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Reclassifying Hotel Room Exhaust

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Introduction

Hotels currently exhaust conditioned air to comply with standards such as *ASHRAE 62.1-2010* (*Std. 62.1*). *Std. 62.1* requires each hotel guest room to exhaust the toilet area, which contains conditioned "hotel room air" with no contaminant sources present when the toilet area is not in use. *Std. 62.1* allows air redesignation and transfer of this air to other areas if it is cleaned via an appropriate air cleaning system. Redesignating and recycling such exhaust and thereby reducing the amount of required conditioned make-up air, may be one option to save energy in large hotels.

In order to provide data to the IAQ industry on this concept, the authors performed direct air sampling at a large atrium hotel that currently recycles guest room toilet exhaust through a particulate and gas-phase air cleaning system for energy savings. This air sampling included both chemicals and bioaerosols.

Materials/Methods

The air cleaning system consisted of MERV 8 51 mm deep prefilters, 457 mm deep V-bank cassettes holding gas-phase media, and 51 mm deep MERV 8 final filters. The gas-phase media consisted of an equal by volume blend of virgin activated carbon and potassium permanganate impregnated alumina (8%).

Direct air sampling was performed upstream and downstream of the air cleaning system and outdoors. The air sampling consisted of the following contaminants.

- Airborne Chemicals
  - Volatile Organic Compounds (Speciated EPA method TO-15)
  - Aldehydes (EPA method TO-11A)
  - Ammonia (OSHA ID-188/ID-164)
  - Hydrogen Sulfide (CAS AQL 110 using spectrophotometer)
- Bioaerosols
  - Non-Viable and Viable Fungi (Spore Trap Active Impaction and SAS Sampler with Anderson Style Active Plate Impaction)
  - Bacteria (SAS Sampler with Anderson Style Active Plate Impaction)

The results downstream of the air cleaning system were compared to the indoor air of non-problem office buildings via the U.S. EPA Building Assessment and Survey Evaluation Study (BASE) and published reference exposure limits. The exposure limits used were the Agency for Toxic Substances & Disease Registry Minimum Risk Level (ATSDR MRL), the California Office of Environmental Health Hazard Assessment Reference Exposure Level (CA OEHHA REL), and when neither of the former limits existed for a chemical the Occupational Safety and Health Administration Permissible Exposure Limits (OSHA PEL).

Results

Out of the seventy five common indoor volatile organic compounds (VOC) targeted in the EPA TO-15 method, only twenty seven were detected downstream of the gas-phase filtration system. The chemical concentrations were lower than the BASE data with the exception of eight compounds. Ethanol had the highest concentration. It was higher than in the BASE data, but well below both the OSHA PEL and well below its odor threshold range of 100-180 ppm (AIHA, 1989).

Out of the eight aldehydes monitored with the EPA TO-11A method, only three aldehydes had concentrations significantly higher than the limits of detection. Two of these were compared to the BASE data and the aforementioned exposure limits. N-hexaldehyde did not have a corresponding exposure limit and was not in the BASE data. Table 1 contains a summary of both the VOC and aldehyde data.

Neither ammonia nor hydrogen sulfide were detected in the airstream. The detection limits for these were 0.13 ppmv and 4.1 ppbv, respectively.

Table 1 – VOC and Aldehyde Data Summary Downstream of Air Cleaning System

Compound	**Conc** [A] **(ppbv)**	**Summary**
VOCs		
1,4-Dichlorobenzene	0.02	< BASE
2-Propanol	8.80	< BASE
Acetone	22.00	< chronic ASTDR
Acetonitrile	0.40	< OSHA PEL, < 1 ppb
alpha-Pinene	0.46	no regs, < 1 ppb
Benzene	0.13	< BASE
Bromodichloromethane	0.09	no regs, < 1 ppb
Carbon Tetrachloride	0.06	< BASE
Chloroform	1.10	< chronic ASTDR
Chloromethane	0.23	< BASE
Dichlorodifluoromethane	0.56	< BASE
d-Limonene	0.82	< BASE
Ethanol	500.00	< OSHA PEL
Ethyl Acetate	0.95	< BASE
Ethylbenzene	0.19	< BASE
m,p-Xylenes	0.52	< BASE
n-Butyl Acetate	0.17	< BASE
n-Heptane	0.16	< OSHA PEL, < 1 ppb
n-Hexane	0.19	< BASE
n-Octane	0.14	< BASE
o-Xylene	0.16	< BASE
Propene	4.40	< chronic CA REL
Tetrachloroethene	0.32	< BASE
Toluene	0.74	< BASE
Trichloroethene	0.05	< BASE
Trichlorofluoromethane	0.26	< BASE
Trichlorotrifluoroethane	0.05	< BASE
Aldehydes		
Acetaldehyde	9.30	< chronic CA REL
Formaldehyde	17.00	< inter ASTDR
n-Hexaldehyde	3.10	no regs, < 4 ppb

[A] Additional zeros in table values do not indicate significant digits, but are to allow easy comparison of data

The bioaerosol results were compared to outdoor concentrations and checked for the specific concerns. The non-viable (spore) and viable fungi downstream concentrations were approximately 90% lower than outdoors. In both cases, the dominant fungi downstream were similar to the dominant fungi outdoors, which is normal and typical of non-problem buildings.
The bacteria data was reviewed with specific focus on Coliform bacteria. The downstream concentration was higher than outdoors but lower than BASE data. *Escherichia coli* (*E. coli*) was not present in any of the samples collected. No other bacteria presence stood out as atypical for indoor environments.

Conclusions

Air being recycled from guest room toilet exhaust into a hotel's supply air was evaluated for airborne chemicals and bioaerosols. The majority of the airborne chemicals were below concentrations in non-problem office buildings. The remaining ones were below their respective exposure limits. The bioaerosol data was also better than outdoors or better than non-problem office buildings. This data points toward the possibility of redesignating the air classification and recycling hotel guest room toilet exhaust air by using proper air cleaning systems. This strategy may save energy for large hotels and other buildings through reduction of required conditioned make-up air.

References

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