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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 SO_3 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 25 μm 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

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