

Two Studies Indicate Carpets Don't Re-Emit Trapped Contaminants

The following two research studies conducted in schools indicate that carpets have little effect on airborne contaminants. One study compared a carpeted classroom with a tile-floor classroom and found similar levels of contaminants. Differences, in fact, were more likely associated with occupancy levels and ventilation. The other study looked at complaint rooms and found little association between health complaints and carpet-borne contaminants. Instead, the researchers found a closer association with high indoor relative humidity (RH).

These findings are interesting. The common wisdom is that because carpets can act as a sink for some contaminants, they will also act as a source. The researchers in the second study challenged that notion and speculated that the carpets actually act as a trap and hold contaminants in place until they can be removed by cleaning. Whether that actually happens, however, depends on several factors including carpet construction and cleaning practices (see story on page 1).

Research Compares Airborne Contaminants in Two Classrooms

The first study comes from Air Quality Sciences, Inc. (AQS — Atlanta, Georgia), which has done numerous studies on carpets and their effects. AQS also works with the carpet industry in its emissions testing program to rate carpet samples.

In this study, AQS looked at two classrooms in an elementary school, which consists of four classroom buildings surrounding a main office facility. The school also has a cluster of portable buildings adjacent to the structure. The researchers chose two of the portable buildings for the study.

At the time of the study, Building 1, approximately 670 square feet (ft²), was one year old and contained all vinyl composition tile (VCT). It housed 15 students and 1 teacher during the normal school day, which ran from 8 am to 2:15 pm Monday through Friday.

Building 2, also 670 ft², was seven years old and contained 500 ft² of carpeting and 170 ft² of VCT. It housed 28 students and 1 teacher during the same schedule as Building 1. Each building also has wall surfaces of wood paneling and a porous, dropped tile ceiling.

For air conditioning, each trailer had a wall-mounted HVAC unit. The system used two ducted supplies with a single return vent in the rear of each classroom.

Study Methods

The researchers studied environmental conditions in each building during one school day with normal activities taking place. Among the measurements taken were:

- Total volatile organic compounds (TVOCs);
- Formaldehyde;

- Particles 10 micrometers and less (PM₁₀);
- Dust mite allergens;
- Dust mite counts;
- Biocontaminants — fungi and bacteria; and
- Carbon dioxide (CO₂).

The researchers also monitored temperature, RH, and carbon monoxide, and sampled outdoor air (O/A). Monitoring for most contaminants took place at various locations within the classroom, while dust mite allergen and mite count readings were taken at 4, 24, and 43 inches off the floor — all approximate exposure locations for different activities. The outside monitoring took place at one location between the two classrooms.

Results

The researchers reported that TVOC concentrations in both rooms were similar — 60.8 micrograms per cubic meter (µg/m³) for Building 1 and 54.3 µg/m³ for Building 2. These aren't levels expected to cause irritation or discomfort. The researchers said the mixture consisted of aldehydes, terpenes, and various alkanes, and could have come from wood paneling, cleaning compounds, and waxes.

Formaldehyde concentrations were also below accepted limits, with the higher value in Building 1, which contained the VCT flooring — 52.8 µg/m³, compared to 24.4 µg/m³. The researchers noted that Building 1 is only one year old and said the higher concentration could be from newer building materials.

Average particle concentrations were very similar — 42 µg/m³ in Building 1 and 49 µg/m³ in Building 2. The peak concentrations were higher in

Table 1 — Airborne Measurements in Two School Buildings

Contaminant	Building 1	Building 2	Reference	Remarks
TVOC ($\mu\text{g}/\text{m}^3$)	60.8	54.3	200-500	Levels commonly found
Formaldehyde ($\mu\text{g}/\text{m}^3$)	52.8	24.4	120	Recommended level, equivalent to 0.1 ppm
Average PM ₁₀ ($\mu\text{g}/\text{m}^3$)	42	49	50	Recommended level
Peak PM ₁₀ ($\mu\text{g}/\text{m}^3$)	241	169	50	Recommended level
CO ₂ (ppm)	534	1,553	1,000	ASHRAE Standard 62-1989
Average Noise (dB)	69.6	74.5	80	Occupational guidelines for 24-hour exposure
Peak Noise (dB)	93.3	105	140	Occupational guideline for peak exposure
Fungi (cfu/m ³)	984	1,072	2,155	Outside air
Bacteria (cfu/m ³)	554	1,956	236	Outside air

Source: AQS

Building 1 than in Building 2 — $241 \mu\text{g}/\text{m}^3$ compared to $169 \mu\text{g}/\text{m}^3$. While the average concentrations were below the accepted limit, the peak concentrations were well in excess of that limit.

Building 2 had nearly three times the CO₂ concentration of Building 1, indicating that the classroom wasn't receiving the necessary amount of O/A for its occupancy. With sufficient ventilation, CO₂ concentrations should have stayed below 1,000 ppm.

Average noise levels were 69.6 dB in Building 1 and 74.5 dB in Building 2. Again, the levels were most likely related to the occupancy factor, as we might expect noise levels to be lower in the classroom with the carpet. Peak noise levels were 93.3 dB in Building 1 and 105.0 dB in Building 2. The researchers said these came from impaction noises, such as students slamming a book down on a desk or bumping the microphone.

Fungal concentrations in both classrooms were similar — $984 \text{ cfu}/\text{m}^3$ for Building 1 and $1,072 \text{ cfu}/\text{m}^3$ for Building 2 — compared with an outdoor concentration of $2,155 \text{ cfu}/\text{m}^3$.

Cladosporium and *Mycelia* were the dominant genera both indoors and outdoors.

Airborne bacteria were also higher in the carpeted classroom, and both classrooms exhibited

higher concentrations than outdoors. The researchers noted that this was most likely because of occupancy levels, resulting in a greater population density in Building 2 and less ventilation per person. Table 1 shows the airborne measurements in the two buildings.

Other Measurements

Dust samples indicated higher fungal levels in Building 1 with the VCT flooring. While the carpet dust in Building 2 had concentrations of $4.1 \times 10^4 \text{ cfu}/\text{g}$, the dust from the HVAC air duct of Building 1 had concentrations of $1.0 \times 10^6 \text{ cfu}/\text{g}$.

Surface samples showed 109 cfu/plate from the carpeted classroom, and 45 cfu/plate from the other classroom. Genera were similar in both rooms.

The researchers found no measurable levels of dust mite allergens in the dust from Building 1, although they did find mites — 15 mites/gram. In Building 2, the carpeted classroom, dust vacuumed from the carpet had 3,654 ng/g of allergen and 10 mites/gram. However, the monitoring showed no airborne mites or allergens in any of the heights measured in either classroom, even with significant activity going on in the rooms.