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Catalytic Removal of Ozone by Pd/ACFs and Optimal Design of Ozone Converter for Air Purification in Aircraft Cabin

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Abstract

Ozone in aircraft cabin can bring obvious adverse impact on indoor air quality and occupant health. The objective of this study is to experimentally explore the ozone removal performance of flat-type catalyst film by loading nanometer palladium on the activated carbon fibers (Pd/ACFs), and optimize the configuration of ozone converter to make it meet the design requirements. A one-through ozone removal unit with three different Pd/ACFs space was used to test the ozone removal performance and the flow resistance characteristic under various temperature and flow velocity. The results show that the ozone removal rate of the ozone removal unit with the Pd/ACFs space of 1.5 mm can reach 99% and the maximum pressure drop is only 1.9 kPa at the reaction temperature of 200℃. The relationship between pressure drop and flow velocity in the ozone removal unit has a good fit to the Darcy-Forchheimer model. An ozone converter with flat-type reactor was designed and processed based on the one-through ozone removal experiment, its ozone removal rate and maximum pressure drop were 97% and 7.51 kPa, separately, with the condition of 150℃ and 10.63 m/s. It can meet the design requirements of ozone converter for air purification and develop a healthier aircraft cabin environment.

Keywords: Ozone; Aircraft Cabin; Optimum Arrangement; Pd/ACFs; Ozone Converter.

1. Introduction

The outdoor air pollution and ventilation system pollution are two major factors influencing the indoor air quality [1]. As a special indoor environment, the air quality in the aircraft cabin is more associated with the ambient air conditions and regulated by the supplied outside air [2, 3]. Since the energy crisis of 1970s, commercial airplanes routinely cruise in the upper troposphere or the lower stratosphere where the ozone concentration can reach the level of hundreds of parts per billion (ppb), ozone will enter aircraft cabin with the bleeding air through engine compressors [4]. Ever since, more and more passengers started to complain the poor air quality caused by the ozone [5]. As to short-term exposure, studies have strengthened the evidence that exposure to the over-standard ozone concentration (>0.1ppm) will increase the mortality and respiratory morbidity rates [6]. Due to the strong oxidizing, ozone can react with the passenger's skin oils and the leather seats in aircraft cabin, which become the important source of volatile organic compounds (VOCs) [7]. Due to the hazards of ozone, the World Health Organization had updated the air quality guideline for indoor ozone that the maximum average concentration cannot exceed 0.09 ppm in 8-hr when people exposure to the ozone environment. The Occupational Safety and Health Administration (OSHA, the United States of American) also required the maximum ozone concentration of 0.1 ppm when human exposure to such environment for

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