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TECHNICAL REPORT

Microchamber Protocols for Material Changes with Extreme Heat and Moisture

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Executive Summary

The rising occurrence of adverse climate events like natural disasters, and the extreme heat and humidity resulting from such incidents, can influence the indoor environment and human health. Chemical pollution within the built environment is particularly notable, with the use of a wide variety of synthetic materials. The effects of climate events like periods of extreme heat become more impactful as heat can be associated with increased chemical emissions. Volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and others can be emitted from building materials, furnishings, human activities, and the myriad of consumer products used within homes, schools, and offices. Many of these materials have not been thoroughly investigated in relation to extreme temperature change within the indoor environment. Currently, third-party certification and testing standards rely on standardized room temperature and humidity conditions, typically, 23°C or 25°C and 50% relative humidity. The aim of this research study by Chemical Insights Research Institute (CIRI) of UL Research Institutes was to close the gap with a more comprehensive scope of tested materials in higher temperature environments. The goal was to raise awareness of the issue of increased chemical emissions from extreme heat scenarios and resulting impacts on health.

Small and intermediate chamber testing of materials and their installation setups to provide an overall chemical emission profile of a built space has been the gold standard in the industry and the design community for decades; however, with greater choice in materials across multiple functions—design, cost, and utility, this type of testing may not be the best choice for efficient screening. CIRI researchers chose to employ a more rapid, easily modifiable testing method known as the microchamber. This method is easy to use and is backed by an American Society for Testing and Materials (ASTM) protocol, which can be adapted to suit solid materials, adhesives, paint, and more.[1] The research, which was conducted jointly between CIRI and the American Society of Interior Designers (ASID), utilized the microchamber because the total analysis time for a set of material replicates, sample duplicates, and background samples at two different chosen temperatures (26°C and 35°C) took less than a day's work for two materials tested simultaneously across the four available sample wells in the device.

Across the 18 building materials tested, 78% demonstrated increased emissions at a moderately elevated temperature. Chemical emissions from eight materials increased by statistically significant measures, and some of these products were labeled as "low-VOC" by the manufacturer. Much like "natural" food products, where the term "natural" is not regulated like an "organic" label, "low-VOC" materials may not signify any special testing or formulation and may not result in a more environmentally friendly and healthy product. This is concerning given current certification standards that do not incorporate temperature variation, only time, when assessing a material's suitability. Additionally, CIRI's results showed up to two-fold increases in the number of individual VOCs measured when assessed at the moderate temperature rise. Chemicals of concern related to respiratory, reproductive, and intestinal health effects were detected and increased when the temperature increased. The wood-flooring samples, for example, showed high levels of formaldehyde. Carpet flooring demonstrated higher total VOC (TVOC) concentrations than recommended by several third-party environmental testing organizations that align with human health hazards. More inexpensive materials did not necessarily translate to higher chemical emissions and vice versa. In fact, one of the most expensive materials—terrazzo flooring—demonstrated the greatest emission rate of all materials tested.

The results from this study may raise greater awareness of the issue of environmental factors affecting chemical pollutant loads within the indoor environment, especially considering human health. Since this issue has not been systematically studied and a limited number of materials were evaluated, results indicate a potential concern that should be studied further. The use of microchambers appears to be a good screening tool for evaluating potential chemical emissions efficiently.

1.0 Introduction

Exposure to chemicals in the indoor environment and their impact on occupant health can be affected by numerous sources, including outdoor pollutants, indoor emission sources, human activity, ventilation, and environmental conditions. Given the increasing amount of extreme weather episodes—like storms and high heat occurrences, and human-related factors—like power outages and moisture intrusion, the built environment is being affected. In recent years, impacts on indoor air quality from elevated levels of chemicals, like VOCs, SVOCs, and per- and polyfluoroalkyl substances (PFAS) permeating indoor air, has raised concern.[2,3] Previous research is minimal on the association between these chemical emissions and indoor climate changes. CIRI's previous research on the effect of temperature rise on building materials in a pilot study mostly showed that with increasing temperature, significant increases in chemical emission occurred from several building products. CIRI concluded the trial experiments with the need for more testing and a streamlined approach. This current research, as summarized in this report, represents a more holistic methodology with a wider range of building materials tested in microchambers. CIRI's goal was to provide evidence of the link between extreme outdoor temperature events and a subsequent rise in chemical emissions from indoor materials due to indoor temperature increase.

2.0 Experimental Approach

2.1 STUDIED MATERIALS

A broad scope of 18 commonly used building materials was selected as part of a climate research initiative in collaboration with ASID based on the design, popularity, and function of the materials. Prices of these materials ranged from basic to premium cost, providing a diverse representation across the built environment. Preference was given to materials of greater built environment surface areas like flooring (**Table 1**), ceiling and construction materials (**Table 2**), and wallcovering and textiles (**Table 3**). Each building material was prepared for sampling within the microchamber by cutting two 16 cm^2 pieces to use as sample duplicates. For the harder surface materials, approximate sized pieces were used.

Table 1. Modern flooring sample list. Price designations range from $-$$$.

Identifier	Material	Type	Composition	Designations	Price
Engineered hardwood flooring (EHF)	Wood	Flooring	Varnish, oak, wood/HDF), other wood		$
Laminate flooring (LF)	Wood	Flooring	Multi-ply + paper		$
Linoleum tile (LT)	Wood-containing	Flooring	100% natural biobased wood and resins	Natural/biobased	$$
Natural wood flooring (NWF)	Wood	Flooring	Solid 100% cypress	"low-VOC"	$$$
Vinyl composite tile (VCT)	Vinyl composite	Flooring	Vinyl composite	FloorScore certified	$
Rubber flooring (RF)	Rubber	Flooring	Rubber	Leadership in Energy and Environmental Design (LEED) low emitting	$$
Terrazzo flooring (TF)	Terrazzo	Flooring	Epoxy resin, amines, fillers	VOC < 50g/L	$$

Table 1. Modern flooring sample list. Price designations range from $-$$$.

Identifier	Material	Type	Composition	Designations	Price
Porcelain tile (PF)	Porcelain	Flooring	Mineral earth	UL GREENGUARD Certified	$$
Marble flooring (MF)	Marble	Flooring	Natural minerals		$$$
Olefin (polypropylene [PP]) carpet (OC)	Olefin	Flooring	Olefin		$$
Nylon carpet (NC)	Nylon	Flooring	Nylon		$$

Table 2. Ceiling and construction material sample list. Prices range from $-$$.

Identifier	Material	Type	Composition	Designations	Price
Acoustic ceiling tile (ACT)	Synthetic/ mineral	Acoustic tile	Resin plaster, marble sand, recycled minerals	“low-VOC”	$$
Felt acoustic tile (FAT)	Felt	Acoustic tile	Recycled polyethylene terephthalate (PET), latex backing		$$
Drywall (DW)	Gypsum	Wall/ceiling	Gypsum, paper	UL GREENGUARD Gold Certified	$

Table 3. Wallcovering and textiles sample list. Prices range from $-$$.

Identifier	Material	Type	Composition	Designations	Price
Polyester metal wallcovering (PMW)	Polyester/ metal	Wallcovering	Polyester (PE)/metallic foil		$$
Composite wall covering (CWC)	Composite	Wallcovering	Polymethyl methacrylate	UL GREENGUARD Gold Certified	$$
Vinyl textile (VTX)	Vinyl	Textile	Vinyl + urethane front/ PE backing	Formaldehyde-free, “low VOCs”	$
Polyester textile (PTX)	Polyester	Textile	PE + acrylic/ proprietary backing	Indoor Advantage Gold certified (CA01350, LEED)	$$

2.2 SAMPLING AND ANALYSIS METHODS

2.2.1 Microchamber Protocol and Analysis

A microchamber setup (**Figure 1**) was utilized for this study based on adaptations from ASTM method D7706-2017.[1] Sample duplicates were tested twice to provide a total of four individual measurements per material. An integrated heater provided the two temperature points used in this study, 26°C and 35°C. Background measurements were taken at each temperature prior to the testing of materials to determine if any chemicals were present within the microchamber wells.

Figure 1: Microchamber setup with four individual sampling wells (one well open shown above).

Each sample was placed into the microchamber well at the chosen temperature and equilibrated for 30 minutes. A set airflow rate of 0.2 L/min provided an air change rate of 105 h^{-1}. It was assumed that all sampled emissions from each microchamber well were captured directly onto the attached sorbent tubes. VOC sampling occurred for 15 minutes, and aldehyde sampling 30 minutes, for total sampled volumes of 3 liters and 6 liters, respectively. VOC samples were collected onto Tenax® TA sorbent tubes and analyzed by thermal desorption-gas chromatography/mass spectrometry (TD-GC/MS) in accordance with United States Environmental Protection Agency (U.S. EPA) TO-17.[4] Aldehyde samples were collected onto 2,4-dinitrophenylhydrazine (DNPH) cartridges and analyzed by high-performance liquid chromatography (HPLC) in accordance with U.S. EPA TO-11A.[5] For further information about these analytical procedures, see CIRI's Technical Brief 080, "VOC and Aldehyde Analysis Methods Used in Research Studies." The entire sampling and instrumental analysis process is depicted in **Figure 2**.

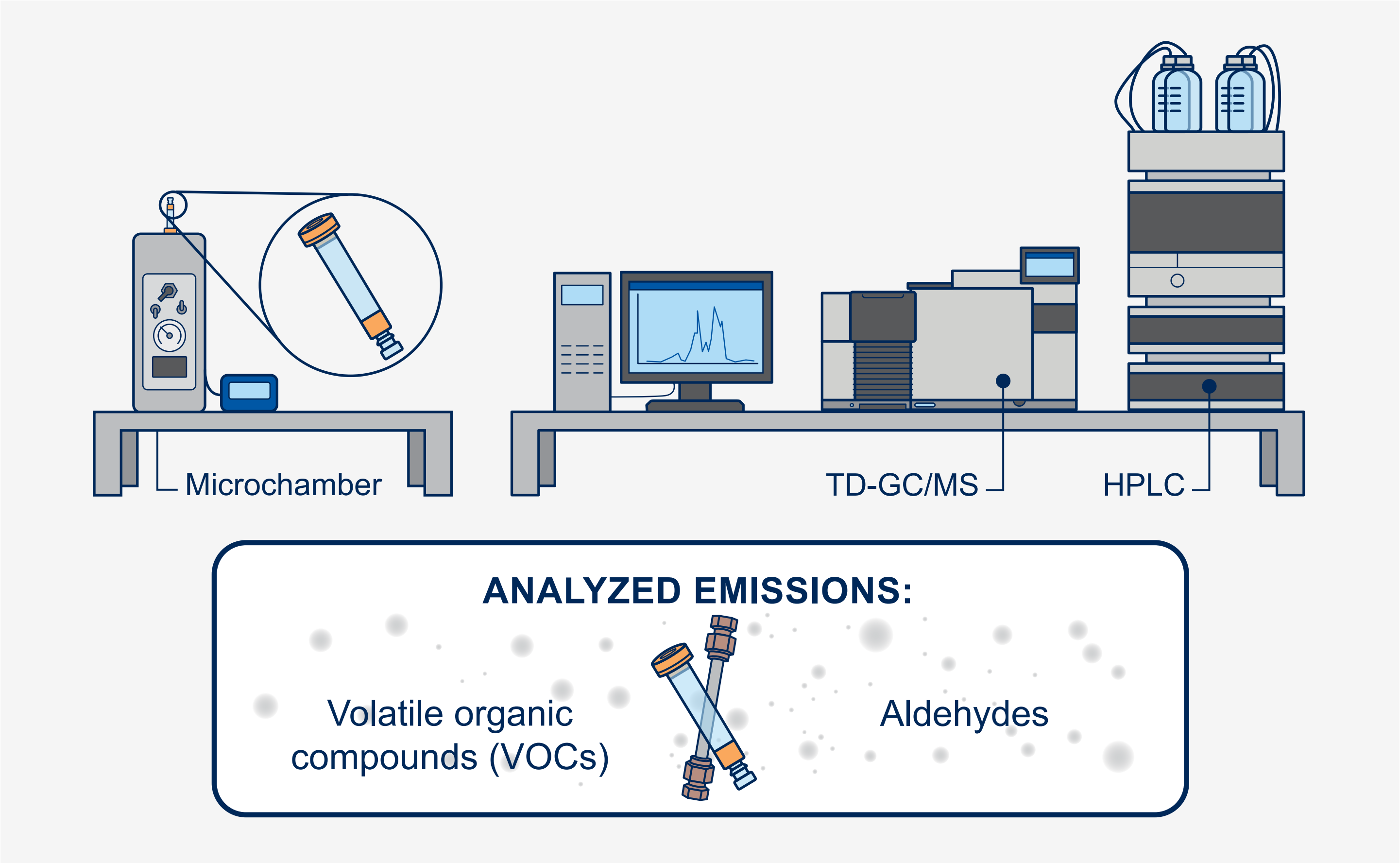

Figure 2: Methods diagram for the analysis of modern building materials.

Data analysis was performed within the instrumental software suites as well as with a combination of Microsoft Excel and GraphPad Prism (Version 10.2.3). TVOC calculations were performed in accordance with International Organization for Standardization (ISO) 16000-6:2021.[6] Emission factors were calculated according to UL 2904[7] following **Equation 1** below:

$$EF = C \times \frac{N}{L} \qquad (1)$$

where C is the VOC concentration in µg/m^3; N is the air change rate in h^{-1}; and L is the loading factor, which was the size of the material divided by chamber volume. Paired t-tests were run for each chemical within each data set with no corrections for multiple comparisons and a p-value of less than 0.05 for significance.

2.2.2 Exposure Modeling

Indoor exposure modeling was performed based on the single-family house adapted from UL 2904[7] with four bedrooms and two bathrooms. A living room and master bedroom were chosen with which to model exposure concentrations in this study, and the conditions of these rooms are shown in **Table 4**. The air change rate in a modern, energy-efficient home with a tight building envelope was chosen to be 0.23 h^{-1} in accordance with the UL standard.

Table 4. Dimensions of the model rooms.

Room	Floor/ceiling area (m^2)	Wall area (m^2)	Volume (m^3)
Living room	59.46	42.74	163.1
Master bedroom	16.96	19.76	38.92

The VOC emission rates calculated from the measured VOC and aldehyde data in relation to exposure potential were done using **Equation 2** below:

$$C'_i = \sum \frac{(EF_{ij} \times A_j)}{V_m \times ACH} \qquad (2)$$

where C_i' ($\mu g/m^3$) is the estimated concentration of the chemical *i*, EF_{ij} is the emission factor of compound *i* from material *j* based on microchamber characterization, *Aj* is the area of the material *j*, V_m (m^3) is the volume of the model room, and ACH (h^{-1}) is the air change rate of the model room.

3.0 Results

3.1 TOTAL VOLATILE ORGANIC COMPOUND EMISSIONS

Except for natural wood flooring, drywall, composite wallcovering, and polyester textile, TVOC concentrations and their corresponding emission rates at 35°C exceeded those at 26°C (**Table 5**). Engineered hardwood flooring, linoleum tile, terrazzo flooring, and olefin carpet demonstrated a two-fold increase in emissions compared to room temperature, and mineral acoustic tile showed a three-fold increase. Felt acoustic tile and nylon carpet samples measured five-fold increases in emissions at the higher temperature. Statistically significant increases were measured for eight of the 18 materials at increased temperature, and among those, four including rubber flooring, terrazzo flooring, mineral acoustic ceiling tile, and vinyl textile were labeled by the manufacturer as “low-VOC.” It is interesting to note that per the US Green Building Council’s LEED certification building standards, many of these materials would not pass the TVOC requirement if evaluated at the higher temperature for a longer time and would thus be responsible for higher chemical emissions within an indoor space. Of the wood flooring group, engineered hardwood had the fewest measured total emissions, and vinyl composite flooring emitted about four times less than the comparable rubber option. Marble flooring, which was the most expensive choice across all flooring materials, emitted the lowest concentration of TVOC; however, another expensive option, terrazzo, was responsible for the highest TVOC level across the entire scope of materials tested.

Table 5: Average TVOC concentrations (µg/m^3) of 18 modern building materials at two studied temperatures.

Material	Temperature 26°C	Temperature 35°C	Material Group	Price
Engineered hardwood flooring	9.3	22.7	Wood-based flooring	$
Laminate flooring*	288.5	369.6	Wood-based flooring	$
Linoleum tile flooring*	102.7	160.7	Wood-based flooring	$$
Natural wood flooring	452.7	345.9	Wood-based flooring	$$$
Vinyl composite tile flooring	16.8	17.0	Synthetic flooring	$
Rubber flooring*	47.8	63.3	Flooring	$$
Terrazzo flooring*	251.2	601.9	Flooring	$$
Porcelain tile	6.0	24.0	Flooring	$$
Marble flooring	7.9	9.7	Flooring	$$$
Olefin carpet	54.9	130.2	Carpet flooring	$
Nylon carpet*	23.5	107.6	Carpet flooring	$$
Mineral acoustic tile*	48.9	140.4	Ceiling	$$
Felt acoustic tile*	2.8	13.2	Ceiling	$$
Drywall*	11.3	3.7	Ceiling/wall	$
Polyester metal wallcovering	50.2	73.4	Wall	$$
Composite wall cover	7.9	5.3	Wall	$$
Vinyl textile*	94.0	138.1	Textile	$
Polyester textile	50.1	37.8	Textile	$$

The * denotes significant change ($p < 0.05$) in emission rate between the two temperatures. Within each material grouping type, the table is organized by increasing price.

3.2 INDIVIDUAL VOCS

The number of unique VOCs detected (**Figure 3**) showed a few interesting trends. Of the flooring and ceiling materials, almost 50% demonstrated greater than 50 individual VOCs. These specific materials also produced greater than 25% more VOCs at the increased temperature in this study. This is concerning given that, with a moderate change in temperature, the built environment may experience new chemicals that are not monitored with current testing and certification protocols. **Figure 4** presents the detection frequency of the top fifteen chemicals found across all 18 materials. Several chemical classes including aldehydes, alcohols, siloxanes, and organic acids were detected frequently in most materials and included common respiratory irritants and renal toxicants. **Tables A1-A18** in the Appendices list all detected VOCs found. The results are discussed briefly in this report.

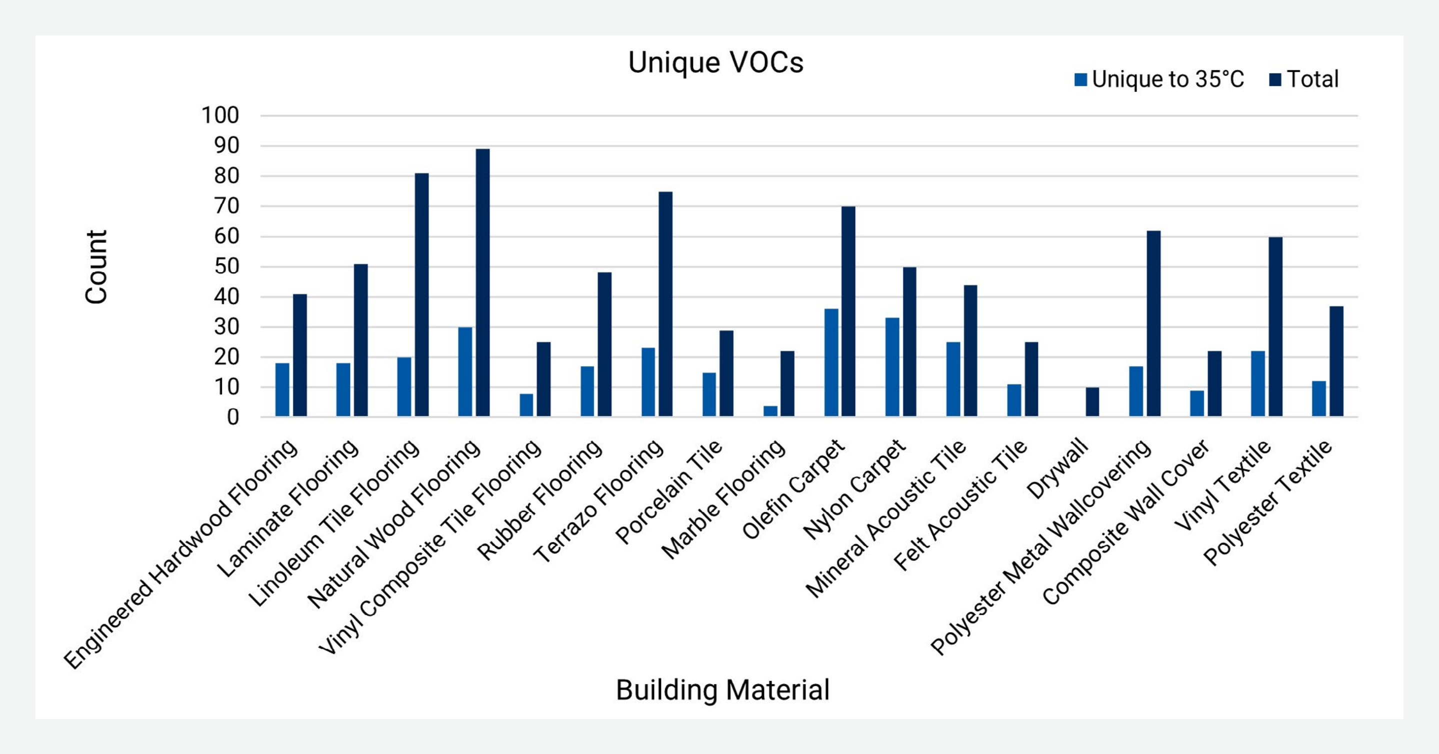

Figure 3: Count of unique VOCs detected from each studied building material.

Formaldehyde, which is an International Agency for Research on Cancer (IARC) Class I carcinogen, was detected in 75% of the wood flooring samples. Many of the VOCs emitted from the wood flooring were not only biogenic, or naturally based VOCs such as furfural, hexanal, benzaldehyde, and short-chain fatty acids, but also VOCs like phenol and toluene that are common to synthetic materials. The laminate and linoleum contained varying levels of longer-chain aldehydes and terpene-related molecules. Several additional chemicals of concern, however, were detected in the wood flooring samples when they were heated to 35°C, especially in the synthetic-based materials. These chemicals included diethyl phthalate, acetic acid, and various medium-chain aldehydes like pentanal and hexanal.

Among the carpet samples, the VOC emissions of the nylon carpet (**Table A10**) at 35°C (107.6 µg/m^3) exceeded those at room temperature (23.5 µg/m^3) by approximately five-fold, and the olefin carpet (**Table A11**) demonstrated approximately double the emissions at the higher temperature (130.2 µg/m^3 versus 54.9 µg/m^3). Several chemicals of concern like nonanal (190 µg/m$^{2}\cdot$hr) and caprolactam (307 µg/m$^{2}\cdot$hr) exceeded emission factor criteria from the industry's Green Label Certification program. A known endocrine toxicant, dibutyl phthalate, which was found in the olefin carpet, had almost six times the measured amount when the temperature was increased during the study. Both carpet samples had seven VOCs that were measured significantly higher at the higher temperature.

Among the miscellaneous materials, the highest TVOC emitter of all 18 materials at 35°C (601.9 µg/m^3) was terrazzo flooring, with VOC emissions approximately 1.5 times higher than laminate flooring (369.6 µg/m^3), the next highest emitter at the studied temperature. Appreciable levels (414.5 µg/m^3) of hexylene glycol, a known construction binder and solvent plasticizer, were found to represent more than half of the emissions for the TVOC levels for terrazzo flooring. The indoor air contaminant 2-ethylhexanol was also detected in a higher amount (14.2 µg/m^3) at the moderately-increased temperature condition in this flooring material. Rubber flooring contained butylated hydroxytoluene (11.3 µg/m^3 at 35°C). Across the wall and ceiling materials, the mineral acoustic tile—another material labeled as "low-VOC"—contained several common chemicals of concern including phenol (increasing from 12.6 µg/m^3 to 25.7 µg/m^3 with increased temperature) and 2-ethylhexanol (increasing from 1.9 µg/m^3 at 26°C to 3.1 µg/m^3 at 35°C), which were detected in 56% and 61% of all materials, respectively. The two textile materials released *para-tert*-butylphenol, a chemical found in adhesives and coatings.

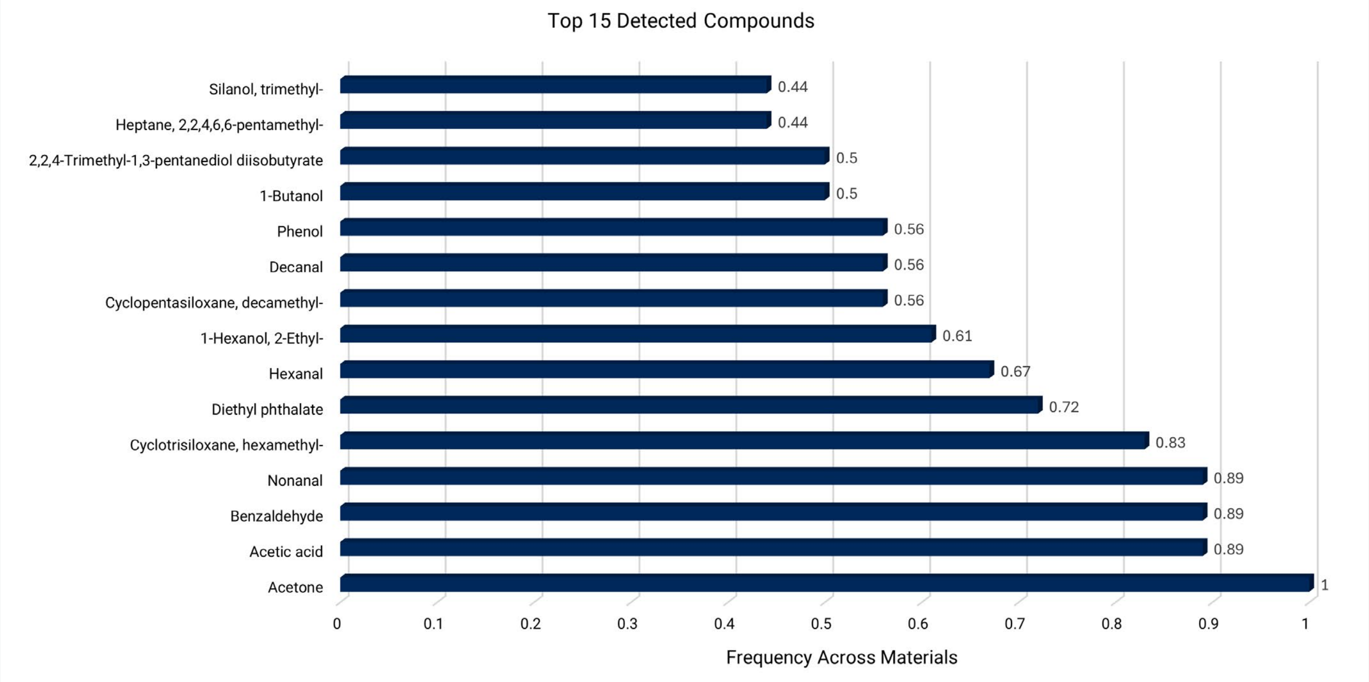

Figure 4: Top 15 detected chemicals across all building materials.

3.3 EXPOSURE LEVEL MODELING IN A SINGLE-FAMILY HOUSE

Table 6 describes the estimated exposure TVOC levels for a modeled living room and primary bedroom with several choices in materials. Emission factors used in exposure modeling were derived from microchamber testing and may not be representative of full chamber test results. Exposure results should be considered estimates. For each room, a high-emitting and low-emitting option were chosen for flooring and ceiling materials, and the results of the model can be seen for both room temperature and moderate temperature rise. Only the pairing of felt acoustic tile and engineered hardwood flooring (**Table 6**) resulted in an exposure concentration (458 µg/m^3) less than the LEED TVOC level (500 µg/m^3). More than 60% and 85% of the material combinations at normal temperature and higher temperature, respectively, gave TVOC concentrations greater than 1000 µg/m^3. Additionally, with the moderate rise in temperature, room TVOC concentration increased 1.9-3.2 times. Only emissions from the materials were considered, and no potential sinks in the room were included, which may have overestimated the exposure levels. Finally, increasing air change rates aid in reducing exposure concentrations.

Table 6: Estimated exposure modeling TVOC concentrations (µg/m^3) in a living room and primary bedroom.

Room	Material	Mineral Acoustic Tile		Felt Acoustic Tile	
		26°C	35°C	26°C	35°C
Living Room	Engineered Hardwood Flooring	789	1970	241	458
	Terrazzo Flooring	3664	8855	3116	7343
Primary Bedroom	Olefin Carpet	1662	3906	1007	2098
	Nylon Carpet	1217	3586	562	1778

4.0 Conclusion and Future Direction

Findings suggest moderate temperature increases can significantly impact VOC and aldehyde emissions from modern building materials, including those labeled as "low-VOC." Such emissions pose a risk to indoor air quality, particularly as global climate patterns change and indoor environments experience extended periods of elevated temperatures. Future research should include additional environmental factors, such as varying humidity, as a testing parameter to evaluate its combined impact with elevated temperature on chemical emissions. A comparative analysis between the standard chamber methodology and microchamber technology of the chemical emission of key materials such as engineered hardwood, nylon carpet, and acoustic tile is warranted. Furthermore, examining how emissions from recycled materials differ from non-recycled materials could provide new insight into the use of sustainable building methods. By incorporating these methods, the building industry can improve indoor air quality and adapt to the evolving challenges that are caused by temperature changes within the indoor environment.

5.0 REFERENCES

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6.0 Appendices

Table A1. Detected VOCs (concentrations in μg/m³) in mineral acoustic ceiling tile.

Chemical	26°C	35°C
5-Methyl-1-heptanol		1.2
1,2-Benzisothiazole		1.6
1,2-Propanediol, 1-phenyl-		0.7
1-Butanol	1.4	0.9
1-Ethyl-2-methylbenzene(2-Ethyltoluene)	1.0	
1-Hexanol, 2-ethyl-	1.9	3.1
1-Hexene, 2,5,5-trimethyl-		1.4
1-Octanol, 3,7-dimethyl-		1.4
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	0.6	1.5
Texanol	15.2	31.7
2,5-Cyclohexadiene-1,4-dione, 5-chloro-2,3-dimethyl-, 1-oxime, o-benzoyl-		1.9
2-Hydroxy-iso-butyrophenone		1.2
3,7-Dimethyl-1-octanol		1.4
Acetic acid	2.7	2.9
Acetone	1.5	3.3
Benzaldehyde	0.6	
Benzene, 1,2,4-trimethyl-	1.0	0.8
Benzene, 1-ethyl-4-methyl-		2.9
Benzenemethanol, .α.,.α.-dimethyl-	0.8	2.1
Benzoyl isothiocyanate		2.1
Cyclohexane, isocyanato-		1.5
Cyclohexane, isothiocyanato-		1.2
Cyclopentane, 1,1,3,3-tetramethyl-		0.7
Cyclopentasiloxane, decamethyl-	0.8	0.6
Cyclotrisiloxane, hexamethyl-		1.6
Ethanol		0.7

Table A1. Detected VOCs (concentrations in μg/m³) in mineral acoustic ceiling tile.

Chemical	26°C	35°C
Ethanol, 2-[2-(2-butoxyethoxy)ethoxy]-		13.0
Ethylbenzene		1.9
Glycerol 1,2-diacetate		2.7
Heptane, 2,4-dimethyl-		0.5
Hexane, 3-bromo-		0.5
Nonanal	0.6	0.7
ortho-Xylene		1.2
Oxalic acid, allyl nonyl ester		0.6
para-Xylene		3.5
Pentane, 2,2,3,4-tetramethyl-	0.5	0.6
Pentane, 2,4-dimethyl-		0.5
Phenacylidene diacetate	1.1	2.0
Phenol	12.6	25.7
Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	11.2	23.4
Silanol, trimethyl-		1.8
Triacetin		2.6

Table A2. Detected VOCs (concentrations in µg/m³) in composite wallcovering.

Chemical	26°C	35°C
2,4-Di-tert-butylphenol	1.5	0.7
2,6-Dihydroxybenzoic acid, 3TMS derivative		0.2
Acetone	4.3	4.2
Benzaldehyde	0.4	0.4
Cyclotetrasiloxane, octamethyl-	0.6	0.5
Cyclotrisiloxane, hexamethyl-	0.9	1.0
Decanal		4.2
Diethyl phthalate	1.4	1.8
Disiloxane, hexamethyl-	0.8	
Hexane	0.3	
Isopropanol	0.8	
Methyl formate	0.7	0.5
Nonanal		20.2
Octanal		0.3
Oxalic acid, butyl propyl ester		0.3
Pentanoic acid, 5-hydroxy-, 2,4-di-t-butylphenyl esters		0.4
Phenacylidene diacetate		0.3
Phenol, 2,6-bis(1,1-dimethylethyl)-		0.7
Phthalic acid, ethyl hex-2-yn-4-yl ester	1.0	
Silanol, trimethyl-	1.1	
Toluene	1.6	1.1

Table A3. Detected VOCs (concentrations in µg/m³) in drywall.

Chemical	26°C	35°C
1-Butanol	0.5	
2-Pentanone	5.5	1.5
Acetone	3.2	2.0
Cyclotrisiloxane, hexamethyl-	1.2	
Dodecane		1.7
Heptane, 2,2,4,6,6-pentamethyl-	3.4	1.8
Hexanal	0.6	
Pentanal	1.4	
Undecane, 3-methyl-		0.6

Table A4. Detected VOCs (concentrations in μg/m³) in engineered wood flooring.

Chemical	26°C	35°C
1,2-Propanediol	3.6	
α-Phellandrene		0.6
α-Terpineol	0.5	0.6
ß-Myrcene	1.0	1.0
1-(Adamantan-1-yl)-2-chloroethanone		1.2
1,4-Methanobenzocyclodecene, 1,2,3,4,4a,5,8,9,12,12a-decahydro-		1.2
1-Butanol	0.6	0.8
1-Decene, 2,4-dimethyl-		0.3
1-Hexanol, 2-ethyl-	0.4	
1-Pentanol, 2-ethyl-4-methyl-		1.0
1-Propionylethyl acetate		0.5
2-Butoxyethyl acetate		1.0
2-Isobutoxyethyl acetate		0.5
3,4-Hexanedione, 2,2,5-trimethyl-	0.4	
5-Hepten-2-one, 6-methyl-		0.7
Acetic acid	139	352
Acetone	6.7	10.7
ß-Pinene	0.4	
Bicyclo[3.1.0]hex-2-ene, 2-methyl-5-(1-methylethyl)-	0.7	0.7
Bicyclo[3.1.0]hex-2-ene, 4-methyl-1-(1-methylethyl)-	1.4	
Bicyclo[3.1.0]hexane, 4-methylene-1-(1-methylethyl)-	0.6	0.9
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-, (1S)-	1.6	
Carbonic acid, nonyl vinyl ester	0.5	
Dodecane, 1-iodo-	0.5	
Ethanol	2.1	3.7
Ethanol, 2-(2-butoxyethoxy)-, acetate		1.1
Formaldehyde	85.2	159.2
Formic acid	1.5	2.5

Table A4. Detected VOCs (concentrations in µg/m³) in engineered wood flooring.

Chemical	26°C	35°C
Furfural		0.9
Heptane, 2,2,4,6,6-pentamethyl-	4.0	2.0
Hexanal	0.5	1.3
Isopropanol		5.0
Nonanal		1.4
Pentanal		0.7
Pentane, 2,2,3-trimethyl-		2.6
Propanoic acid		0.9
Propanoic acid, 2-methyl-, 2-ethyl-3-hydroxyhexyl ester	0.6	
Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester		0.6
Toluene	8.3	9.9
Tridecane		0.5

Table A5. Detected VOCs (concentrations in µg/m³) in felt acoustic tile.

Chemical	26°C	35°C
1,2-Ethanediol, 1,2-diphenyl-		0.3
2-Vinylfuran	1.0	
Acetic acid	26.9	27.2
Acetone	5.9	4.9
Benzaldehyde	0.3	0.4
Decanal		0.2
Decane, 2,5,9-trimethyl-		0.4
Diethyl phthalate	0.6	1.8
Glycerol 1,2-diacetate	1.2	
Hexadecane	0.3	
Hexamethylcyclotrisiloxane	0.8	0.8
Hexanal		0.4
Hexanal, 3-methyl-		0.4
Methyl formate	1.2	
Methylene chloride	0.3	
Nonanal		26.5
Octanal		0.3
Octane, 2,4,6-trimethyl-	0.3	
Octane, 2,7-dimethyl-		0.4
Oxalic acid, butyl propyl ester		0.3
Phenol	1.0	1.2
Tetradecane	0.6	1.3
Triacetin		3.6

Table A6. Detected VOCs (concentrations in μg/m³) in laminate flooring.

Chemical	26°C	35°C
α-Pinene	0.3	1.6
α-Terpineol	21.8	34.7
1,4-Methanobenzocyclodecene, 1,2,3,4,4a,5,8,9,12,12a-decahydro-	3.9	4.8
1-Adamantanecarboxylic acid chloride	4.5	
1-Adamantanecarboxylic acid, 2-bromo-4-fluorophenyl ester		20.1
1-Adamantyl bromomethyl ketone	4.7	
1-Butanol		0.4
1-Ethyl-2-methylbenzene(2-Ethyltoluene)	1.2	
1-Hexanol, 2-ethyl-	0.9	1.6
1-Isopropyl-4,7-dimethyl-1,2,3,5,6,8a-hexahydronaphthalene		1.7
2,2,4,4-Tetramethyloctane	23.2	29.1
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	1.4	2.1
2-Butanone, 3-methoxy-3-methyl-		0.6
3-Adamantanecarboxylic acid, phenyl ester	9.6	21.0
3-Carene		0.9
3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-		1.9
4,7-Methano-1H-indene, octahydro-, (3aα,4α,7α,7aα)-		0.7
Acetic acid	5.2	6.4
Acetone	55.8	71.2
Benzaldehyde	0.6	0.7
Benzene, 1,2,4-trimethyl-	1.1	
Bicyclo[3.1.1]hept-2-ene, 3,6,6-trimethyl-	0.6	
Carbonic acid, nonyl vinyl ester	1.1	1.8
Caryophyllene	6.3	9.4
Cyclohexane, isocyanato-		1.0
Cyclohexane, isothiocyanato-		0.7
Cyclopentasiloxane, decamethyl-	0.6	0.5
Cyclotetrasiloxane, octamethyl-		0.9

Table A6. Detected VOCs (concentrations in µg/m³) in laminate flooring.

Chemical	26°C	35°C
Cyclotrisiloxane, hexamethyl-		1.2
Decane, 2,5,9-trimethyl-	4.6	3.9
Decane, 2,6,6-trimethyl-	3.1	
Diethyl phthalate	1.4	5.7
Formaldehyde	46.4	57.7
Formamide	2.2	2.4
Heptane, 2,2,4,6,6-pentamethyl-	222	267
Heptane, 4-ethyl-2,2,6,6-tetramethyl-		2.3
Hexanal	0.7	1.0
Humulene	3.0	4.9
Isopropanol	2.1	3.1
Naphthalene, 1,2,3,5,6,8a-hexahydro-4,7-dimethyl-1-(1-methylethyl)-		1.4
Nonanal	0.5	0.7
Pentane, 2,2,3,3-tetramethyl-	3.2	3.6
Pentanoic acid, 5-hydroxy-, 2,4-di-t-butylphenyl esters		1.8
Propanal	61.2	62.7
Propanoic acid, 2-methyl-		0.7
Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester	1.3	1.9
Silanol, trimethyl-		1.6
Tetradecane, 2,2-dimethyl-		1.3
Texanol	1.2	1.8
Trichloroacetic acid, 2-(1-adamantyl)ethyl ester	10.5	
Tricyclo[3.3.1.1(3,7)]decane, 2-bromo-		9.5

Table A7. Detected VOCs (concentrations in μg/m³) in linoleum tile.

Chemical	26°C	35°C
1,1-Diphenyl-2-propanol		0.9
1-Butanol	0.5	0.5
1-Ethyl-2-methylbenzene(2-Ethyltoluene)	1.1	
1-Heptanol	1.2	1.6
1-Hexanol, 2-ethyl-	2.5	3.4
1-Octanol	0.9	1.4
1-Pentanol	0.5	0.6
2(3H)-Furanone, 5-butyldihydro-	4.2	
2(3H)-Furanone, 5-ethyldihydro-		1.9
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate		2.0
2-Butanone(Methyl ethyl ketone, MEK)		1.9
2-Decanone	1.1	2.0
2-Decenal	0.7	1.6
2-Decene, 8-methyl-	0.2	
2-Ethylhexanoic acid		0.7
2-Heptanone	1.0	2.0
2-Hexanone		0.6
2-Propanol, 1-(2-methoxy-1-methylethoxy)-		1.1
2-Propanol, 1-(2-methoxypropoxy)-	2.2	2.6
2-Undecenal		1.5
2-Vinylfuran	1.8	
4-Oxohex-2-enal		1.5
4-t-Butylphenol		1.1
Acetic acid	48.5	63.1
Acetone	3.2	4.4
Benzaldehyde	1.6	1.8
Benzene, 1,2,4-trimethyl-	1.6	0.8
Benzene, 1-ethyl-4-methyl-	2.2	3.1

Table A7. Detected VOCs (concentrations in µg/m³) in linoleum tile.

Chemical	26°C	35°C
Benzenemethanol, α,α-dimethyl-	1.1	1.3
Benzophenone	0.8	2.1
Benzothiazole	1.9	
Butanal		0.5
Butanoic acid	3.2	4.5
Butyric acid	2.1	
Cyclobutane-1,1-dicarboxamide, N,N'-di-benzoyloxy-	0.9	1.0
Cyclohexane, isocyanato-	1.3	1.3
Cyclohexane, isothiocyanato-	1.1	
Cyclooctane, 1,4-dimethyl-, cis-		1.1
Cyclopentasiloxane, decamethyl-	1.1	0.6
Cyclotrisiloxane, hexamethyl-	1.4	1.7
Decanal	0.4	0.9
Diethyl phthalate		1.7
Diisobutyl cellosolve	1.6	
Ethylbenzene	1.8	2.0
Formic acid		1.7
Formic acid, pentyl ester	0.6	
Heptanal	0.6	1.0
Heptane	1.0	1.9
Heptane, 2,4-dimethyl-	0.9	
Heptanoic acid	9.0	13.8
Hexanal	1.2	2.4
Hexane, 2,4-dimethyl-	0.7	
Hexanoic acid	52.7	63.6
Hexanoic acid, 2-ethyl-	0.5	
Nonanal	1.6	3.5
Nonane		0.9

Table A7. Detected VOCs (concentrations in µg/m³) in linoleum tile.

Chemical	26°C	35°C
Nonanoic acid	4.7	11.7
Octanal	1.1	1.9
Octane	0.9	2.1
Octanoic acid	14.3	26.2
ortho-Xylene	1.2	1.3
para-Xylene	3.6	3.8
Pentanal, 2,4-dimethyl-	0.9	
Pentanal, 2-methyl-		0.6
Pentane, 2-methyl-		1.0
Pentanoic acid	7.2	9.8
Phenol	1.0	1.1
Propanal, 2-methyl-	0.4	
Propanoic acid	21.4	27.7
Propanoic acid, 2-methyl-	0.8	0.9
Quinoline, 2,7-dimethyl-	1.0	
Silanol, trimethyl-	2.1	2.4
Valeric anhydride		1.5

Table A8. Detected VOCs (concentrations in μg/m³) in marble flooring.

Chemical	26°C	35°C
1,2,3-Trifluoro-4-trifluoromethylbenzene	0.8	
1,2-Benzenedicarboxylic acid	0.4	
1,3,5-Trifluorobenzene	6.0	
Acetic acid	28.8	
Acetone	4.6	4.3
Acetophenone	0.7	
Benzaldehyde	0.8	0.6
Benzene	0.5	
Benzene, 1,2-difluoro-4-(trifluoromethyl)-	0.5	
Cyclopentasiloxane, decamethyl-	0.3	
Cyclotetrasiloxane, octamethyl-	2.7	0.6
Cyclotrisiloxane, hexamethyl-	1.9	1.9
Diethyl phthalate	1.3	3.1
Disiloxane, hexamethyl-	1.6	
Hexane		0.6
Isopropanol		0.9
Methyl formate		1.1
Methylene chloride	0.4	5.7
Nonanal		0.3
Silanol, trimethyl-	1.5	
Toluene	0.8	2.0
Undecane, 4,7-dimethyl-	0.8	

Table A9. Detected VOCs (concentrations in µg/m^3) in natural wood flooring.

Chemical	26°C	35°C
(1R,4aR,4bS,7R,10aR)-1,4a,7-Trimethyl-7-vinyl-1,2,3,4,4a,4b,5,6,7,9,10,10a-dodecahydrophenanthrene-1-carbaldehyde		4.1
(2E,4S,7E)-4-Isopropyl-1,7-dimethylcyclodeca-2,7-dienol		3.2
2-Pentanol	12.5	9.5
1,2-Propanediol	6.7	5.3
2-Pentanol	18.6	10.0
α-Terpineol	0.9	1.7
ß-Bisabolene		15.3
γ-Elemene		1.0
1-Butanol	17.1	13.3
1-Butanol, 2-methyl-	0.9	0.6
1-Butanol, 3-methyl-	1.0	0.7
1H-3a,7-Methanoazulene, octahydro-1,4,9,9-tetramethyl-		11.1
1-Heptanol	0.4	0.7
1-Hexanol	26.4	30.7
1-Hexanol, 2-ethyl-	0.9	1.7
1-Hexanol, 4-methyl-		0.6
1-Naphthalenol, decahydro-1,4a-dimethyl-7-(1-methylethylidene)-, [(1α,4aß,8aα)]-	1.0	4.8
1-Pentanol	2.9	2.1
1-Propanol	1.9	1.5
1-Propanol, 2-methyl-	1.0	0.6
2,2,6,6-Tetramethylheptane		0.4
2-Butanol	2.3	
2-Butanone	13.6	5.7
2-Butanone, 3-methyl-	2.7	1.5
2-Furanmethanol	0.3	0.4
2H-3,9a-Methano-1-benzoxepin, octahydro-2,2,5a,9-tetramethyl-, [(3α,5aα,9α,9aα)]-		1.9
2-Hexanone	2.2	1.1
2-Naphthalenemethanol, 1,2,3,4,4a,5,6,7-octahydro-α,α,4a,8-tetramethyl-,	45.1	305
2-Naphthalenemethanol, decahydro-α,α,4a-trimethyl-8-methylene-, [(2α,4aα,8aß)]-	190	656
2-Pentanone	267	111

Table A9. Detected VOCs (concentrations in µg/m³) in natural wood flooring.

Chemical	26°C	35°C
3,7-Cyclodecadiene-1-methanol, α,α,4,8-tetramethyl-,	34.1	
3-Furanmethanol		0.3
4a,8-Dimethyl-2-(prop-1-en-2-yl)-1,2,3,4,4a,5,6,7-octahydronaphthalene	4.4	10.1
Acetic acid	165	245
Acetoin	1.0	1.0
Acetone	227	91.2
Benzaldehyde	0.5	0.6
Bicyclo[5.2.0]nonane, 4-methylene-2,8,8-trimethyl-2-vinyl-	5.4	11.3
Butanoic acid	38.6	59.8
Butanoic acid, 2-methyl-	1.5	2.7
Carbamic acid, methyl-, phenyl ester		1.1
Caryophyllene	1.6	2.7
Cyclobutanone, 2-ethyl-		0.5
Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-	4.9	8.4
Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-, [(1α,2ß,4ß)]-	4.1	
Cyclohexanemethanol, 4-ethenyl-α,α,4-trimethyl-3-(1-methylethenyl)-, [1R-(1α,3α,4.ß)]-	27.9	133
Cyclohexanone	0.7	
Cyclohexene, 1-methyl-4-(1-methylethenyl)-,		0.7
Cyclohexene, 3-methyl-6-(1-methylethylidene)-		1.4
Cyclohexene, 4-ethenyl-4-methyl-3-(1-methylethenyl)-1-(1-methylethyl)-,		1.4
Cyclopentaneacetaldehyde, 2-formyl-3-methyl-α-methylene-	6.8	14.3
Cyclotrisiloxane, hexamethyl-	1.2	1.7
Decane, 2,5,9-trimethyl-		2.0
Diethyl phthalate		4.9
Formaldehyde	49.0	53.1
Formic acid, pentyl ester	0.8	
Furfural	1.3	1.6
Heptane, 2,2,4,6,6-pentamethyl-	3.1	
Heptane, 2,5,5-trimethyl-	0.7	
Hexanal	0.6	0.6

Table A9. Detected VOCs (concentrations in μg/m^3) in natural wood flooring.

Chemical	26°C	35°C
Hexane, 2,2-dimethyl-		1.6
Hexane, 2,3,4-trimethyl-	0.8	
Hexane, 2,4-dimethyl-	0.9	
Hexanoic acid	22.0	38.7
Hexanoic acid, hexyl ester		0.8
Isopropanol	7.6	4.2
Ledol	6.6	
Methyl isobutyl ketone	0.1	0.1
Neointermedeol		3.1
Nonanal	0.5	1.0
Nonane, 2-methyl-		1.3
Octane	0.6	
Octane, 2,4,6-trimethyl-		2.1
Octane, 2,7-dimethyl-		1.3
Octane, 3,4,5,6-tetramethyl-	0.8	
Octane, 4-ethyl-		2.1
Pentanal	0.4	0.7
Pentane, 2,2,3,4-tetramethyl-	0.6	
Pentane, 2,2,3-trimethyl-		1.7
Pentane, 2,2-dimethyl-		0.4
Pentanoic acid, 4-methyl-		0.7
Phenanthrene, 7-ethenyl-1,2,3,4,4a,4b,5,6,7,9,10,10a-dodecahydro-1,1,4a,7-tetramethyl-, [4a(4aα,4bß,7ß,10aß)]-		4.0
Propanoic acid	42.2	55.5
Propanoic acid, 2-methyl-	6.0	6.8
Silanediol, dimethyl-		2.9
Toluene	0.9	1.2
Tridecane, 3-methyl-		0.9
Vinyl acetate		29.8

Table A10. Detected VOCs (concentrations in μg/m³) in nylon carpet.

Chemical	26°C	35°C
1,2-Propanediol	1.9	2.6
5-Methyl-1-heptanol		1.6
1,3-Diacetin	2.3	5.2
1-Butanol, 2-methyl-, propanoate		0.7
1-Dodecanol	0.6	6.4
1-Hexanol, 2-ethyl	1.3	2.7
1-Octene, 6-methyl-		18.1
2,2,4-trimethyl-1,3-pentanediol monoisobutyrate	5.4	12.7
2,3,3-Trimethyl-1-hexene		7.7
2,4,4-Trimethyl-1-pentanol, trifluoroacetate		4.9
2,4-Di-tert-butylphenol		1.8
2-Nonenal, (E)-		1.1
2-Octene, 2,3,7-trimethyl-		2.2
2-Propyl-1-pentanol		2.3
2-Vinylfuran	1.2	
3-Decene, 2,2-dimethyl-		8.6
3-Ethyl-2-methyl-1-heptene		3.0
3-Ethyl-4-methylpentan-1-ol		1.9
4-Decene, 3-methyl-		2.1
4-Decene, 6-methyl-		4.7
4-Phenylcyclohexene	1.2	3.1
4-Undecene, 4-methyl-		14.3
4-Undecene, 6-methyl-		2.6
5-Ethyl-1-nonene		5.3
5-Undecene, 5-methyl-		5.4
6,6-Dimethyl-1,3-heptadien-5-ol		3.6
6-Dodecene		7.6
Acetic acid	1.3	1.9

Table A10. Detected VOCs (concentrations in μg/m³) in nylon carpet.

Chemical	26°C	35°C
Acetone	1.6	3.6
Benzaldehyde	0.6	1.5
Benzene, 3-cyclohexen-1-yl-		3.4
Caprolactam (2H-Azepin-2-one, hexahydro)	15.8	41.0
Cyclopentasiloxane, decamethyl-		0.7
Cyclotrisiloxane, hexamethyl-		1.3
Decanal		0.5
Decane, 6-ethyl-2-methyl-		0.6
Dodecane	1.5	2.4
Ethanol, 2-(2-butoxyethoxy)-		1.4
Glycerol 1,2-diacetate	2.2	5.4
Hexadecane		0.6
Hexanal	0.4	0.5
Hexane, 3,3-dimethyl-		0.8
Nonanal	1.4	6.0
Phenol	0.6	1.5
Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester		8.6
Propanoic acid, pentyl ester		0.8
Triacetin		5.6
TXIB (2,2,4-Trimethyl-1,3-pentanediol diisobutyrate)		2.6

Table A11. Detected VOCs (concentrations in µg/m³) in olefin carpet.

Chemical	26°C	35°C
1,2-Propanediol	2.0	1.5
1-Hexanol, 2-ethyl-	10.9	11.8
1-Hexene, 3,5,5-trimethyl-	0.2	1.2
1-Pentanol, 2-ethyl-4-methyl-	1.9	
2,2,4,4-Tetramethyloctane		18.8
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate		0.7
2-Propanol(Isopropanol)		1.2
3-Ethyl-3-methylheptane		0.6
3-Methyldecane	0.4	
4-t-Butylphenol		1.1
Acetic acid	40.8	44.5
Acetone	6.3	7.2
Benzaldehyde	0.5	0.5
Benzothiazole		13.6
Borane, diethyl(decyloxy)-	1.3	
Butane, 2,2-dimethyl-		1.6
Caprolactam (2H-Azepin-2-one, hexahydro)		2.0
Cyclopentasiloxane, decamethyl-	0.8	1.2
Cyclotrisiloxane, hexamethyl-		1.9
Decanal	0.4	2.9
Decane	1.9	3.2
Decane, 2,2,6-trimethyl-		6.3
Decane, 2,3,6-trimethyl-		1.0
Decane, 2,5,9-trimethyl-		13.0
Decane, 3,4-dimethyl-		1.6
Decane, 3-methyl-		2.2
Diethyl phthalate		1.1
Di-n-butyl phthalate	7.5	42.4

Table A11. Detected VOCs (concentrations in µg/m³) in olefin carpet.

Chemical	26°C	35°C
Limonene	1.9	3.6
Dodecane	4.7	9.2
Dodecane, 3-methyl-		1.4
Glycerol 1,2-diacetate		2.0
Heptanal	0.3	0.3
Heptane, 2,2,4,6,6-pentamethyl-	24.1	45.5
Heptane, 4-ethyl-2,2,6,6-tetramethyl-	1.0	
Hexadecane		1.0
Hexanal	0.5	0.6
Hexanal, 2-ethyl-		0.4
Hexane, 2,2,3,3-tetramethyl-		0.8
Hexane, 2,2,5-trimethyl-	2.5	7.8
Hexane, 2,3,4-trimethyl-		0.8
Hexane, 3,3-dimethyl-		0.9
Hexyl octyl ether		0.6
Isobutyl isobutyrate		0.8
Methyl methacrylate	1.2	
Nonanal	21.4	24.4
Nonane, 1-iodo-		1.1
Octane, 2,6-dimethyl-	1.4	11.7
Octane, 3,6-dimethyl-		9.0
Oxalic acid, butyl propyl ester	0.2	
Oxetane, 2,3,4-trimethyl-, (2α,3α,4ß)-		0.3
Pentadecane		0.8
Pentane, 2,2,3,3-tetramethyl-		1.7
Pentane, 2,2,3,4-tetramethyl-	0.8	
Pentane, 2,3,3-trimethyl-		1.0
Phenol	0.7	1.5

Table A11. Detected VOCs (concentrations in μg/m³) in olefin carpet.

Chemical	26°C	35°C
Phenol, 3,5-bis(1,1-dimethylethyl)-		1.9
Phenol, p-tert-butyl-		1.2
Propanoic acid, 2-methyl-, butyl ester		0.6
Propylene glycol	11.3	11.9
Silanediol, dimethyl-	1.6	1.5
Tetradecane	1.3	3.5
Triacetin		1.4
Tridecane, 3-methyl-	1.3	2.1
Trifluoroacetic acid, heptyl ester	1.9	
Undecane		1.1
Undecane, 2,8-dimethyl-		2.5
Undecane, 3-methyl-	1.5	4.1
Undecane, 6,6-dimethyl-	0.7	

Table A12. Detected VOCs (concentrations in µg/m³) in polyester metal wallcovering.

Chemical	26°C	35°C
1,2-Propanedione, 1-phenyl-		0.9
1-Butanol	0.6	0.4
1-Decanol		0.8
1-Dodecanol		1.1
1-Hexanol, 2-ethyl-	10.9	10.6
1-Pentanol, 2-ethyl-4-methyl-	0.7	0.7
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	2.1	4.0
2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester)	1.8	2.5
2,4,7,9-Tetramethyl-5-decyn-4,7-diol	7.0	18.7
2-Butanone	1.1	
2-Nitro-3-phenylbutane-1,3-diol	0.5	
2-Pentanone, 4,4-dimethyl-	0.4	
2-Propenoic acid, 2-methyl-, 3,3,5-trimethylcyclohexyl ester	1.0	0.7
2-Propyl-1-pentanol	1.8	
3,3,5-Trimethylcyclohexene	0.5	
4-t-Butylphenol	1.9	
Acetic acid	28.4	26.9
Acetone	22.7	6.2
Benzaldehyde		1.1
Benzothiazole	14.2	15.5
Benzyl alcohol	0.6	0.6
Butanedioic acid, methyl-, dimethyl ester		0.3
Butyric acid	0.4	
Carbonic acid, nonyl vinyl ester		1.7
Cyclohexane, 1,1,3-trimethyl-	1.6	
Cyclohexanol, 3,3,5-trimethyl-	0.9	
Cyclohexene, 3,3,5-trimethyl-	0.6	
Cyclopentasiloxane, decamethyl-	0.4	
Cyclotrisiloxane, hexamethyl-	2.3	0.9
Decanal		0.3

Table A12. Detected VOCs (concentrations in µg/m³) in polyester metal wallcovering.

Chemical	26°C	35°C
Decane		0.7
Decane, 2,5,6-trimethyl-		2.1
Diethyl phthalate		2.0
Dimethyl glutarate		0.3
Ethanol, 2-(1,1-dimethylethoxy)-		0.7
Ethanol, 2-(2-butoxyethoxy)	1.8	1.6
Ethanol, 2-butoxy-	1.0	
Ether, hexyl pentyl		1.9
Ethylene glycol monoisobutyl ether	0.8	1.5
Fumaronitrile	0.8	
Furan, 2-methyl-	5.0	
Glycerol 1,2-diacetate	2.5	
Heptanal	0.2	
Hexanal	0.4	
Hexanoic acid, 2-ethyl	24.4	25.4
Hexylene glycol	0.6	0.5
Methyl vinyl ketone	63.2	
Nonanal	19.7	
Nonane, 2-methyl-		2.6
Pentanal	0.3	
Pentane, 2,2,3-trimethyl-		1.2
Pentanoic acid		0.4
Phenol	8.4	12.4
Phenol, p-tert-butyl-	2.5	5.0
Propanoic acid, 2-methyl-, butyl ester	0.9	
Silanediol, dimethyl-		1.2
Tetradecane	1.4	1.1
Triacetin	3.6	8.1
Tridecane	1.7	1.1
Undecane, 4,6-dimethyl-	2.9	

Table A13. Detected VOCs (concentrations in µg/m³) in polyester textile.

Chemical	26°C	35°C
1,3-Diacetin	1.1	1.0
1-Butanol	0.7	0.5
1-Phenyl-1-decanol		0.3
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	0.5	0.4
2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester)	2.0	
2,4,7,9-Tetramethyl-5-decyn-4,7-diol	1.3	2.5
2,4-Di-tert-butylphenol		0.6
2-Propanol, 1-ethoxy-	0.6	
2-Propanol, 1-methoxy-	0.8	
3,4-Dihydroxyphenylglycol, 4TMS derivative		0.4
Acetic acid	27.0	27.1
Acetone	8.3	6.4
Benzaldehyde	0.6	0.6
Benzothiazole	15.4	15.9
Cyclobutanol, 2-ethyl-		0.3
Cyclotrisiloxane, hexamethyl-	1.1	1.3
Decanal		0.7
Diethyl phthalate		1.8
Disiloxane, hexamethyl-	6.1	8.1
Ethanol	94.4	131
Glycerol 1,2-diacetate	0.8	1.1
Heptanal		0.2
Hexanal		0.5
Hexanoic acid, 2-ethyl-		0.4
Isopropanol	6.2	2.4
Methyl formate	1.5	1.8
Methylene chloride	0.5	0.4
Nonanal		24.3

Table A13. Detected VOCs (concentrations in µg/m^3) in polyester textile.

Chemical	26°C	35°C
Octanal		0.5
Phenol	3.2	2.3
Phenol, p-tert-butyl-	5.1	6.2
Silanediol, dimethyl-	1.7	
Silanol, trimethyl-	8.4	11.0
Tetradecane	1.2	
Toluene	7.3	3.6
Tridecane		0.7

Table A14. Detected VOCs (concentrations in µg/m³) in porcelain flooring.

Chemical	26°C	35°C
1-Iodoundecane	1.0	
2-Chloroethyl benzoate		0.8
2-Propanol, 1-ethoxy-		0.4
Acetic acid	26.9	
Acetic anhydride		1.2
Acetone	3.9	5.2
Acetophenone		1.1
Benzaldehyde	0.7	0.7
Benzene, 1,2,4-trimethyl-	0.7	
Cyclopentasiloxane, decamethyl-	0.7	
Cyclotetrasiloxane, octamethyl-	0.6	0.9
Cyclotrisiloxane, hexamethyl-	1.0	1.9
Decanal		0.1
Diazene, dimethyl-	1.7	
Diethyl phthalate		3.2
Disiloxane, hexamethyl-		0.9
Hexane		0.5
Isopropanol	1.0	1.1
L-Lactic acid		17.0
Methyl formate		1.7
Methylene chloride	0.6	5.1
n-Hexane		0.7
Nonanal		0.6
Pentane, 2,2,3,4-tetramethyl-		0.3
Silanol, trimethyl-		2.1
Tetradecane	3.9	
Toluene	0.5	3.6
Tridecane	5.1	
Undecane, 2,8-dimethyl-		0.5

Table A15. Detected VOCs (concentrations in µg/m³) in rubber flooring.

Chemical	26°C	35°C
1-Hexanol, 2-ethyl-	10.6	10.7
1-Pentanol, 2-ethyl-4-methyl-	1.8	
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	0.4	0.6
2,2,4-Trimethylhexane	0.5	
2-Butoxyethyl acetate	1.9	
2-Propyl-1-pentanol		1.8
2-Vinylfuran	1.1	
3,3,5-Trimethylheptane		0.6
Acetic acid	0.6	
Acetone	4.1	5.6
Benzaldehyde	0.3	0.4
Benzothiazole	15.6	15.7
Butylated hydroxytoluene (BHT)	11.0	11.3
Cyclohexene, 1-methyl-4-(1-methylethenyl)-		3.2
Cyclopentasiloxane, decamethyl-	3.5	4.1
Cyclotrisiloxane, hexamethyl-	0.6	0.8
Decane	0.8	0.7
Decane, 2,2,6-trimethyl-	1.8	
Decane, 2,3,4-trimethyl-		1.7
Decane, 2,5,9-trimethyl-	3.5	
Decane, 3,4-dimethyl-	1.3	1.7
Diethyl phthalate		2.0
Limonene	2.6	2.8
Dodecane	1.5	2.2
Dodecane, 2,6,10-trimethyl-	4.5	
Dodecane, 2,7,10-trimethyl-	3.6	7.6
Ethanol, 2-(2-butoxyethoxy)	2.8	
Ethyl 4-oxo-2-phenylpentanoate		1.8

Table A15. Detected VOCs (concentrations in µg/m³) in rubber flooring.

Chemical	26°C	35°C
Heptane, 2,2,4,6,6-pentamethyl-	9.4	10.5
Hexadecane	0.4	1.3
Hexane, 2,4-dimethyl-		0.9
Hexane, 3,3-dimethyl-	1.4	
Nonanal		0.5
Nonane		1.0
Octane, 2,4,6-trimethyl-	1.3	1.6
Octane, 2,6,6-trimethyl-	1.0	
Octane, 2,6-dimethyl-	3.4	6.0
Octane, 3,6-dimethyl-		5.8
Octane, 3-ethyl-2,7-dimethyl-		1.0
Octane, 6-ethyl-2-methyl-		1.7
Pentadecane		1.4
Phenol	1.2	1.7
Tetradecane	1.0	1.9
Undecane	1.0	
Undecane, 2,8-dimethyl-	1.7	1.7
Undecane, 4,7-dimethyl-		3.1

Table A16. Detected VOCs (concentrations in µg/m³) in terrazzo flooring.

Chemical	26°C	35°C
6-Methyl-1-octanol		1.4
1,2,3,5-Tetramethylbenzene		2.4
1,2,4,5-Tetramethylbenzene		1.9
1,3-Benzenediol, o-(2-furoyl)-o'-(2-methoxybenzoyl)-		20.5
1,3-Benzenediol, o-(2-methoxybenzoyl)-o'-ethoxycarbonyl-		4.2
1,3-Benzenediol, o-(4-methylbenzoyl)-o'-(2-methoxybenzoyl)-	3.0	
1-Butanol	1.3	3.1
1-Dodecanamine, N,N-dimethyl-		2.9
1-Heptanol, 6-methyl-	1.1	2.2
1-Hexanol, 2-ethyl-	11.8	14.2
1-Methoxy-2-propyl acetate	0.6	2.2
1-Nonanol		2.2
1-Pentanol, 2-ethyl-	0.8	
1-Pentanol, 3,4-dimethyl-		0.8
2,2,4,4-Tetramethyloctane	2.1	9.1
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	1.1	2.1
2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester)	0.4	
2,2-Dimethyloctane		1.2
2,4-Di-tert-butylphenol		2.8
2-Butanone	1.1	
2-Pentanone, 4,4-dimethyl-	0.4	
2-Propanol, 1-methoxy-		0.8
2-Propenoic acid, 2-methyl-, 3,3,5-trimethylcyclohexyl ester	1.6	1.6
3,4-Hexanedione, 2,2,5-trimethyl-	0.3	
4-(1,1-Dimethylheptyl)phenol	5.1	7.0
4-(7-Methyloctyl)phenol	5.1	5.2
4-Penten-2-ol, 3-methyl-	0.5	0.8
9-Octadecenoic acid, methyl ester	1.4	26.7

Table A16. Detected VOCs (concentrations in µg/m³) in terrazzo flooring.

Chemical	26°C	35°C
Acetic acid	1.1	0.8
Acetic acid, butyl ester	1.6	6.1
Acetic acid, methyl ester		0.9
Acetone	28.7	14.8
Benzene	0.6	
Benzene, (1-methylethyl)-	0.7	0.6
Benzene, 1,2,4-trimethyl-	2.9	9.8
Benzene, 1-ethyl-3-methyl-	12.3	35.8
Benzene, propyl-	0.9	3.5
Bicyclo[3.2.0]hepta-2,6-diene	0.9	
Butanal		0.5
Cyclobutanol, 2-ethyl-	0.3	
Cyclohexane, 1,1,3-trimethyl-	1.7	
Cyclohexane, 1,1-dimethyl-	0.7	
Cyclotetrasiloxane, octamethyl-	4.7	
Decane, 2,2-dimethyl-	3.0	8.2
Decane, 2,5,9-trimethyl-		7.1
Diethyl phthalate		3.2
Diglycolic acid, di(3-phenylpropyl) ester	0.4	
Dodecanoic acid, 2-methyl-		1.3
Furan, 2-methyl-	4.8	
Heptanal	0.3	
Heptane, 2,2,4,6,6-pentamethyl-	23.5	43.2
Hexadecanoic acid, methyl ester	27.6	145
Hexamethylcyclotrisiloxane	3.8	
Hexanal	0.5	
Hexestrol		14.1
Hexylene glycol	183	415

Table A16. Detected VOCs (concentrations in μg/m³) in terrazzo flooring.

Chemical	26°C	35°C
Indane		2.4
Methyl vinyl ketone	62.7	
Nonane, 3,7-dimethyl-	0.4	
Octane	0.2	
Octane, 2,2,6-trimethyl-	2.7	8.2
o-Cymene	0.2	0.7
ortho-Xylene	0.2	0.7
Oxetane, 2,3,4-trimethyl-	0.5	
Oxirane, 2-methyl-3-(1-methylethyl)-	0.5	0.9
p-Cymene		0.3
Pentadecanoic acid, 14-methyl-, methyl ester	29.7	41.6
Pentanal	0.4	
Pentane, 2,3,3,4-tetramethyl-		0.4
Propanoic acid, 2-methyl-, butyl ester		0.5
sec-Butylbenzene		2.2
Tetradecane	1.3	
Tridecane	1.2	

Table A17. Detected VOCs (concentrations in µg/m³) in vinyl composite tile.

Chemical	26°C	35°C
1-Hexanol, 2-ethyl-	1.0	0.9
1-Pentanol, 2-ethyl-4-methyl-	0.9	0.7
2,2,4-Trimethyl-1,3-pentanediol monoisobutyrate (Texanol Isomer 1)	0.7	1.2
2-Propyl-1-pentanol	1.4	
2-Vinylfuran	1.7	
4-t-Butylphenol		1.1
Acetic acid	0.8	
Acetone	1.9	1.7
Acetophenone	0.4	
Benzaldehyde	2.3	1.8
Benzyl alcohol	2.3	1.9
Cyclotetrasiloxane, octamethyl-	4.5	4.7
Cyclotrisiloxane, hexamethyl-	3.3	3.3
Decanal		0.5
Diazene, dimethyl-		1.4
Nonanal	0.5	0.7
Octanal	0.3	0.3
Octane, 6-ethyl-2-methyl-	0.5	
Phenol	2.3	1.8
Phenol, 4-(1,1,3,3-tetramethylbutyl)-		1.6
Phthalic acid, ethyl pentyl ester		2.9
Propanoic acid, 2-methyl-, heptyl ester		1.2
Silanol, trimethyl-		1.4
TXIB (2,2,4-Trimethyl-1,3-pentanediol diisobutyrate)		2.3

Table A18. Detected VOCs (concentrations in μg/m³) in vinyl textile.

Chemical	26°C	35°C
1,2-Propanediol	2.2	
1,2-Propanediol, 1-acetate	0.5	
1,2-Propanedione, 1-phenyl-	0.7	
1-Dodecanol		1.6
1-Hexanol, 2-ethyl-	11.0	10.9
1-Propanol, 2-(2-hydroxypropoxy)-		1.0
2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	3.1	7.7
2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (Propanoic acid, 2-methyl-, 3-hydroxy-2,2,4-trimethylpentyl ester)	2.0	3.8
2,4,7,9-Tetramethyl-5-decyn-4,7-diol		4.0
2-Butanone, 3-ethoxy-3-methyl-	0.5	
2-Hydroxy-iso-butyrophenone		0.9
2-Propanol, 1,1'-oxybis-		0.5
2-Pyrrolidinone, 1-methyl-	0.6	0.7
Acetic acid	37.2	30.6
Acetone	5.1	5.2
Benzaldehyde	0.8	0.8
Benzoic acid, 2-ethylhexyl ester		1.0
Benzyl alcohol	1.0	1.7
Butanoic acid	0.6	
Butylated hydroxytoluene (BHT)	10.8	11.0
Butyric acid		0.7
Caprolactam (2H-Azepin-2-one, hexahydro)	1.3	4.2
Carbonic acid, nonyl vinyl ester		3.1
Cyclobutane-1,1-dicarboxamide, N,N'-di-benzoyloxy-		0.5
Cyclopentasiloxane, decamethyl-	0.8	0.8

Table A18. Detected VOCs (concentrations in µg/m³) in vinyl textile.

Chemical	26°C	35°C
Cyclotrisiloxane, hexamethyl-	0.7	0.6
Decanal	0.7	0.7
Decane, 2,5,6-trimethyl-		3.5
Diethyl carbitol	1.2	
Diethyl phthalate		1.7
Dimethyl phthalate		4.7
DL-2,3-Butanediol		0.9
Dodecane	1.0	1.1
Ethanol	0.5	
Ethanol, 2-(2-butoxyethoxy)	0.9	1.6
Ethanol, 2-(2-ethoxyethoxy)-	13.1	13.1
Ethanol, 2-phenoxy-		0.7
Glycerol 1,2-diacetate	2.3	
Heptanal	0.3	0.3
Heptane, 2,2,4,6,6-pentamethyl-	4.2	4.2
Hexanal	0.4	0.4
Hexanoic acid		0.8
Hexanoic acid, 2-ethyl	24.9	27.1
Nonanal	23.4	24.6
Octanal	9.6	
Octane, 1-chloro-		0.4
Octane, 3-ethyl-2,7-dimethyl-		0.6
Oxalic acid, isobutyl nonyl ester		1.4
Pentane, 2,2,3,4-tetramethyl-	1.0	

Table A18. Detected VOCs (concentrations in μg/m³) in vinyl textile.

Chemical	26°C	35°C
Pentanoic acid	0.7	0.7
Phenol	29.5	35.6
Phenol, p-tert-butyl-	12.4	31.3
Propanoic acid, pentyl ester	0.5	
Propylene glycol	12.2	
Silanediol, dimethyl-	2.3	
Tetradecane	2.7	1.7
Triacetin		5.9
Undecane, 2,7-dimethyl-		3.3