Computational Fluid Dynamics Approach to Evaluate Electrostatic Precipitator Performance

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Abstract

Electrostatic precipitation is an extremely efficient way of filtering fine particles from the airstream. Electrostatic precipitators (ESPs) can control airborne emission without significantly slowing down the rate of flow, because of the low pressure drop across this type of filters.

A computational model was developed for the simulation of ESP operation and the parameters of interest were evaluated by COMSOL Multiphysics®. The model proposed takes into account the coupling between gas, electric fields, and particle trajectories.

The simulation was structured as follow: First, the Turbulent Flow, SST interface in the CFD Module was applied for stationary fluid flow simulation, then Electrostatics and partial differential equation (PDE) interfaces were used to simulate stationary electrostatics. Lastly, Particle trajectories were evaluated by Time-dependent particle motion using Particle Tracing for Fluid Flow physics interface.

This paper also demonstrated the important criteria in the design of collection plates to increase the particle trapping mechanism and reduce the particle re-entrainment at the collecting section. The numerical results allow for estimation of ESP performance and can be considered as a valuable tool in the development of this type of technology in air filtration systems.