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# Periodically reversible supply/exhaust ventilation strategy

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ABSTRACT

A Periodically REversible Supply/Exhaust Ventilation (PRESEV) strategy was developed. The potential advantage of the PRESEV strategy was demonstrated by carpark ventilation in reducing ventilation flow rate requirement and at the same time satisfying the time-averaged local CO concentration criteria. It was shown that compared to conventional piston or mixed ventilation, around 30% reduction in the ventilation flow rate may be achievable with the PRESEV strategy. The PRESEV strategy may be applicable to some ventilation system designs for pollutant exposure controls where the averaged local pollutant concentration is the main concern.



## 1. Introduction

Mechanical supply/exhaust ventilation is frequently used for pollutant exposure controls in commercial and industrial buildings. Conventional ventilation strategies for pollutant exposure control can be categorised to piston, mixed and displacement ventilations [1]. Mixed and displacement ventilation strategies dominate the ventilation designs for commercial and industrial buildings, while piston ventilation is used in some applications such as clean rooms [2].

Piston and mixed ventilation strategies may be illustrated by carpark ventilation for the dilution of carbon monoxide (CO) emitted from vehicles. Assuming evenly distributed constant vehicle CO emission rate in a carpark, an ideal piston ventilation and a fully mixed ventilation would result in a linear CO ppm rise and a constant CO ppm rise respectively, from the air supply to the exhaust, as shown in Fig. 1. In Fig. 1, $x$ is the dimensionless distance from the air supply, where $x = 0$ is at the air supply and $x = 1$ is at the exhaust.

In order to limit CO exposure, various countries set standards on CO concentrations in carparks. Table 1 lists the standards for CO concentrations (in ppm) in Greece [3], UK [4] and Australia [5]. Despite the differences in the CO concentration standards in different countries, the general rule is that long term and medium term CO concentration should be much lower than the short term excursions. The Australian Standard for ventilation and air conditioning, AS 1668.2 [5], requires everywhere between 0.9 m and 2.5 m above the floor that

- hourly averaged CO ppm rise at any location inside a carpark should be no more than 51 ppm (60 ppm absolute CO concentration with a 9 ppm ambient peak CO concentration); and
- half hour averaged short term excursion of CO ppm rise should not be above 91 ppm (100 ppm absolute CO concentration with a 9 ppm ambient peak CO concentration).

For enclosed carparks, supply only, exhaust only and supply/exhaust combined ventilations are commonly used for CO removal [5–9]. For exhaust only ventilation designs, the exhaust air intake shall be located on the opposite sides of the carpark from the sources of make-up air [5]. When combined ventilation is used, the exhaust should be at least 10% more than the air supply to maintain a slightly negative pressure in the carpark compared to adjacent spaces [5]. Australian standard AS 1668.2 allows performance-based carpark ventilation designs which can be demonstrated to satisfy the CO concentration criteria. Currently, the existing carpark ventilation design methodology is to keep the maximum local hourly averaged CO ppm rise, which is normally at the air exhaust or car queueing area, less than 51 ppm. This design methodology

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