Numerical Analysis of Flow and Collection Characteristics in a Swirling Flow-Type Electrostatic Precipitator

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Abstract

We developed a device to collect particles with significant inertial forces by combining Coulomb and centrifugal forces. A swirling flow and corona discharge from a sharp disk impart charges to particles, enabling their collection. Numerical simulations were conducted to analyze flow and particle behavior.

Figure 1 shows a schematic diagram of a cylindrical electrostatic precipitator. A slit nozzle generates a swirling flow inside the double cylindrical tube. A corona discharge, created by a disk installed inside the cylinder, imparts an electric charge to the particles, which are subsequently collected by the electrodes on the inner wall of the cylinder. The air flow rate was set to 0.75 m³/min. A voltage of 16 kV was applied to the discharge wires and collecting electrodes in the corona discharge section, and a maximum current of 1 mA was discharged from the wires.

The particle diameter was assumed to be 1 μm, representing a water particle, and the particles passing through the disk were given a charge of 2.7×10^{-16} C. The slit nozzle imparted a swirling motion to the particles, which were charged immediately after passing through the disk in the cylindrical tube. It was evident that the particles, after being charged, were effectively collected on the wall surface. The particle collection rate was 99.6%..

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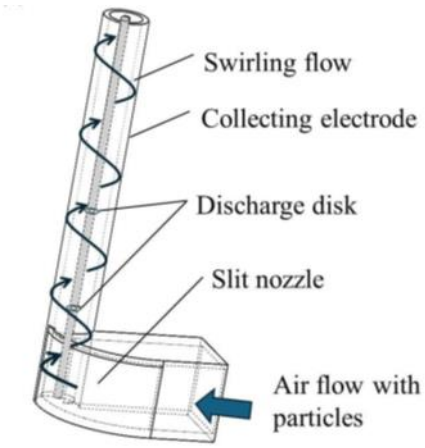

Figure 1 Schematic of the electrostatic precipitator