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Hugo Destaillats
Meera Sidheswaran
Sebastian Cohn
Douglas P. Sullivan
William J. Fisk

Environmental Energy Technologies Division

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Disclaimer

Topic B5: Filtration and air cleaning

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Hugo DESTAILLATS[1,*], Meera SIDHESWARAN[1], Sebastian COHN[1], Douglas SULLIVAN[1], William J FISK[1]

[1] Indoor Environment Group, Lawrence Berkeley National Laboratory, Berkeley, CA, USA

[*]Corresponding email:HDestaillats@lbl.gov

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INTRODUCTION

We are seeking to develop an air cleaning system containing a manganese oxide catalyst (MnO_x) that can preserve or improve indoor air quality at reduced outdoor air supply rates, thus enabling significant energy savings. The catalyst can be synthesized using inexpensive precursors and a simple process, enabling scaling-up to industrial production volumes. Relative to commercial MnO_2, the synthesized manganese oxide has a much higher surface area and the presence of different Mn species, consistent with superior catalytic performance (Sidheswaran et al 2011a; Sidheswaran et al 2011b).

METHODOLOGY

In laboratory studies, we determined the removal efficiency of formaldehyde and a suite of volatile organic compounds (VOCs). In addition, we evaluated the effectiveness of a catalyst-treated pad-type particle filter over 95 days operating at 0.5 m s^{-1}, a velocity and lifetime consistent with those required in filtration systems. We carried out field studies to evaluate the performance of catalyst-coated filters under realistic conditions in a commercial building, and the performance of the catalyst combined with other air cleaning technologies integrated in portable units for residential use.

RESULTS AND DISCUSSION

In the laboratory, the MnO_x catalyst-treated pad filter removed formaldehyde with an 80% efficiency at room temperature under initial conditions, and preserved a significant activity (~65% time average formaldehyde removal efficiency) over more than 3 months of continuous operation. It also showed high activity in the removal of acetaldehyde and several other VOCs. Field results showed significant reductions in indoor formaldehyde levels (up to 80%) over relatively short periods in a commercial building. However, in residential field studies single pass formaldehyde removal efficiencies ranged from -10% to +40%, as shown in Figure 1. Field results shown in Figure 2 and subsequent laboratory studies confirmed that incomplete decomposition of some VOCs can lead to formaldehyde as a product, hence reducing the efficiency of formaldehyde elimination.

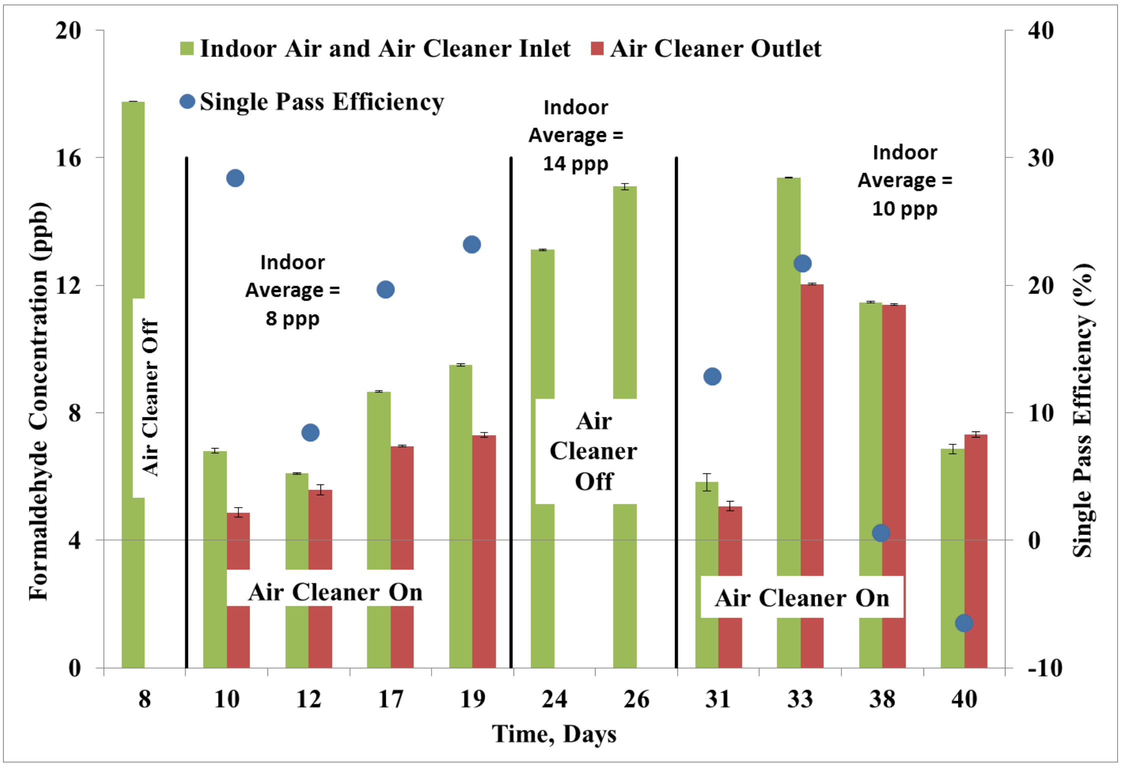

Figure 1: Formaldehyde concentration (left axis) and single pass removal efficiency (right axis) determined in a field study using a MnOx-modified portable air cleaner.

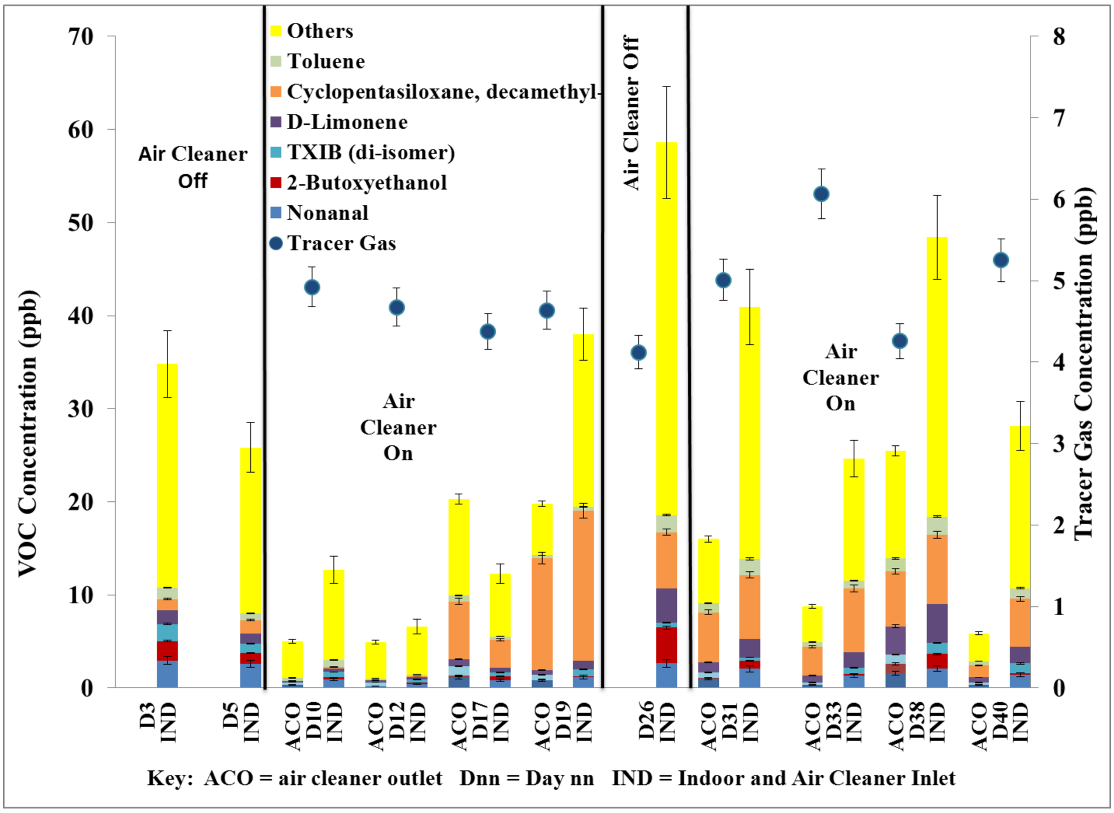

Figure 2: VOC concentration (left axis) and tracer gas concentration (right axis) determined in a field study using a MnOx-modified portable air cleaner.

By increasing the amount of catalyst applied to the filter and decreasing air velocities, formaldehyde production from incomplete VOC decomposition was reduced by up to a factor of four. Modeling indicated that an air cleaner employing more catalyst and lower air velocities will generally decrease both indoor formaldehyde concentrations, as well as concentrations of other VOCs. However, in a scenario with initially high VOC and low formaldehyde concentrations, modeling still predicted a net increase in indoor formaldehyde.

CONCLUSIONS

This technology is a promising approach for reducing indoor VOC concentrations; however, further optimization of the system design and additional field trials are necessary.

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