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Charge conditioning of aerosol particles for particle characterization and the generation of calibration and test aerosols

Conditionnement de la charge (électrique) des particules d'aérosols pour la caractérisation de particules et la génération d'aérosols pour calibration et essais

Reference number
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Foreword

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This document was prepared by Technical Committee ISO/TC 24, *Particle characterization including sieving*, Subcommittee SC 4, *Particle characterization*.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Charge conditioning of aerosol particles is the crucial process of establishing a known, size-dependent charge distribution on aerosol particles. Different designs for charge conditioners exist. In charge conditioners, aerosol particles are exposed to a cloud of ions of either both positive and negative polarities (bipolar charge conditioners) or a single polarity (unipolar charge conditioners).

The transport of the ions to the aerosol particles can either be driven by Brownian motion of the ions (diffusion charging) or by an electrical field (field charging). Since field charging is strongly biased by a particle's electrical properties (namely the relative permittivity), diffusion charging is generally used to condition aerosol particles:

— for particle size distribution measurement with the differential mobility analysing system (DMAS);

— for particle size classification with the differential electrical mobility classifier (DEMC).

Several parameters determine whether or not charge conditioning achieves its goal of either generating a mathematically describable bipolar steady-state charge distribution or a quantifiable unipolar mean charge. Examples for such parameters are the ion concentration, the particle concentration, the residence time of the particles in the ion cloud, the ion mass distribution or the ion mobility distribution. However, there is no standard methodology to specify the performance of charge conditioners.

The electrical mobility of aerosol particles is a physical particle property which is widely used for particle characterization (e.g. size distribution measurement with DMAS) and for particle classification (e.g. by DEMC). For a given particle size, the particles' electrical mobility is proportional to the net number of elementary charges on the particle. Therefore, the knowledge of particle charge distribution is an essential requirement for particle size distribution measurements with the DMAS and for particle size classification with the DEMC.

The purpose of this document is to provide a methodology to specify the performance of charge conditioners and for adequate quality control when charge conditioners are used in particle size and number concentration measurement or in particle size classification.

Other typical uses of charge conditioners which are not covered in this document are:

— conditioning of test aerosols for filter testing where particle charge has an influence on the test results;

— particle charge reduction during the droplet evaporation in an electrospray aerosol generator, where the very high unipolar charge of the sprayed solution or dispersion droplets can lead to the unwanted disintegration of the droplets due to exceeding the Rayleigh limit during droplet evaporation;[34]-[36]

— diffusion chargers (DC) in particle number devices (PND) that are typically used as robust, compact systems to measure particle number concertation in the exhaust emission of passenger cars, light and heavy duty cars under real driving emissions (RDE) as well as under periodical technical inspections (PTI) in Europe. The charging process in such a device is provided by a diffusion charger, which is charging the aerosol in a positive unipolar diffusion state. Typically, a thin wire is used as a high voltage electrode to generate positive ions. The ions are injected through a grounded grid into buffer volume where they are mixed with the particles. Afterwards, the charged aerosols will be counted in a two stage procedure by an pulsed precipitator and in an Faraday cup aerosol electrometer (FCAE);[37,38]

— large-scale ionizers combined with electrostatic precipitators (ESP) for cleaning flue gases of waste incinerators or power plants fired with solid fuels. In the ESP, a corona discharge generates ions which charge the flue gas particles (usually fly ash) by diffusion and field charging (depending on the particle size). Subsequently, the particles are deflected by electrophoresis in the ESP's electrostatic field and deposited on grounded collection electrodes. Industrial ESP are usually several tens of meters high and consist of a multi-stage configuration to optimize the overall collection and gas cleaning efficiency.

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Charge conditioning of aerosol particles for particle characterization and the generation of calibration and test aerosols

1 Scope

This document specifies requirements and provides guidance for the use of charge conditioners for aerosol particles, especially for particle characterization and for the generation of calibration and test aerosols.

This document provides a methodology to specify the performance of charge conditioners and for adequate quality control, with respect to their application in:

— particle size and concentration measurement with differential mobility analysing systems (DMAS);

—particle size classification with differential electrical mobility classifiers (DEMC).

For these applications, this document covers particle charge conditioning for particle sizes ranging from approximately 1 nm to 1 µm and for particle number concentrations at the inlet of the charge conditioner up to approximately 10^7 cm^{-3}.

This document does not address specific charge conditioner designs or other applications besides those specified in Clause 1.

Radiation safety for charge conditioners with radioactive sources or x-ray tubes is not covered by this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15900, *Determination of particle size distribution — Differential electrical mobility analysis for aerosol particles*

ISO 27891, *Aerosol particle number concentration — Calibration of condensation particle counters*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15900, ISO 27891 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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