Performance of a Spiked Electrode-Plate Precipitator for Collecting Submicron Dust Particles

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Abstract*— A 3D hybrid Finite Element (FE)-Flux Corrected Transport (FCT) numerical algorithm is proposed to evaluate the electrical characteristics of a laboratory scale single spike-plate electrostatic precipitator and to predict the collection of submicron particles with diameters in the range of 0.25-1.5 µm. The precipitator consists of two parallel collecting plates with a spike electrode mounted at the center, parallel to the planes and excited with a high negative dc voltage. The complex interaction between the electric field, fluid dynamics and the particulate flow in this precipitator are taken into account in the simulation. Particles are assumed to be charged by combined field and diffusion charging mechanisms. The motion of submicron particles under electrostatic and aerodynamic forces in turbulent flow is calculated using a Lagrangian-type Discrete Random Walk (DRW) model and several User Defined Functions (! UDFs) have been developed for use in the commercial FLUENT 6.2 software. The electrohydrodynamic secondary flow patterns, particle migration velocity patterns and particle collection efficiencies were examined for three different corona discharge electrode configurations: spikes located only on one side of the electrode with the tips directed either upstream or downstream of the channel, and spikes located on both sides. For a given particle concentration at inlet, the particle deposition rate along the channel and the average charge-to-mass ratios were evaluated for different particle sizes and applied voltages. Finally, the influence of particle concentration on particle collection efficiency for an ESP with spikes on two sides is investigated for -30 kV applied voltage. In selected cases, the numerical results are compared with the existing experimental data.