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Investigation on the performance of airliner cabin air filter throughout the lifetime usage

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ABSTRACT

The supply air from the airliner ventilation system is a mixture of outside air and recirculated air that passes through a high efficiency particulate air (HEPA) filter. The effectiveness of two commercial-available airliner cabin air filters were investigated under the laboratory-based measurement due to the practical restriction of airliner cabin filter test during usage. The filtration efficiency and pressure drop were assessed at particle size range of 20-500 nm under various airflow rates throughout the filter usage period. The Most Penetrating Particle Sizes (MPPS) were observed at ~150 and ~55 nm, where the filtration efficiency was 86% and 99% at the rated airflow rates (1600 m^3 h^{-1} and 1970m^3 h^{-1}), respectively. The filtration efficiency decreased in response to the increased airflow rate from 1000 m^3 h^{-1} to 2200 m^3 h^{-1} with the greatest reduction (~10%) occurred at MPPS. An increase of 250 Pa pressure drop across the filter was observed as the airflow rate increased from 1000 m^3 h^{-1} to 2200 m^3 h^{-1}. The filter usage led to the increases of filtration efficiency and pressure drop. The actual filter usage was estimated using dust loading in the laboratory. Filtration efficiency increased ~10% and pressure drop increased ~800% as 220 g m^{-2} dust was loaded that corresponds to ~6000 hours filter usage at in-cabin PM_{10} concentration of 100 μg m^{-3}. Explicit relationships among filtration efficiency, pressure drop and filter usage under various in-cabin particle concentrations were presented as a reference to facilitate airliner cabin air filter exchange periods.
Key words: In-cabin particles; Particle filtration; Dust loading; Filtration efficiency; Pressure drop.

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INTRODUCTION

A large number of epidemiological studies have shown positive associations between exposure to atmospheric particulate matter (PM) and various adverse health effects, including respiratory and cardiopulmonary effects (Delfino *et al.*, 2005; Pope and Dockery, 2006; Bai *et al.*, 2007). Previous experimental studies have reported a high PM concentration (50-200 μg m^{-3}) due to some routine activities (e.g. food