

REMOVAL OF DUST WITH DIFFERENT CLEANING METHODS IN A LIBRARY STORE

Raimo Halonen¹, Esko Korhonen¹, Timo Kesikuru¹, Kujanpää Liisa², Marjut Reiman², Helmi Kokotti¹

¹*University of Kuopio, Kuopio, Finland*

²*Regional Institute of Occupational Health, Kuopio, Finland*

ABSTRACT

This study included the IAQ survey concentrated on particle levels in the library store (area of 1000 m² and having books or journals over 100 000 pieces in total) at the basement. The store was divided into three sections covered with plastic walls. Each section was cleaned with three different methods: two vacuum cleaners equipped either by HEPA filters I or II and one cleaner equipped with a water filtration unit. In addition, the surfaces of all sections were swept by wet cloth after twelve hours of vacuum cleaning. The relative humidity and temperature were found to be nearly the same during three cleaning periods. Both wet and two dry cleaning methods were found to remove dust on surfaces similarly effective.

KEYWORDS

Dust, cleaning method, filtering, air cleaning, library

MATERIALS AND METHODS

The object site of this study was the library store (area of 1000 m²) at the basement, where about 100 000 books or papers were stored. The floor, walls and ceiling were constructed from painted concrete and shelves were constructed from painted steel. Ventilation ducts of steel were not painted. The air flow amount was designed to be 1 dm³/m²s. The store was divided into five sections separated with plastic walls: the supply air section, the exhaust air section, three cleaning sections (1, 2 and 3) according to cleaning order and methods: two different types I and II of vacuum cleaners equipped by HEPA filter and a vacuum cleaner with water filtration. Each section (area of 160 m²) was cleaned by two vacuum cleaners of the same type. Figure 1. All sections were swept by wet cloth treated by disinfectant after a half day of vacuum cleaning. Delicate papers were brushed under the local exhaust equipment. The door openings of each section were in direction of the exhaust air vent and thus, each section was slightly depressurized.

Sampling locations were chosen so that they presented different heights of dust settling (on the floor, on the shelf and above shelves) and they uniformly presented the whole cleaning area. The temperature and relative humidity were monitored (Vaisala HMP 143 A, Vaisala HMP 230 and a data taker Grant SQ 1027) continuously as ten minutes averages during cleaning periods. The surfaces of all sections were swept by wet cloth after twelve hours of vacuum cleaning. The additional effect of the air cleaner was studied in the section cleaned with the HEPA I vacuum cleaner. The concentrations of particles were measured by BM Dust detector on surfaces and by Climet CI 500 (range from 0,3 μm to 25,0 μm) and ELPI (Electrical Low Pressure Impactor, range from 30nm to 10 μm) in indoor air.



Figure 1: A cleaning worker in a library store.

RESULTS

Relative humidity and temperature

Averages of relative humidity (%) and temperature ($^{\circ}\text{C}$) in room air during three cleaning periods were nearly the same: 19% and 24 $^{\circ}\text{C}$ (water filtration); 24% and 26 $^{\circ}\text{C}$ (HEPA I); 22% and 27 $^{\circ}\text{C}$ (HEPAII).

Particles

The dust concentration on painted metal surfaces of book shelves decreased the most and the dust concentration on the painted rough concrete floor was the highest before and after cleaning (Figure 2). The concentrations of airborne particles (0.3-25 μ m) increased clearly during working hours (from 6 am to 6 pm) (Figure 3.) Total concentrations of airborne particles (0.3-25 μ m) during cleaning (from 6 am to 6 pm) were in three sections according to the cleaning method as follows: water infiltration, 38.6×10^4 #/dm³; HEPA I, 26.2×10^4 #/dm³ and HEPA II, 17.2×10^4 #/dm³. Although the total concentrations of airborne particles was the lowest during cleaning with vacuum cleaners having HEPA filters I or II, the concentration of the particles above the size of 1 μ m were the highest in comparison with the water infiltration vacuum cleaner (Figure 4.). When the air cleaner operated, the total concentrations of airborne particles having size range from 0.030 μ m to 10 μ m decreased remarkably to the concentration of 10×10^5 #/dm³ being one third of the original concentration (Figure 5.).

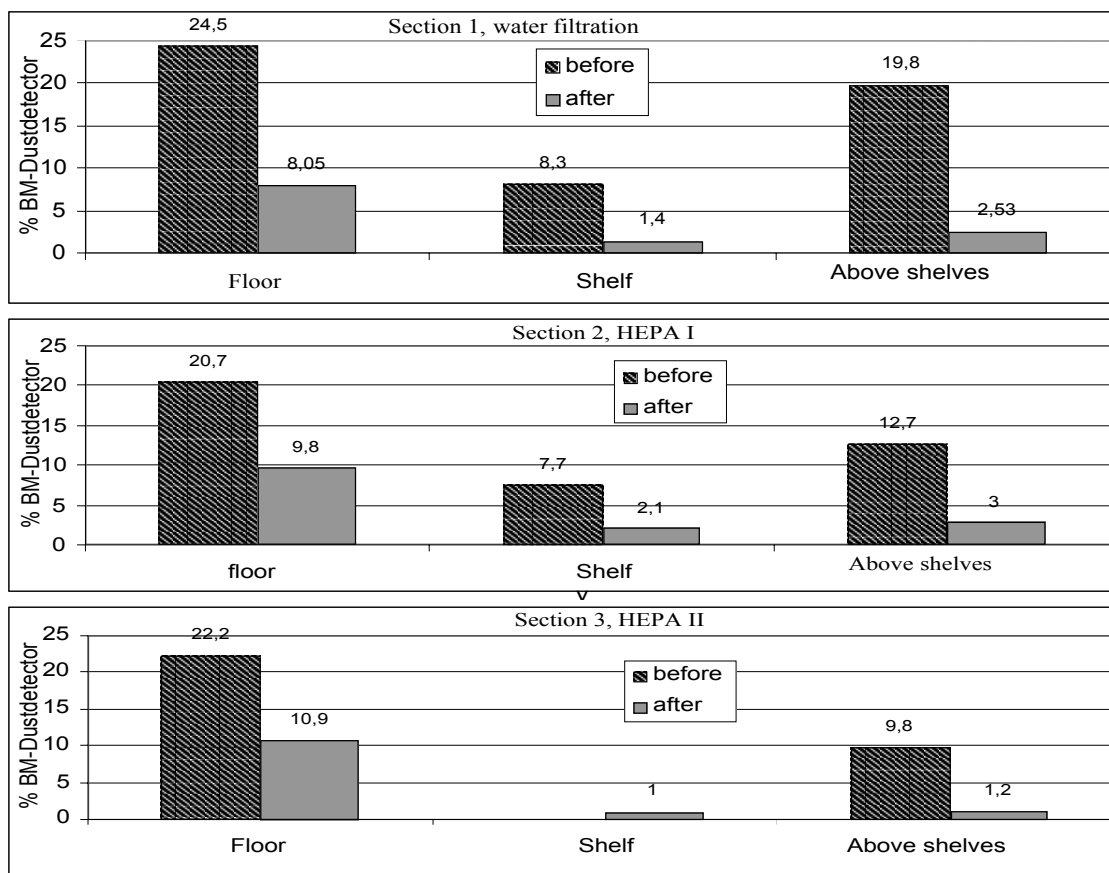


Figure 2: Relative dust concentrations (BM Dust detector) on painted metal surfaces of book shelves and on the painted rough concrete floor in three sections divided according to the cleaning method: water infiltration, HEPA I and II.

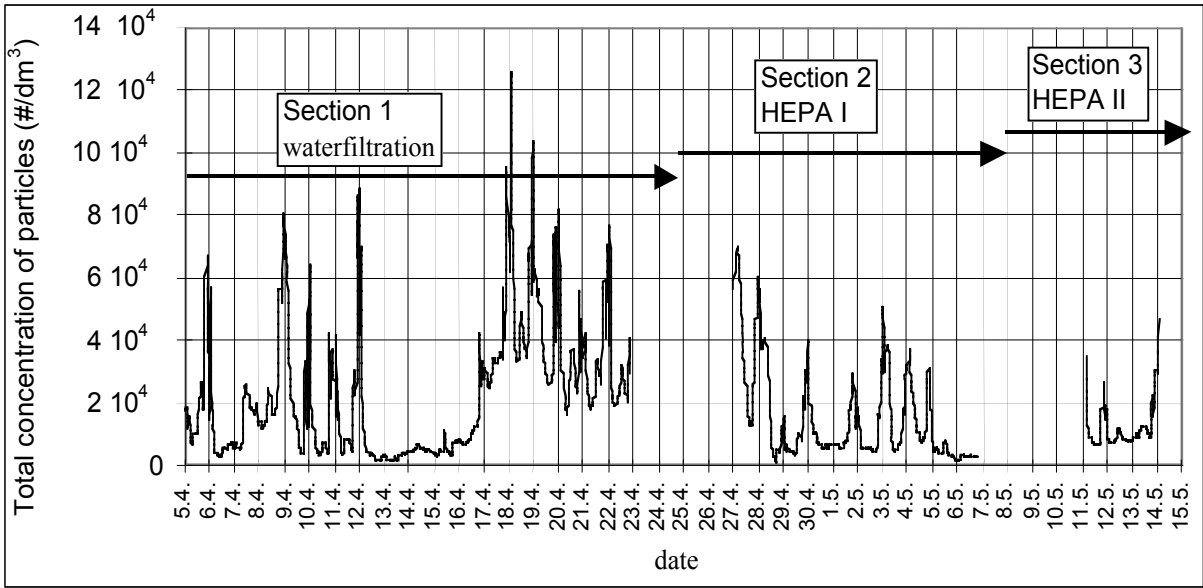


Figure 3: Total concentrations of airborne particles (Climet CI 500, 0.3-25 μm) during cleaning (from 6 am to 6 pm) and nights in three sections divided according to the cleaning method: water infiltration, HEPA I and II.

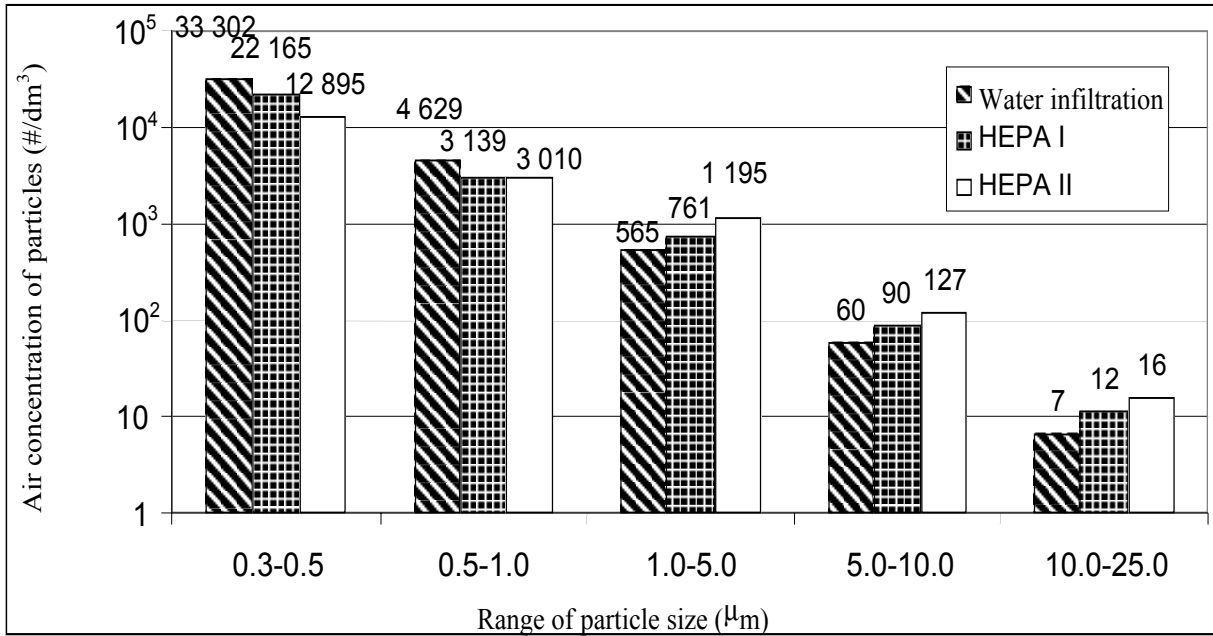


Figure 4: The concentrations of airborne particles in different size ranges (Climet CI 500, 0.3-25 μm) measured during cleaning (from 6 am to 6 pm) in three sections divided according to the cleaning method: water infiltration, HEPA I and II.

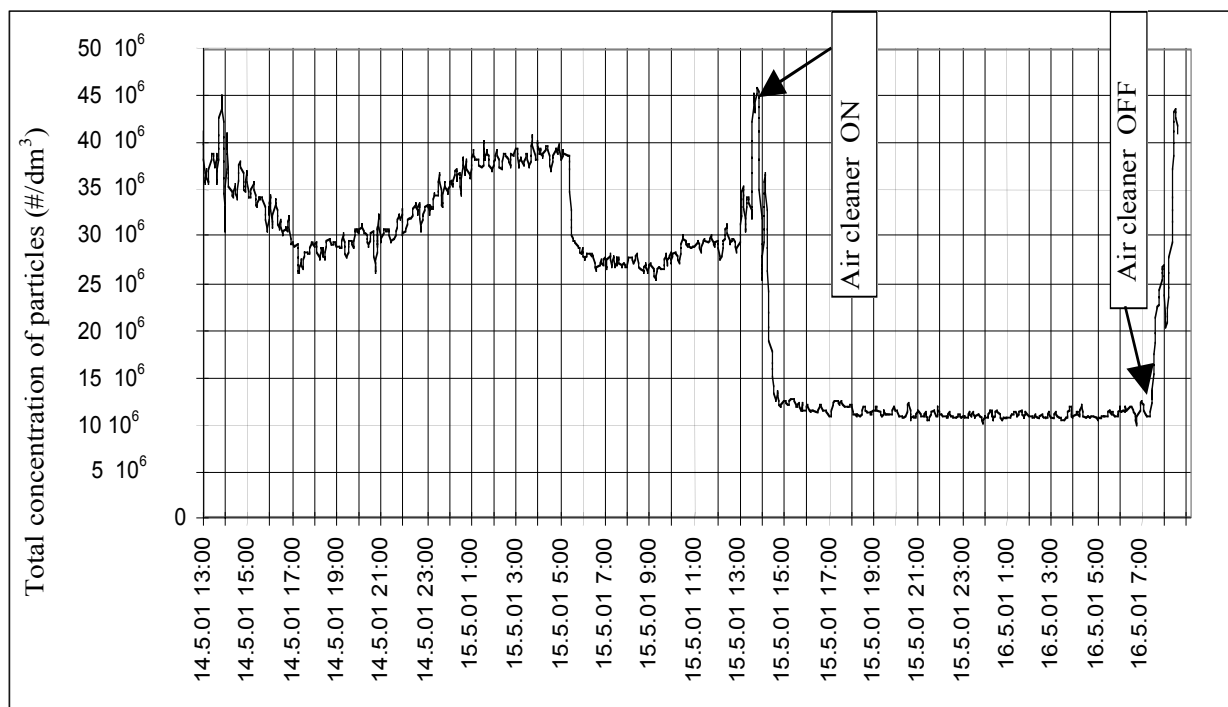


Figure 5: Total concentrations of airborne particles (ELPI, in the range of 0.03 μm to 10 μm) during operation of the air cleaner in the section cleaned earlier with the vacuum cleaner having the HEPA I filter.

DISCUSSION AND CONCLUSIONS

Only a few studies (Reiman et al, 2002) on the effect of cleaning on indoor air quality in moisture damaged buildings has been earlier reported. According to them the normal cleaning after repair work is not enough to clean the surfaces from microbial contamination. According to our results the dust concentrations in air increased clearly during all cleaning periods. In addition, the concentration of the particles above the size of 1 μm were the highest during dry cleaning in comparison with the water infiltration vacuum cleaning. This observation might be significant, because the size of mould spores are expected to range from 1 μm to 200 μm . Indeed, the microbial study (Kokotti et al., 2002) conducted at the same time with this particle study revealed that all cleaning methods lowered microbial concentration in air and on surfaces, especially xerophilic fungi with dry spores (*Aspergillus*, *Penicillium* and *Wallemia*) recovered most frequently before and after cleaning. Thus, these two findings together indicate that wet method is during cleaning slightly safer for the worker and after cleaning both wet and dry methods give similarly effective result. As final conclusion it can be stated that the dust can be more easily removed from the surfaces than in the air.

ACKNOWLEDGEMENTS

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REFERENCES

Reiman M., Kujanpää L., and Kujanpää R. (2002) Sufficiency of cleaning after repair of mold damage evaluated by microbiological methods. Abstract accepted to *EPIC 2002 AIVC* joint conference in Lyon, France, 23-26 October 2002.