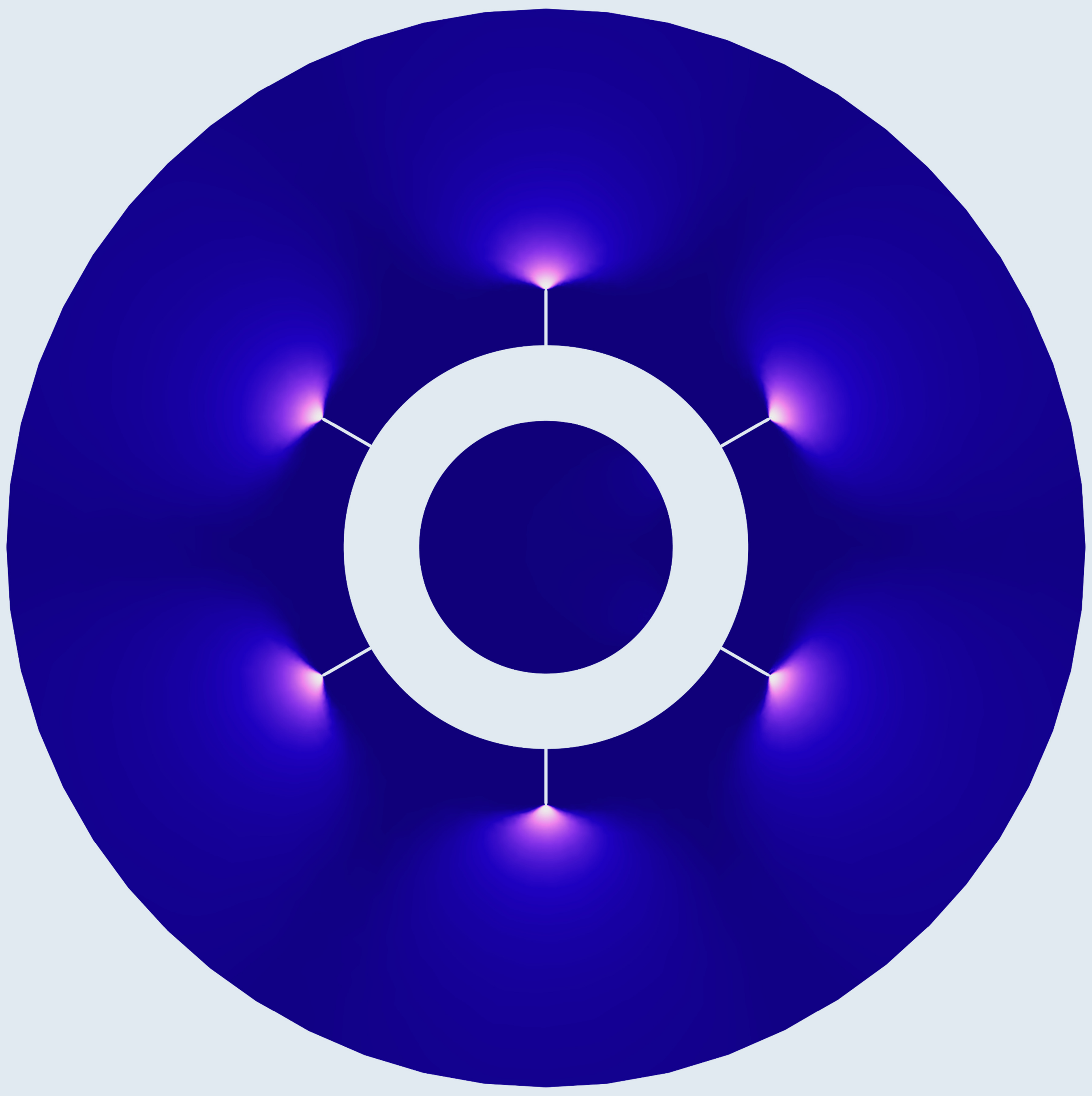

Simplified Two-Stage Electrostatic Precipitator for Particulate Matter Removal

Electrostatic precipitation (ESP) is a widely used and efficient technique for removing particulate matter from the air. In this work, a model is built to evaluate a simplified ESP device for indoor air purification.

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Introduction

ESP devices consist of an ionization section where a strong electric field is generated between the electrodes present. This leads to corona discharge of the air passing through, causing the entrained particles to become charged. Subsequently, in the collector section, the charged particles are electrostatically attracted to a collecting surface and removed from the air.

In contrast to the single-stage ESP model found in the COMSOL® Application Libraries, this work concerns a two-stage ESP, with a separate ionization and collector section. The device is 'simplified' because it contains only two collector plates as opposed to other setups with numerous plates. The header displays a cross-sectional view of the ionization section, where corona discharge takes place at the electrode tips.

The final model will be validated with climate chamber experiments and can be used to optimize PM removal efficiency by varying the operational parameters.

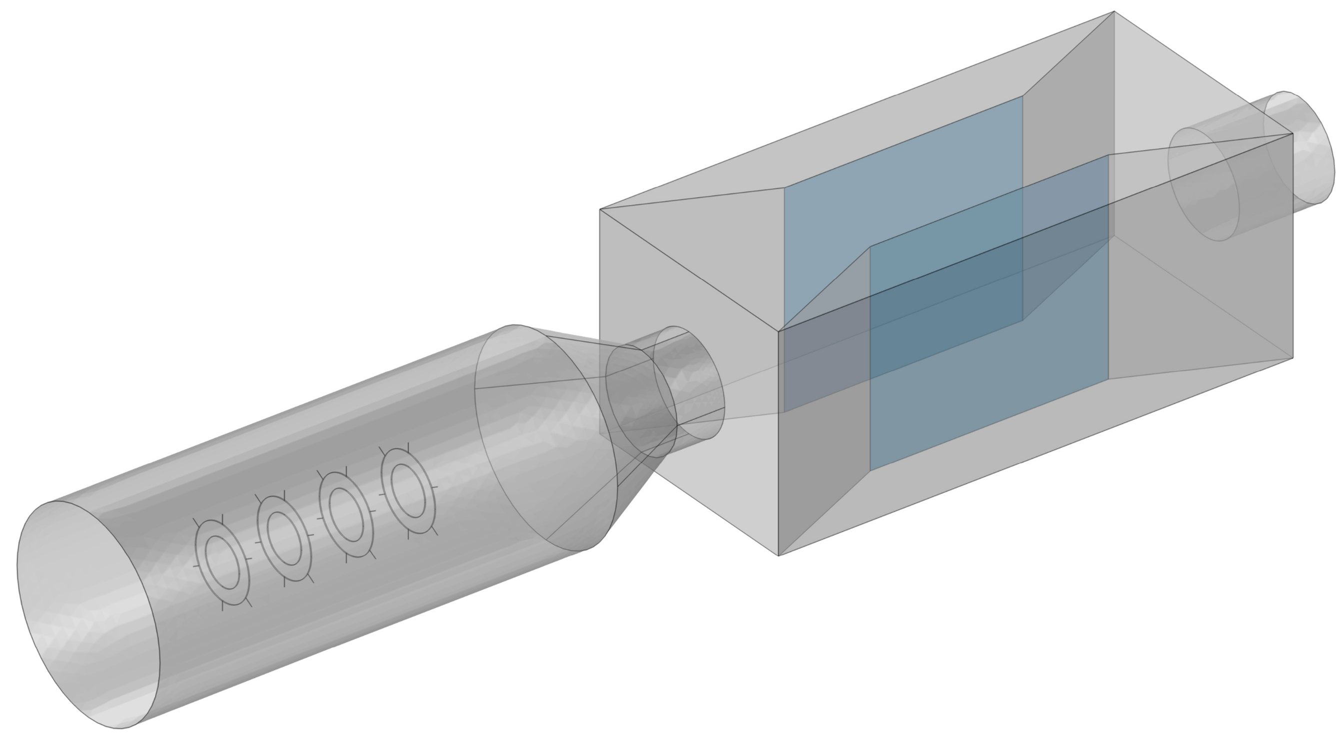

FIGURE 1. Geometry of the complete ESP device with ionization (left) and collector section (right). The collector plates are indicated in blue.

Methodology

Separate 3D models for ionization and collector section

Both sections

- Steady-state airflow: k-ω turbulence model
- Particle tracing: accounting for drag force and Coulomb force

Ionization section

- Positive corona discharge: simplified model
- Charging of passing particles

Collector section

- Static electric field for particle collection

Results

Ionization section

Fig. 2 (left) presents the average charge a particle has accumulated at the outlet of the ionization section, as a function of the particle radius.

Collector section

Increasing the applied voltage between the collector plates results in improved collection of the charged PM (Fig. 2, right).

In a later stage both models will be coupled: the charged particles at the outlet of the ionization section will be introduced at the inlet of the collector section. After validation, the operational parameters will be adjusted to maximize PM capture.

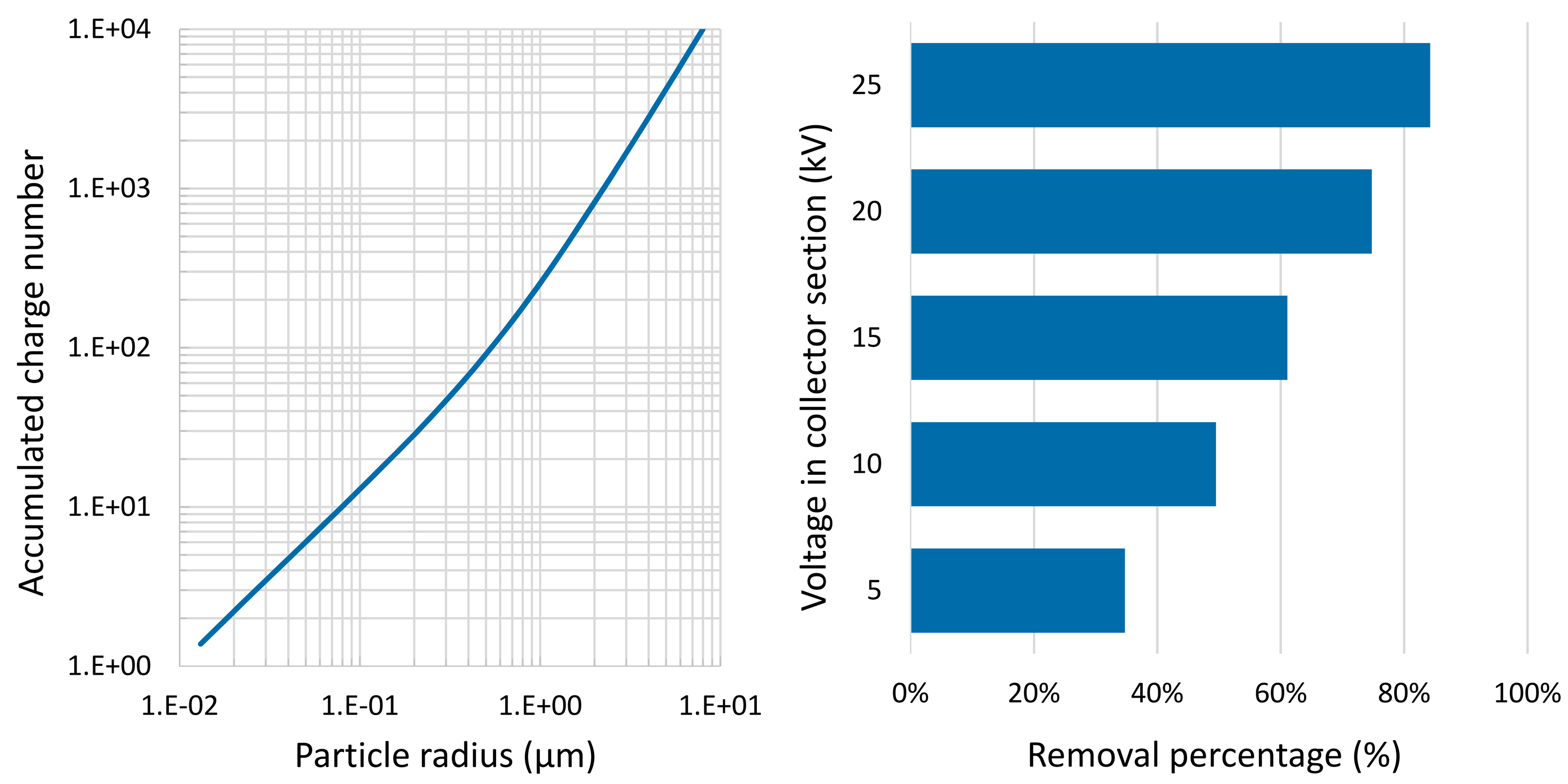

FIGURE 2. Average particle charge at the outlet of the ionization section as a function of the particle radius (left); percentage of incoming PM removed at varying voltages applied in the collector section (right).

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