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Procedia Engineering 17 (2011) 343 – 353

Procedia Engineering

www.elsevier.com/locate/procedia

The 2nd International Symposium on Aircraft Airworthiness (ISAA 2011)

Studies on New Air Purification and Air Quality Control System of Airliner Cabin

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Abstract

Airworthiness standards of China and America both give the maximum permissible concentrations of CO, CO_2 and O_3 in airliner cabin. The general specifications of aircraft engine (GJB241-87, GJB242-87) also have the maximum permissible concentrations of pollutants in the engine bleed air used for the air conditioning system. During airworthiness certification flight tests, the concentrations of these harmful pollutants in cabin are required to be tested and validated. According to these requirements, combined with active and passive control strategies, a new cabin air quality (CAQ) control system was presented based on nano-photocatalytic oxidation (NPCO) purification technique. A CAQ dynamic model was established and used to do simulation analysis of the CAQ control strategies. Results showed that the CAQ control system based on new NPCO device can well handle the CAQ problems in current airliner cabins, and the new CAQ control strategies may help to reduce the CAQ change amplitude, and to improve the CAQ as well.

Keywaords: Airworthiness; Nano-photocatalytic oxidation (NPCO); Cabin air quality (CAQ); Control strategies

1. Introduction

The airliner cabin is small and crowded, and needs to bleed air from outside to adjust the cabin pressure, temperature and other environmental parameters during flight. The metabolisms of passengers

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1877-7058 © 2011 Published by Elsevier Ltd.
doi:10.1016/j.proeng.2011.10.039

and crews, equipment operation, material release, and the bled air from external environment, make the composition of cabin air very complicated. Besides the external atmosphere components, the cabin air also contains inorganic and organic contaminants.

Nomenclature

A	the UV intensity influence constant, mW/cm^2
C	the concentration of pollutant inside the cabin, mg/L
C_0	the initial concentration of the pollutant, mg/L
C_B	the pollutant concentration in the fresh air, mg/L
C_e	the pollutant concentration after purification, mg/L
D	the impeller diameter of the fan, m
I_0	the initial UV intensity, mW/cm^2
k_1	the adsorption equilibrium constant, L/mg
k_m	the catalytic reaction constant, mg/(L•min)
k_2, k_3 & k_5	linear regression constants, dimensionless
k_4	linear regression constant, L/mg
k_6	linear regression constant, (L/mg)^2
$\dot{M}$	the amount of pollutant that is emitted from pollution sources, mg/min
n	fan speed, r/min
Q_f	amount of fresh air supply for the cabin, L/min
Q_r	recirculated air amount from the cabin, L/min
$\bar{r}_{avg}$	the average catalytic rate, mg/(L•min)
RH	relative humidity (%) of the cabin air, dimensionless
V	the cabin volume, L
V_{bed}	the catalyst bed volume, L
V_p	the volume of air purifiers, L
ε	the UV absorption coefficient, cm^2/g
δ	the catalyst layer thickness, cm
ρ_b	the catalyst density, g/cm^3