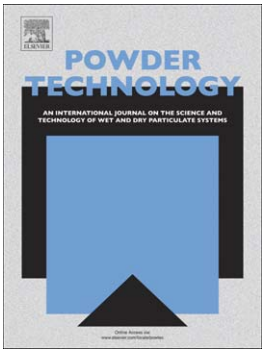

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Process Modelling of Low Temperature Electrostatic Precipitators

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Abstract

Wet type electrostatic precipitators (ESPs), or Cold ESPs can effectively remove particulate matters, particularly fine particles ($PM_{2.5}$), from flue gases. The present paper describes a numerical model for assessing ESPs' performance, considering a series of factors including dust layer resistivity, dewpoint, acid condensation, electric field distribution, particle charging and gas-particle flow. The roles of sulfur trioxide (SO_3) in the flue gas and temperature are analysed together with case studies. Without SO3 in flue gas, the collection efficiency of the dry ESP is controlled by the dust layer resistivity. With SO_3 present, different physics are involved, which are considered according to the following steps: Firstly, the acid dewpoint and acid condensation are calculated based on mass balance and phasic equilibrium. Then the electric field around a dielectric sphere and the field charging mechanism in relation to wet particles are discussed. An effective electric permittivity for a composite sphere is verified by a sub-particle scale electric field simulation and implemented in a wet particle charging model. The collection efficiencies for ash particles with dielectric constant of 3.9-80 are predicted over a wide range of particle sizes from 0.02 to 25μm under various conditions. Some questions of industry interest have been clarified by both qualitative and quantitative manners.

Keywords: CFD; Numerical simulation; acid condensation; collection efficiency; dust resistivity