Impact of household daily activities on indoor air quality

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Household activities, such as cooking and cleaning, are known to generate considerable amounts of particulate matter indoors. In this study, the impact of four standard vacuum cleaners (washable filter bag less vacuum, wet vacuum, bag vacuum and a HEPA filter equipped robot) and two flat irons (steam iron and a steam iron with boiler) on indoor particulate matter levels were studied. The measurements were performed in León (Spain), in a house living room trying to reproduce the everyday conditions in late autumn (all the doors and windows were kept closed due to the cold weather outside - situation 1). Additionally, the particulate levels generated during steam ironing were also characterized while keeping the room doors opened and the windows closed (situation 2). On average, 45 min measurements were conducted during vacuum cleaning and 3 and half hours during ironing. After each household activity, the sampling continued until the restoration of particle concentration to the original level. Background indoor air measurements were also performed. A real-time laser photometric instrument (TSI, DustTrak DRX 8533) was used to record particulate matter concentration over time. Submicrometer particle number concentration was measured using a Scanning Mobility Particle Sizer (SMPS, TSI Incorporated), which gives real time particle size distributions and number concentrations in the range from 7.64 to 310.6 nm. Simultaneous sampling with a PM_{10} high volume air MCV (model CAV-A/mb) instrument for gravimetric quantification was carried out. The equipment was operated at a flow of 30 m^3 h^{-1}. Particulate samples were collected on pre-weighed 150 mm quartz fibre filters (Pallflex®) for gravimetric and chemical analyses. The gravimetric quantification was performed with a microbalance (XPE105 DeltaRange®, Mettler Toledo). After gravimetric determinations, thermo-optical analysis of PM_{10} filters was performed to obtain the carbonaceous content.
Regarding vacuum cleaning, the highest increase of PM_{10} concentrations and total particle number concentration was observed using the wet vacuum, 14.5 fold and over 40-fold compared to background concentration , respectively. A 2-fold increase in PM_{10} mass over the background level was observed during the use of the HEPA filter equipped robot. $PM_{2.5}$ to PM_{10} ratios ranged from 0.43 (HEPA filter equipped robot) to 0.81 (wet vacuum). As regards the total number of particles, the readings were in the same order of magnitude, before, during and after the vacuum operation. Total carbon accounted from 9.0 ± 1.8 (wet vacuum) to 45.5 ± 4.1 (HEPA filter equipped robot) % wt. of the PM_{10} mass.
Average PM_{10} mass concentration during situation 1 steam ironing without (191 ± 16 µg/m^3) and with boiler (180 ± 20 µg/m^3) increased over 15 and 14 times compared to background concentration, respectively. Steam ironing under situation 2 conditions still increased the PM_{10} concentration 4.8 times (60 ± 17 µg/m^3). The lowest $PM_{2.5}/PM_{10}$ ratio (0.87) was observed during steam ironing under situation 2 conditions. Total particle number concentrations were from one to almost two orders of magnitude higher during ironing than before the activity start.

Total carbon accounted for 30.4 ± 5.1 (steam ironing, situation 1), 51.8 ± 8.2 (steam ironing, situation 2) and 38.8 ± 3.1 (boiler steam ironing, situation 1) % wt. of the PM_{10} mass.