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AN IMPROVED MODELING FOR PREDICTION OF PM2.5 COLLECTION EFFICIENCY IN ELECTROSTATIC PRECIPITATORS

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Abstract

In this work, PM2.5 removal mechanism was explored to investigate PM2.5 collection efficiency under the influences of applied magnetic field and diffusion charging (the main charging mode for submicron particle). The proposed electrostatic precipitators (ESPs) mathematical model considered three-field interaction between fluid field, electromagnetic field and particle dynamic field. CFD software FLUENT was used to generate the simplified solid structure of the ESP. In numerical calculation, the mathematical expressions for charge of dusty particles, drag force, electric force and Lorentz force were and input by using UDF. Deutsch-Anderson formula was applied to process and analyze CFD numerical solution to obtain the grade efficiency and overall efficiency of PM2.5. The results indicate that the PM2.5 grade efficiency increases non-linearly with increasing particle diameter when only applied magnetic field is considered. Both grade and overall efficiencies of PM2.5 improve under a strong magnetic field. The effect of magnetic field on collection efficiency also depends on the particle removal mechanisms. The PM2.5 grade efficiency under diffusion charging decreases first and then levels off. Furthermore, diffusion charging increases PM2.5 removal performance with the decrease of working potential or the increase of gas velocity. The diffusion charging mainly influences the fine particles in PM2.5 diameter range and is a much more important particle removal mechanism than magnetic field. Under the combined effect, the PM2.5 grade and overall efficiencies also increase with increasing magnetic field intensity, and dust removal ability of a wire-pipe ESP can be further improved in the entire PM2.5 diameter range.

Key words: applied magnetic field, diffusion charging, grade efficiency, multi-field coupling, overall efficiency, wire-pipe ESP

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