18th ETH-Conference on Combustion Generated Nanoparticles, Zurich, June 2014

DIESEL EXPOSURES IN PORT WORKERS IN MONTREAL, CANADA

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Introduction

Exposure to diesel-emitted particles has been linked to increased cancer risk and cardiopulmonary diseases.

The aim of this study was to assess the occupational exposure of port workers to various emissions of diesel engines from container trucks using several measurement devices.

The port of Montreal moves more than one million TEU (twenty-foot equivalent unit) containers each year. Around 2500 container trucks go through the port gates every day and each one has to stop at one of the checkpoints to enter and leave the terminals.

Methods

A 10-day measurement campaign was carried out at two terminal checkpoints (CAST and RACINE) in 2013:

- **Personal measurements (Figure 1):** respirable elemental carbon (EC) (Method NIOSH 5040), gases (NO_2, NO, CO) in six workers
- Two urine samples (Monday before work, Friday afternoon) for six workers were collected for the determination of 1-hydroxypyrene (1-OHP), a biomarker of the exposure to polycyclic aromatic hydrocarbons (PAHs).
- **Stationary measurements (Figure 2&3):** particle mass concentration (PM) (Dust-Track DRX), particle number concentration (PNC) (P-Trak), particle size distribution (Engine Exhaust Particle Sizer EEPS)

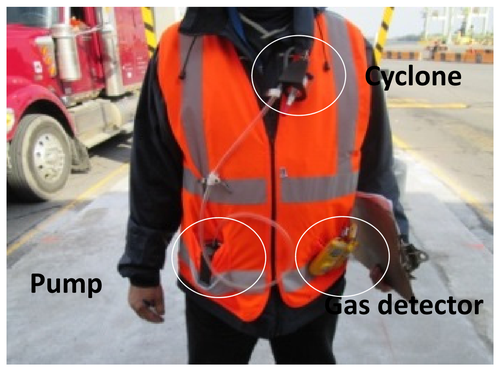

Figure 1: Personal sampling of elemental carbon (pump & cyclone), carbon monoxide (CO) and nitrogen oxides (NO2 & NO).

Figure 2: stationary measurements at the terminal

Figure 3: Checkpoint “CAST”

Figure 4: Older truck with exhaust pipe at the level of the workers

Results

Personal measurements

- Average daily cumulative concentration of respirable EC was 2 µg·m^{-3} (maximum: 4 µg·m^{-3}). The correlation to respirable PM and PNC was moderate to low **(Figure 5)**.
- The elementary chemical composition and morphological analyses using microscopy showed the presence of spherical aggregate carbon particles associated with various metals such as iron and aluminum **(Figure 6)**.
- Maximum concentration of urinary 1-OHP was 0.12 µmol/mol creatinine and no significant 1-OHP concentration increase was observed during the week.

	EC	PM resp	PNC
EC	1		
PM resp	0.40	1	
PNC	0.33	0.72	1

Figure 5: Pearson correlation coefficients between daily personal EC, stationary respirable PM and stationary PNC.

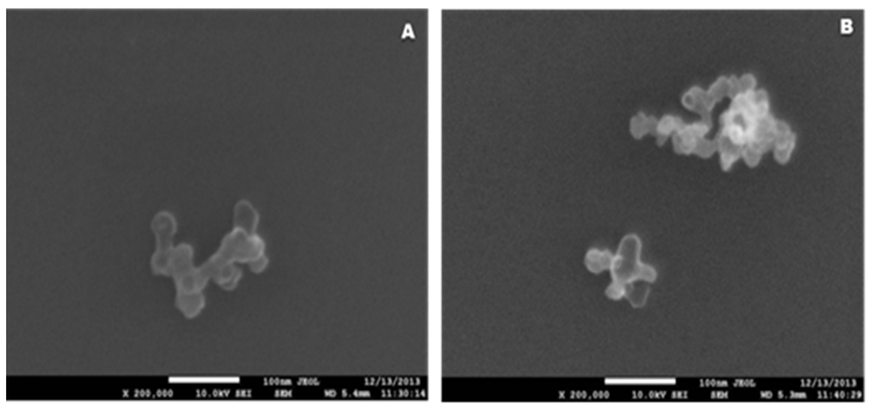

Figure 6: Particles collected on a copper grid analysed by Scanning Electron Microscopy (A: 200000 X; B: 200000 X)

Stationary measurements

- Average hourly (±standard deviation) PNC was 38,500 (±20,000) p·cm^{-3} **(Figure 7)**. Daily average PNC ranged between 16,500 and 67,300 p·cm^{-3}.
- Peaks up to 500,000 particles·cm^{-3} were associated with the crossing of container trucks with cooling systems and “old” trucks with engine exhausts at the level of the worker **(Figures 4, 8)**.
- The main particle size fraction was 20-40 nm, with 99% < 100 nm.
- Wind speed and the number of trucks explained 43% of the total variance of the particle number concentration **(Figure 9)**.

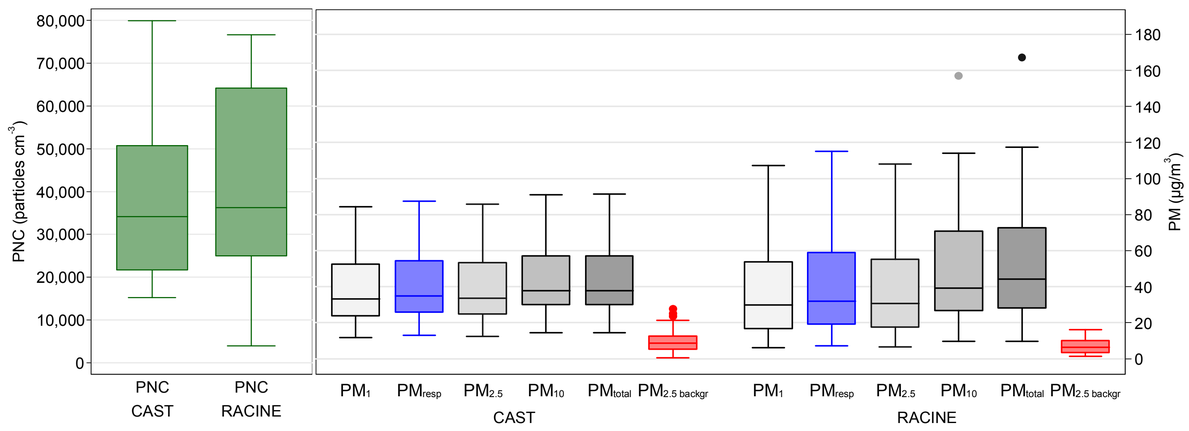

Figure 7: Hourly PNC, various PM fractions and background $PM_{2.5}$ by gate.

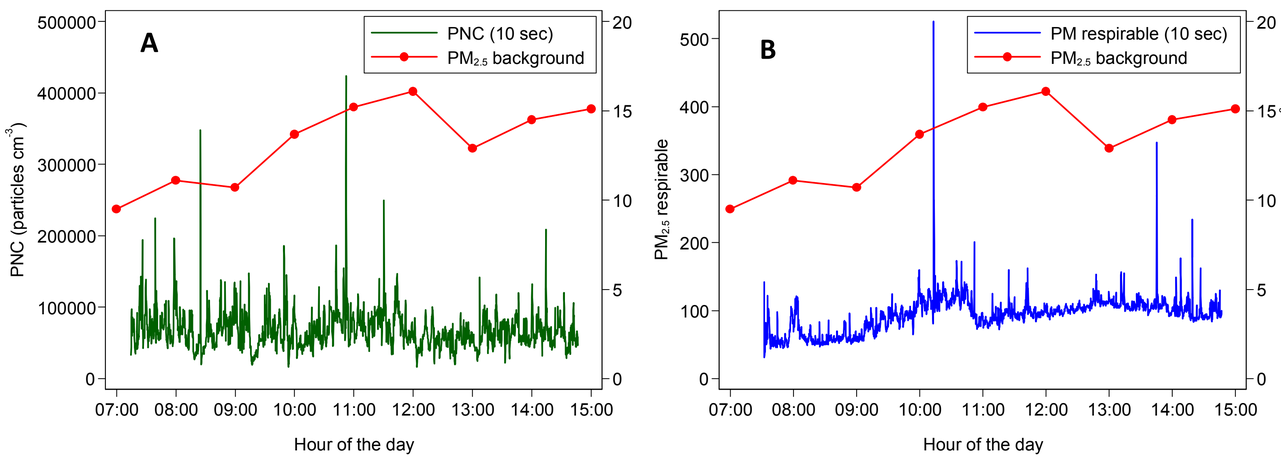

Figure 8: Diurnal profiles of PNC (A), PM_{resp} (B) and background $PM_{2.5}$ for gate RACINE (31.10.2013).

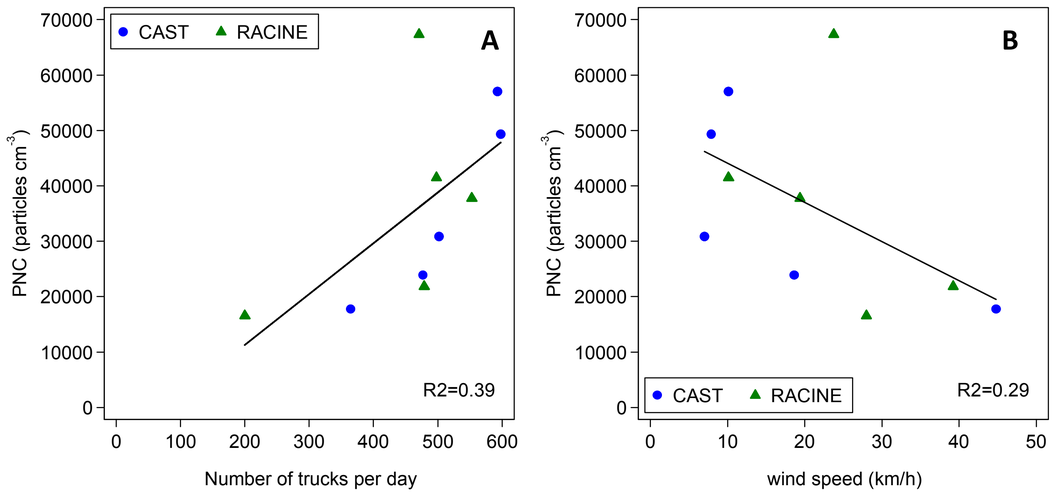

Figure 9: Correlation between daily PNC and number of trucks per day (A) and average daily wind speed (B).

Conclusions

- This study is a contribution to the understanding of the occupational exposures to diesel engines exhaust as few data are available for non-mining industries.
- Port workers employed at the checkpoints in Montreal are exposed to diesel exhaust below the elemental carbon recommendation level for workplaces of 100 µg·m^{-3}. However, precaution should be taken as lifetime occupational exposures to diesel exhaust below this limit have been suggested to excess lung cancer deaths through 80 years of age (Vermeulen et al. 2014).
- Further analyses on exposure determinants (with e.g. detailed data on background levels, meteorological data, port activities) and with other exposure groups of workers are needed to characterize occupational exposure to diesel and vessel engine exhausts.

We acknowledge the funding support by the port of Montreal and the Canadian not-for-profit research organization Mitacs.

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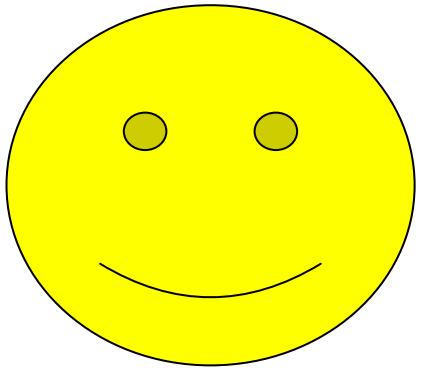
Index



Contents