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Development of a PJWF Cleaning Method for Wet Electrostatic Precipitators

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Abstract : This study designed and tested a wet electrostatic precipitators (WEP) system featuring a Pulse-Air-Jet-Assisted Water Flow (PJWF) to shorten water cleaning time, reduce water usage, and maintain high particle removal efficiency. The PJWF injected cleaning water tangentially at the cylinder wall, rapidly enhancing the momentum of the water flow for efficient dust cake removal. Each PJWF cycle uses approximately 4.8 liters of cleaning water in 18 seconds. Comprehensive laboratory tests were conducted using a single-tube WEP prototype within a flow rate range of 3.0 to 6.0 cubic meters per minute(CMM), operating voltages between -35 to -55 kV, and high-frequency power supply. The prototype, consisting of 72 sets of double-spike rigid discharge electrodes, demonstrated that with the PJWF, -35 kV, and 3.0 CMM, the PM2.5 collection efficiency remained as high as the initial value of 88.02±0.92% after loading with Al_2O3 particles at 35.75± 2.54 mg/Nm^3 for 20-hr continuous operation. In contrast, without the PJWF, the PM2.5 collection efficiency drastically dropped from 87.4% to 53.5%. Theoretical modeling closely matched experimental results, confirming the robustness of the system's design and its scalability for larger industrial applications. Future research will focus on optimizing the PJWF system, exploring its performance with various particulate matter, and ensuring long-term operational stability and reliability under diverse environmental conditions.

Keywords : wet electrostatic precipitator, pulse-air-jet-assisted water flow, particle removal efficiency, air pollution control
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