Afshari A, Ekberg L, Forejt L, Mo J, Rahimi S, Siegel J, Chen W, Wargocki P, Zurami S, Zhang J. 2020. Electrostatic precipitators as an indoor air cleaner – A literature review. *Sustainability*, **12(21)**, 8774. DOI: 10.3390/su12218774

Abstract

Many people spend most of their time in an indoor environment. A positive relationship exists between indoor environmental quality and the health, wellbeing, and productivity of occupants in buildings. The indoor environment is affected by pollutants, such as gases and particles. Pollutants can be removed from the indoor environment in various ways. Air-cleaning devices are commonly marketed as benefiting the removal of air pollutants and, consequently, improving indoor air quality. Depending on the type of cleaning technology, air cleaners may generate undesired and toxic byproducts. Different air filtration technologies, such as electrostatic precipitators (ESPs) have been introduced to the market. The ESP has been used in buildings because it can remove particles while only causing low pressure drops. Moreover, ESPs can be either in-duct or standalone units. This review aims to provide an overview of ESP use, methods for testing this product, the performance of existing ESPs concerning removing pollutants and their byproducts, and the existing market for ESPs.

Main findings

- Both in-duct and portable air cleaners have advantages and disadvantages.
- **Ozone** is the major by-product of ESPs: its generation rate can be affected by **product design** (corona type and polarity, current density, discharge electrode diameter, wire material, overall geometry) and **operating conditions**.
- No standards consider ultrafine particles.
- All standards focus on the performance of new, unused air cleaners. No test standards address the potential generation of **by-products** other than ozone.
- The **positioning** of a portable air cleaner affects its overall particle removal.
- ESPs in **HVAC applications** generate less ozone, thus are more suitable for use in occupied space.

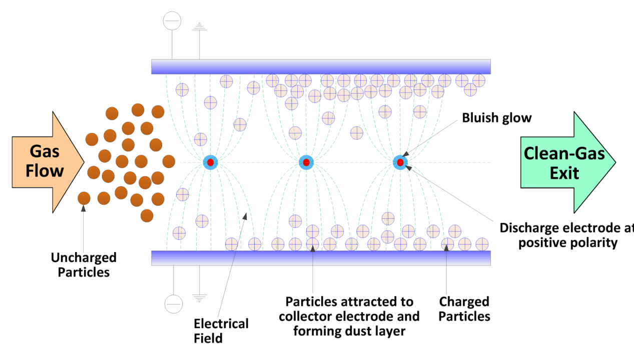

Figure 1. Schematic of the basic processes of an electrostatic precipitator (Source: modified from a guide document published by Ohio Environmental Protection Agency, USA, accessible at: www.epa.state.oh.us/portals/27/engineer/eguides/electro.pdf).

Standard/Protocol (Ref.)	Country	Method	Challenge Particles	Measured Particle Size Range	Performance Index
Portable Air Cleaners					
ANSI/AHAM [17]	US	Pull-down	Environmental Tobacco Smoke Arizona Road Dust Paper Mulberry Pollen	0.1 to 1.0 μm 0.5 to 3.0 μm 5 to 11 μm	CADR [a]
GB/T-18801 [18]	China	Pull-down	Environmental Tobacco Smoke Arizona Road Dust Paper Mulberry Pollen	0.1 to 1.0 μm 0.5 to 3.0 μm 5 to 11 μm	CADR
NRC Protocol [27]	Canada	Pull-down	Polydisperse Potassium chloride (KCl)	50 nm to 5 μm	CADR
NCEMBT Procedure [28]	US	Pull-down	Polydisperse potassium chloride (KCl)	0.1 to 11.5 μm	CADR
Lucerne University (2012) [29]	Switzerland	Pull-down	ISO 12103-1 A1 Ultrafine test dust.	0.2 to 5 μm	
JIS C 9615 [30]	Japan	Single-pass	JIS Z 8901 standard dusts	…	Removal rate
XP B44-200 [31]	France	Single-pass	DEHS, cat allergens, *Staphylococcus epidermidis* *Aspergillus niger*	0.3 and 5 μm	SPE [b], CADR
In-duct air cleaners					
ANSI/AHRI 681 [32]	US	Single-pass	Polydisperse potassium chloride (KCl)	0.3 μm to 10 μm	SPE

Table 1. Standards and procedures for evaluating the initial performance of electrostatic precipitators (ESPs) in portable air cleaning (PAC) and in-duct systems.

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