

Effect of Particle Electrostatic Charge Level on Collection Efficiency of an Electric Metal Mesh Filter

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Abstract:

Despite findings in the field of air filtration, the consequences of pollution persist and remain significant, causing thousands of deaths, as well as chronic and irreversible diseases. It also plays a major role in climate change and sky's obscurity. These factors have pushed researchers to continuously explore ways to improve air filtration technologies. Air purification using filter media is among the techniques having received wide validation from the scientific community. Aerosol collection with this technique is initially based on mechanical mechanisms, where solid particles are mainly captured under inertial impaction, interception and diffusion mechanisms. To achieve high filtration efficiency, it is essential to use a finely porous media with a large thickness. However, this results in a significant pressure drop. In order to have the right balance between collection efficiency and pressure drop, it becomes necessary to introduce another category of mechanisms such as those of electrical types. These exploit the electrostatic charge of particles and fibers, giving the possibility to improve efficiency while maintaining a low pressure drop across the filter. In this paper, our main objective is to investigate in depth the role of electrostatic forces in the collection process of an Electric Metal Mesh Filter (EMMF), bringing clarity to ambiguities present in the literature on this topic and providing key insights essential for optimizing filter's design and effectiveness. To achieve this, we developed an experimental setup that includes four main parts: particle generator (PALAS, AGK-2000) capable of producing NaCl particles ranging from 5 nm to 15 μm , connected to an EMMF consisting of three sequentially arranged electrically isolated metallic grids, spaced 5 mm apart. We employed a high-voltage DC source (KEITHLEY, model 248, ± 5 kV) to supply the grids with either negative or positive polarity. Aerosol concentrations are measured using an aerosol sensor (PALAS, Welas 1100) sensitive to particles sized from 0.2 to 10 μm . In this study, Filtration efficiency is explored depending on several parameters: particle charge level, and grid voltage magnitude and polarity. Preliminary results revealed that efficiency increases with increasing particle charge level and grid voltage magnitude.

Keywords: Particle electrostatic charge level; Electric Metal Mesh Filter (EMMF); Electrostatic forces; Collection efficiency

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