In The Name of God

Mathematical Modeling of Fluid Flow and Particle Movement in Electrostatic Precipitators

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To My Wife, Parents and Family

And

To All Who Teach Me

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Abstract

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A mathematical model was developed to evaluate the electrostatic precipitator performance and investigate the effect of various parameters on the particle removal efficiency. This model consists of three interactive sections, namely electrical field, gas flow and turbulence and particle movement predictions. Two kinds of ESP single-stage and double-stage were considered and due to ESP's configuration the governing equations were obtained for two-dimensional case. In order to evaluate the electrical conditions of an ESP the Maxwell's relation was used. A new model was developed to calculate the electrical conditions of a single-stage ESP. this model is capable of evaluating corona sheath growth and ionic current for different values of applied voltages. The gas flow field was determined by using the normal k-ε turbulent model with considering electrical body force due to presence of ions and charged particles. SIMPLER algorithm was applied to solve the Navier-stokes, continuity, k and ε equations. The particle movement was evaluated by using two different methods of

Eulerian and Lagrangian. Both methods were modified for considering the effect of particle size distribution on the ESP performance. The effect of applied voltage, particle diameter, particle size distribution, inlet particle concentration, configuration of ESP's channel and baffles were investigated on the ESP performance.

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