria, where the dust emission is monitored. The output of these dust measurements is furthermore compared to the results of the simulation evaluation. Thereby the simulation results and the dust reducing measures may be validated. Present work handles a calibration process to obtain a quantitative statement of dust emission by two-way coupled DEM-CFD simulation with DDP.

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Keywords: DEM-CFD, Diffuse Dust, Simulation, DDP, Transfer Point.
Fig. 1. Full-scale two-way coupled DEM-CFD simulation with Discrete Dust Particles (DDP) of a transfer point with deflection chute and spoon without settling area.

Fig. 2. Maximum air velocity over time of different transfer point options by simulation.
Fig. 3. Comparison of total emitted Discrete Dust Particles (DDP) over time of the different transfer point options by simulation

References


