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Numerical simulation of an industrial spray dryer

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This paper presents a three dimensional simulation of an industrial scale spray dryer employed by ceramic tile industries through the use of CFD - Computational Fluid Dynamics, techniques. A previous work presented in Qualicer 2002 [Favalli, R. C., Pimenta, M. M.; Paschoal, J. O. A. Numerical simulation of spray dryers. Conference on Ceramic Tile Quality, 2002, Castellón.] showed the preliminary results of a laboratory scale spray dryer simulation in two dimensions. Therefore, the present work represents a significant improvement on the subject of numerical simulation of spray dryers employed by the ceramic tile industries.

An A/S NIRO Atomizer equipment installed in the 1980's at Pilkington's Tiles, Poole, UK is the dryer simulated here. The air inlet is at the top of the chamber and the air flow of hot air is made approximately parallel to the axis by L-shape vanes. The slurry is injected at mid chamber height by pressure nozzles in a fountain mode. The air is pumped out through a protruding pipe at the side of the chamber, passing by the cyclone and filter to retain finer granules to finally be released to the atmosphere. The material collected by the cyclone is returned to the bottom of the dryer to be stored with the rest of the produce. The domain of interest for the simulations is the drying chamber only. STAR-CD, STAR*design* and Pro*Am, all from Computational Dynamics - Adapco Group, were respectively the software employed in the numerical simulations, spray dryer virtual design and computational mesh generation.

Results from the simulations include velocity and temperature profiles of the air flow inside the spray dryer chamber before and after the injection of the ceramic slurry. In the study case presented here, droplets of alumina suspension were injected using 12 nozzles symmetrically displayed inside the dryer. The influence of droplets injection on the gas acceleration and cooling in the whole drying chamber is presented. Calculated parcels track inside the dryer is also showed in this paper.

For the model validation, however, it is necessary to compare simulated results with experimental data, which is unfortunately not available in the literature. Hence, a great effort must be done by the ceramic tile community towards the establishment of a database for spray dryers of ceramic slurry as well as for wet and dry material properties. With a validated model, improvements on the operation and design of spray drying systems could be made through the use of CFD tools with relative easiness, cutting down on the number of experimental runs that would be otherwise necessary to optimize the drying system.