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Indoor vacuum cleaner emissions: particle size distributions and health impact

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1. Introduction

Vacuuming can be considered as an essential cleaning activity in households. However, during this domestic work, resuspension of particles may occur. Household dust may come from indoor and/or outdoor sources. Dust is a complex mixture of particles that may contain toxic, carcinogenic or allergic components. Several studies have shown that dust particles can penetrate the respiratory tract and adversely affect the health of those present. The objective of this study is to determine the size distribution of resuspended particles during vacuum cleaning in a living room of a house, located in a suburban area of León (Spain).

2. Materials/Methods

The measurements were made in a house living room, with closed door-window conditions using four vacuum cleaners during about 45 min each

Following the standard ISO, 1995, the aerosol size fractions deposited in respiratory tract regions (inhalable, thoracic, tracheobronchial and respirable) were estimated

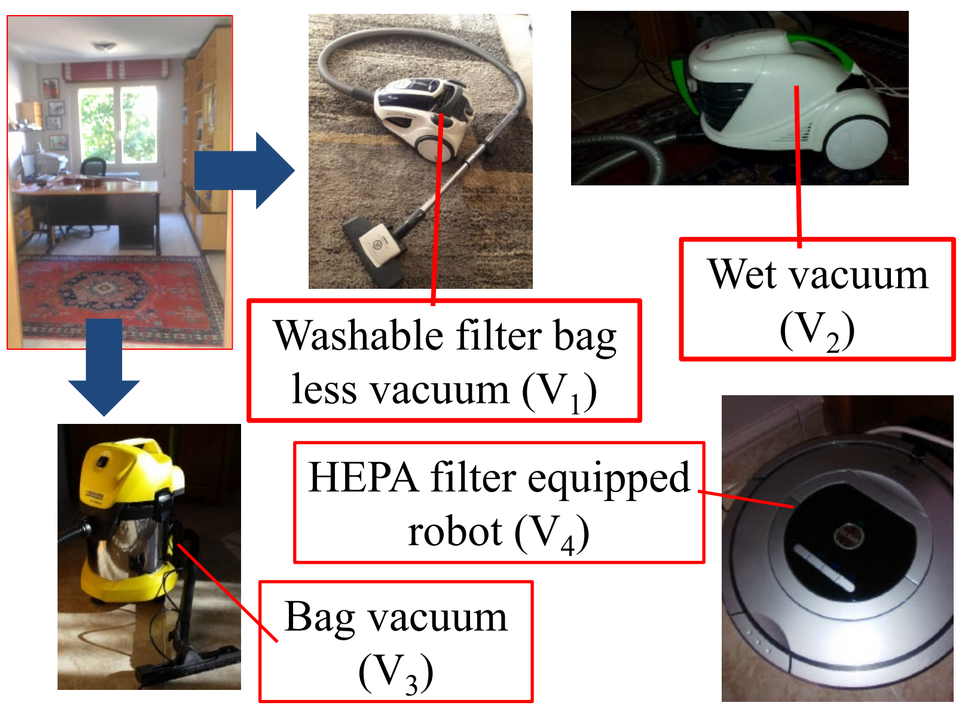

Fig. 1. Sampling site and vacuum cleaners

Fig. 2. Sampling instruments

Particle size distributions were measured using: **i**) a PCASP-X in a range between 0.1 and 10 μm; **ii**) a SMPS for the submicrometer particles ranging from 8 to 310 nm

iii) The aerosol light-attenuation at seven wavelengths was continuously measured with an Aethalometer model AE31

3. Results and Discussion

There is an increase in the particle number concentration during cleaning with the four vacuum cleaners and a decrease in the concentration of particles in the accumulation mode ($N_{>100\ nm}$) compared to the value obtained before cleaning (Table 1).

Table 1. Maximum particle concentration registered for the total distribution (Nt) and for each of the three modes: nucleation, Aitken and accumulation (in particles cm^{-3}) and variation of the particle number concentration before and during vacuuming (Δ_N) in %.

		V_1	V_2	V_3	V_4
Nt	Max	45,774	65,789	106,576	7,349*
	Δ_N	274	1647	163	-21
$N_{<30nm}$	Max	27,838	54,253	74,922	1,676**
	Δ_N	4,148	7,753	384	116
$N_{30-100nm}$	Max	11,091	11,057	37,045*	3,107*
	Δ_N	93	347	44	-37
$N_{>100nm}$	Max	8,998	554	3,263*	2,778*
	Δ_N	28	-17	-19	-40

*Value obtaining before vacuuming (considered between 10 min and 1 hour before vacuuming).
**Value obtaining after vacuuming (considered between 30 min and 1 hour after vacuuming).

The concentration of black carbon (BC) increases during vacuum cleaning activity (80- 200%), except for V_4, where the BC concentration decreases by 17%.

The maximum particle concentrations were recorded for $N_{<30nm}$ particles during vacuum cleaner, except for the V_4, which shows the maximum after it (Fig. 3a and 3b).

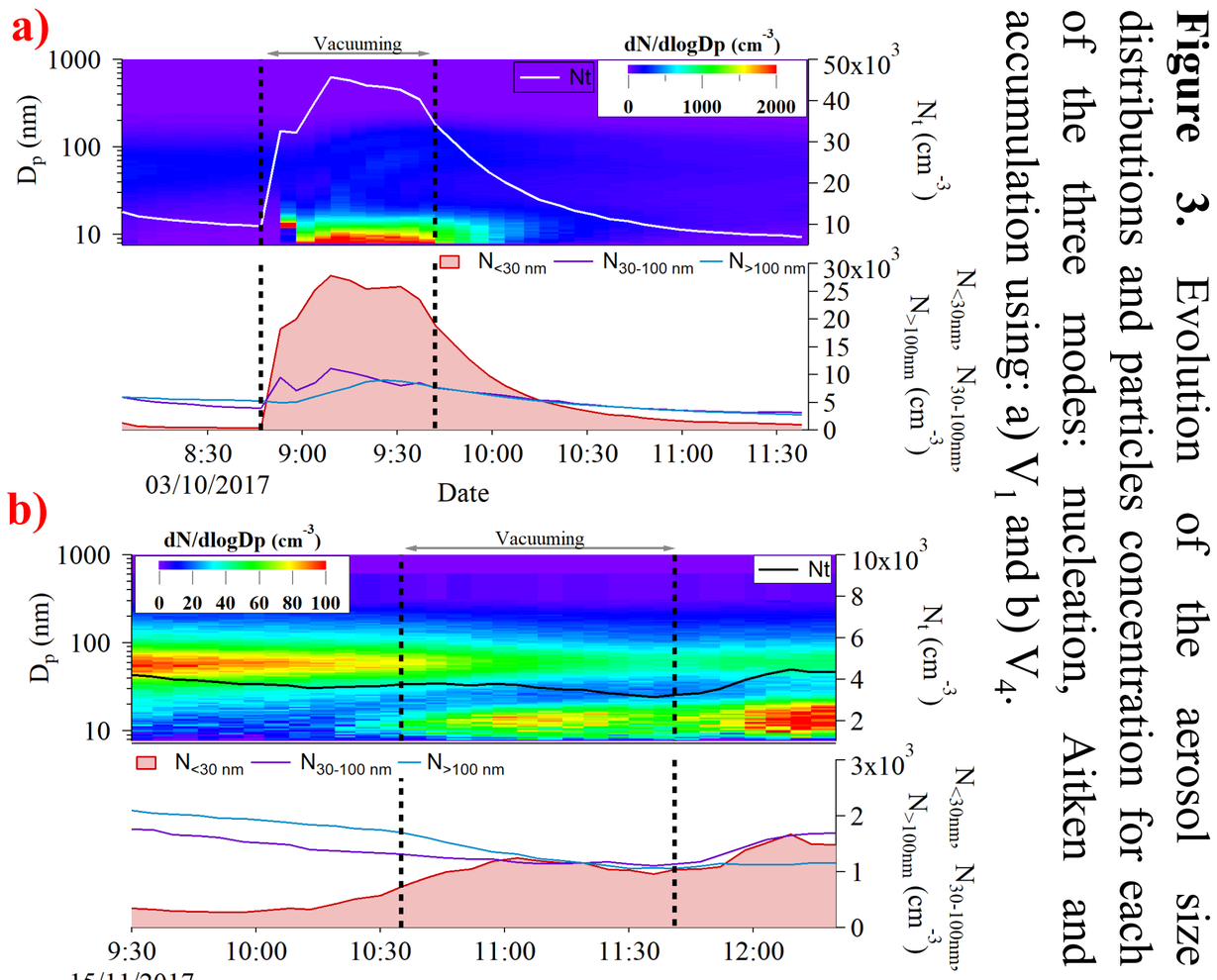

Figure 3. Evolution of the aerosol size distributions and particles concentration for each of the three modes: nucleation, Aitken and accumulation using: a) V_1 and b) V_4.

Table 2. % of particles that could reach the respirable regions

Fraction	% of particles
Inhalable	99
Tracheobronchial (healthy adults)	1- 4
Respirable	90- 95

The concentration of particles emitted from vacuuming equipment can be high during the vacuuming process, affecting the mass fraction of the particles deposited in the respiratory regions (Table 2). However, the levels of particles emitted during the process can be reduced by using vacuum cleaners equipped with HEPA filters.

5. Acknowledgement

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