

Personal exposure assessment of non-electric ice resurfacer operators in Toronto ice rinks

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Introduction

The operation of non-electric ice resurfacers which serve to clean and resurface the ice in indoor arenas can pose a health hazard to the public. The exhaust emissions associated with their operation is known to produce elevated concentration levels of contaminants indoors such as NO, NO₂, CO, CO₂, SO₂ and volatile organic compounds (VOCs). Elevated levels of these hazardous contaminants have been responsible for numerous incidents of poor air quality and consequent public poisonings in ice arenas. However, the risk of exposure to elevated levels of these contaminants posed to the operators of non-electric ice resurfacers has yet to be thoroughly characterized. The health effects associated with these contaminants include, but are not limited to, eye, nose and throat irritation, dizziness, shortness of breath, cancer and death. This pilot study aims to assess the exposure levels of the ice resurfacer operators to indoor air concentrations of the contaminants of interest, to ultimately determine if they are at risk of exposure to hazardous levels.

Methodology

- Six City of Toronto indoor ice rinks were visited
- Ice resurfacer operators were asked to complete a short questionnaire about resurfacer use and arena characteristics
- Non-indoor air quality parameters (NO, NO₂, SO₂ and VOCs) and indoor air quality parameters (CO and CO₂) were measured
- Two sets of direct reading instruments (such as a Multi RAE, Multi RAE Pro and Q Trak) were used to record near instantaneous measurements of hazardous contaminants at two sites within each arena.
- One set of direct reading instruments was attached to the ice resurfacer with the probes in the area of the operator, while the second set was placed in the area adjacent to the ice surface
- Measurement data was recorded and stored on the direct reading instruments for 2-3 regularly scheduled resurfacings at each site



Fig 1. Direct reading instrument setup

Results

Table 1. Characteristic and technical information on the indoor ice arena sites and their respective resurfacers

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Age of Resurfacer	2 to 4	0 to 2	4 to 7	*	2 to 4	>8
Resurfacings per day	7 to 9	>10	7 to 9	>10	7 to 9	4 to 6
Resurfacing duration (min)	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10
Fuel Type	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas	Natural Gas
User hours/day	7 to 9	>9	>9	*	>9	7 to 9
Number of users	150 to 249	>250	>250	*	150 to 249	50 to 149
Age of the rink/pad (years)	6 to 10	>15	>15	*	>15	>15
Size of rink (ft ²)	>20,000	>20,000	>20,000	12,000 to 20,000	12,000 to 20,000	*
Ventilation System	Mechanical	Air dehumidifier	Mechanical & Air dehumidifier	Mechanical	Mechanical & Air dehumidifier	Air dehumidifier
IAQ currently tested	Yes	Yes	Yes	Yes	Yes	Yes

* Indicates that the ice resurfacer operator was unable to answer this question in the questionnaire.

It is important to note that all sites that were visited used natural gas as a fuel source.

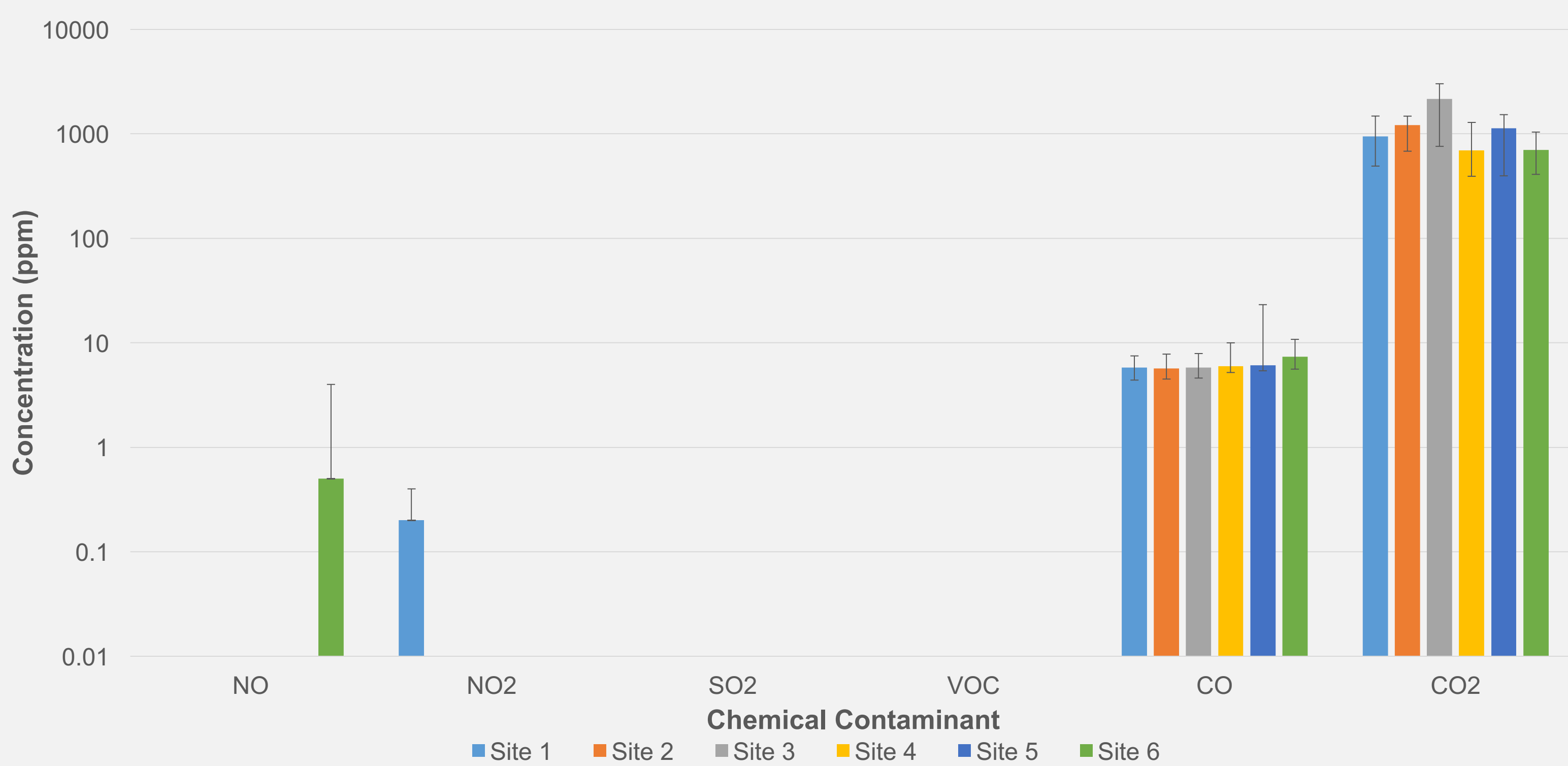


Fig 2. Graph illustrating the concentrations of chemical contaminants measured across six Toronto indoor ice arenas sites.

*Average values for SO₂ and VOCs were 0 ppm across all sites. However, peak values above 0 ppm were found at Sites 2, 4, 5 & 6 for SO₂ and VOCs.

**Error bars represent the ranges of measurements that were obtained.

*** Error bars for NO and NO₂ have minimums of 0 ppm

Discussion

The results obtained for the non-indoor air quality contaminants illustrated that the concentration levels around the ice resurfacer operator area at most sites had an average of 0 ppm. However at sites 6 and 1, NO and NO₂, had averages of 0.5 and 0.2 ppm, respectively. When examining the results obtained for the indoor air quality parameters, their levels were low as well. The highest average CO and CO₂ levels across all sites were 7.4 and 2171 ppm at site 6 and site 3, respectively. All results that were obtained for the parameters of interest were below the relevant occupational exposure limits (OEL) with respect to Ontario Table 1 under Reg. 833. It is important to note that the CO levels ranged from 5.7 – 7.4ppm across all sites, which is close to the ASHRAE maximum recommendation of 9 ppm for indoor air. CO₂ levels at sites 2, 3 and 5 exceeded the ASHRAE warning level of 1000 ppm with site 3 having greater than double the warning level. The non-indoor air quality parameters were found to be lower than results obtained in previous studies. This is believed to be due in large part to the use of natural gas as a fuel source which is associated with lower emissions of the contaminants of interest (NO, NO₂, CO, CO₂, SO₂ and VOCs) into the environment.

Recommendations

It is recommended that for future assessments of personal exposure levels of ice resurfacer operators, that sampling occur during ice maintenance days in which an ice edger is used for one to two hours. Ice edger's are still fueled by gasoline and are more likely to generate additional airborne contaminant. This would allow for a better assessment of the ice resurfacer operators complete exposure to the contaminants of interest. It is also further recommended that future exposure assessments take into account other hazards such as noise and vibration as the resurfacer can become particularly loud during operation. Lastly, future studies are also recommended to confirm the findings of this study.

Acknowledgements

This project was co-funded by Ryerson University and Toronto Public Health. We would like to acknowledge the ice resurfacer operators and their respective City of Toronto facilities for their time and cooperation. Furthermore, we would like to acknowledge Chris MacDonald and Joseph Xavier for their dedication, time and commitment to ensuring the success of this project.