Eliminating Blinds with Smart Windows Reduces Exposures to Harmful Chemicals

EXECUTIVE SUMMARY

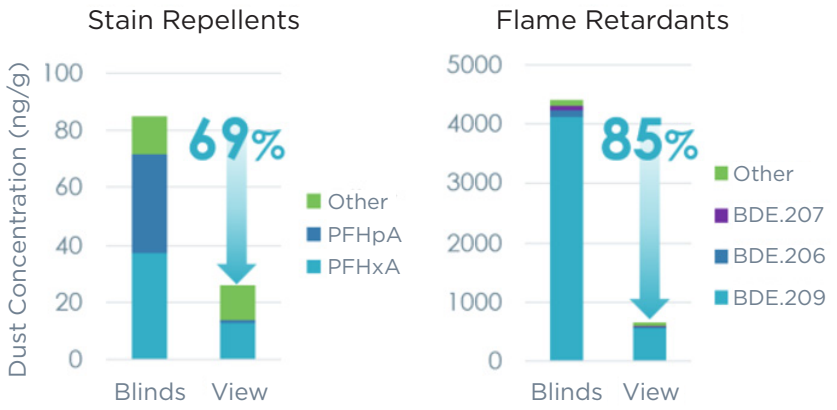
The building materials and furnishings we use every day contain tens of thousands of chemicals, and less than 1% have any safety testing and less than 20 are regulated in the U.S. despite significant epidemiological research into the toxicology of these compounds. Two classes of chemicals in particular, flame retardants and stain repellents, have been linked to numerous health outcomes. PBDE flame retardants are associated with thyroid dysfunction and poor birth outcomes. PFAS stain repellents, known as 'forever chemicals' for their Fluorine-Carbon bond, have been linked to reduced vaccine effectiveness and impact reproductive hormones. Both classes of chemicals are known carcinogens. These chemicals are often used in window blinds as the stain repellents help prevent the fabrics from staining and the flame retardants make the fabrics flame resistant in the case of a fire.

Methods

In this study we measured concentrations of stain repellents and chemical flame retardants in dust from two buildings on a tech campus in the San Francisco bay area. The buildings were constructed in 2016 with identical designs, floor layouts and interior finishes; however, one had interior blinds and the other had View Smart Windows, which control heat and glare without the need for blinds.

Results

Dust concentrations of total PFASs were 69% lower and total PBDEs were 85% lower in the building with View Smart Windows compared to the building with blinds. In the building with blinds, concentrations were 42% and 29% lower in the core offices compared to the perimeter offices for PFAS and PBDEs respectively, indicating that the source of both chemicals was located along the perimeter.



Implications

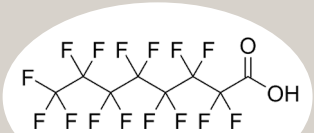
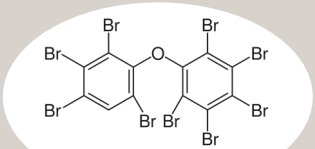
This study shows that a single product category – in this case window blinds – can have a pronounced effect on occupant chemical exposures. Creating a healthy environment requires a shift from status quo procurement practices. Banning chemical classes, rather than one-off chemicals, will prevent regrettable substitution with equally toxic replacements. Most importantly, companies and their design teams should strive to simplify the building design in a way that eliminates product categories known to have chemicals of concern and reduces the material requirement of the building as a whole.

INTRODUCTION

Every year, chemical manufacturers generate 250 billion tons of anthropogenic chemicals, representing 150,000 unique chemical compounds that end up in the environment and our bodies. 287 of these chemicals are detectable in babies at birth through their exposures in utero, and by the time kids reach adolescence they have thousands of toxic chemicals circulating in their blood stream.[1]

In the U.S., we conduct basic safety testing on less than 1% of chemicals and less than 20 of the 150,000 chemicals currently in use in everyday products have enforceable regulations. Each of those regulated chemicals required decades of exposure science and epidemiological research prior to any rule-making – this reactive approach means that significant morbidity and mortality is a precondition of public health protections. Given the persistent nature of many of these chemicals, they continue to negatively affect society decades after they are phased out, as evidenced by lead in paint and plumbing or mercury in fish.

CHEMICAL SPOTLIGHT

	Stain Repellents	Flame Retardants
	 PFHpA	 BDE-207
Description	Known as 'Forever Chemicals' or collectively as PFAS compounds	Two primary classes of chemicals are PBDEs and OPEs
Sources	Non-stick pans, water-resistant clothing, stain-resistant furniture	Foam cushioning, fabrics, electronics
Exposure	97% of all Americans had detectable amounts of chemical in blood[2]	90% of all Americans had detectable amounts of chemical in blood[2]
Health Effects	• **50%** reduction in vaccine effectiveness for each doubling of PFASs[3] • **25%** higher testosterone, lower sperm quality, and higher risk of testicular cancer[4] • **10%** higher cholesterol for highest quartile of PFAS exposure compared to lowest[5]	• **50%** lower odds of live birth for highest quartile of PBDE exposure compared to lowest[6] • **50%** higher odds of thyroid disorder for highest quartile of PBDE exposure compared to lowest[7] • **10%** lower IQ scores at age 4 for those in the top 20% for prenatal exposures to PBDEs[8]

1 Body burden: The pollution in newborns. Environmental Working Group. (2005, July 15). Retrieved from https://www.ewg.org/research/body-burden-pollution-newborns

2 Centers for Disease Control and Prevention. (2022, June 21). National Report on Human Exposure to Environmental Chemicals. Centers for Disease Control and Prevention. Retrieved from https://www.cdc.gov/exposurereport/index.html

3 Grandjean, P., Heilmann, C., Weihe, P., Nielsen, F., Mogensen, U. B., Timmermann, A., & Budtz-Jørgensen, E. (2017). Estimated exposures to perfluorinated compounds in infancy predict attenuated vaccine antibody concentrations at age 5-years. Journal of immunotoxicology, 14(1), 188-195.

4 Tarapore, P., & Ouyang, B. (2021). Perfluoroalkyl chemicals and male reproductive health: do PFOA and PFOS increase risk for male infertility?. International Journal of Environmental Research and Public Health, 18(7), 3794.

5 Andersen, M. E., Hagenbuch, B., Apte, U., Corton, J. C., Fletcher, T., Lau, C., ... & Longnecker, M. P. (2021). Why is elevation of serum cholesterol associated with exposure to perfluoroalkyl substances (PFAS) in humans? A workshop report on potential mechanisms. Toxicology, 459, 152845.

6 Carignan, C. C., Mínguez-Alarcón, L., Butt, C. M., Williams, P. L., Meeker, J. D., Stapleton, H. M., ... & EARTH Study Team. (2017). Urinary concentrations of organophosphate flame retardant metabolites and pregnancy outcomes among women undergoing in vitro fertilization. Environmental Health Perspectives, 125(8), 087018.

7 Allen, J. G., Gale, S., Zoeller, R. T., Spengler, J. D., Birnbaum, L., & McNeely, E. (2016). PBDE flame retardants, thyroid disease, and menopausal status in US women. Environmental Health, 15(1), 1-9.

8 Eskenazi, B., Chevrier, J., Rauch, S. A., Kogut, K., Harley, K. G., Johnson, C., ... & Bradman, A. (2013). In utero and childhood polybrominated diphenyl ether (PBDE) exposures and neurodevelopment in the CHAMACOS study. Environmental health perspectives, 121(2), 257-262.

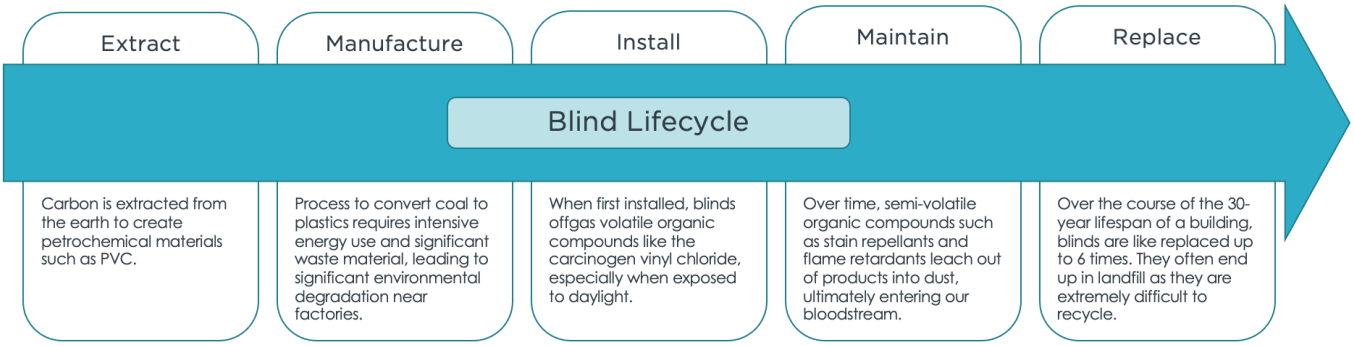
Manufacturers leverage advances in chemistry to sidestep any regulation that does occur. Through small alterations in the chemical structure, they can generate new chemicals with the same functional properties – and same toxicity profile. This regrettable substitution keeps public health researchers racing to demonstrate that the new chemicals in the same class result in the similar outcomes. Manufacturers are also not required to disclose the chemicals within their products, which prevents consumers from being able to determine if products have chemicals of concern.

The health outcomes tied to man-made chemicals cover the gamut of diseases with significant research connecting them to cancer, reproductive, endocrine, neurodevelopmental, respiratory, and cardiovascular diseases. It is estimated that 20% of our overall health is a function of our environmental exposures in life, which excludes exposures in utero or reproductive/epigenetic changes in our parents prior to conception.

We spend 90% of our time indoors in spaces that are built and furnished primarily with man-made materials and products, many of which have known chemicals of concern. While strides have been made to proactively replace chemicals with healthy alternatives, several product categories struggle to maintain functional requirements without these additives. Window blinds are a prime example:

- Blinds are hard to clean compared hard surfaces, leading to stain repellents being added to help prevent spills from staining.
- Blinds are fabric and vertically oriented, making them highly flammable without chemical flame retardants.
- Blinds are typically made of plastics for durability and cost, requiring phthalates to make the plastics pliable.

Over the course of a 30-year lifespan, blinds in a building may need be replaced up to 6 times, and each replacement increases the material burden and the potential for new chemicals to leach out into the building. The old blinds are nearly impossible to recycle, ending up in landfills where the remaining chemicals enter the environment as the product degrades. From cradle to grave, the manufacturing and use of these products cause significant environmental and health damages. In this study, we sought to understand how blinds influence the exposure of office workers to toxic chemicals.



METHODS

This study was conducted at two adjacent buildings on a tech campus in the San Francisco bay area. The buildings were constructed in 2016 with identical designs, floor layouts, and interior finishes; however, one of the buildings was designed with View Smart Windows, which eliminated the need for blinds. The other building has interior blackout and light-filtering fabric blinds installed above each window.

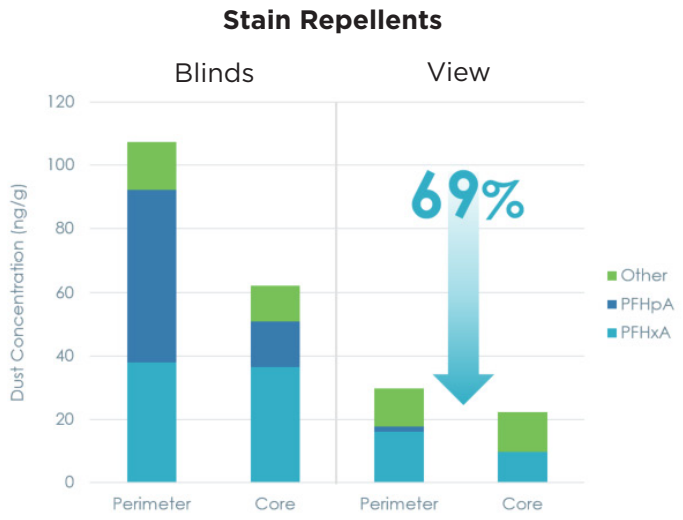
The research team leveraged this natural experiment to assess the concentrations of PBDE and PFAS chemicals in dust attributable to the presence of blinds after 5 years of occupancy. Dust samples were collected from three perimeter locations and three core locations in the open floor plan on the 3rd floor of each building in January of 2022.

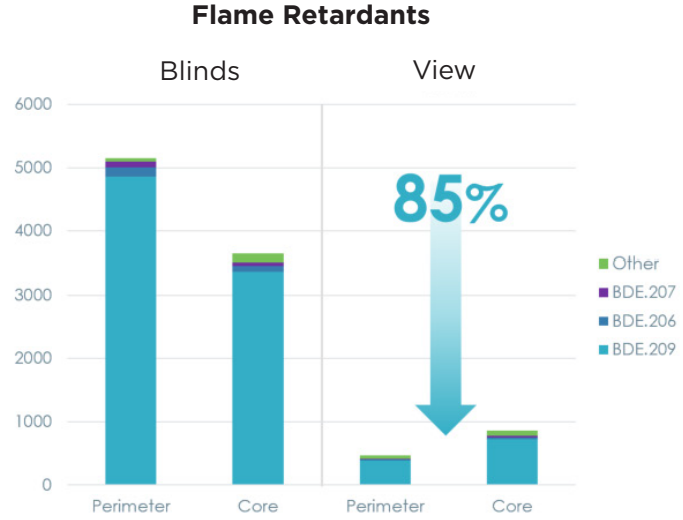
The research team mirrored the sampling locations between buildings and distributed them equally along the south façade of the building. A product inventory was collected to ensure similarity between the furnishings from one sampling location to the next. Products logged in the inventory included workstation furnishings, electronics, flooring, and lounge furnishings.

Each zone was vacuumed for 15 minutes for each chemical class, and the collected dust was sent to Vista Labs to be analyzed for 41 common PFAS compounds and 77 common PBDE compounds. Blank samples were also analyzed and used to blank correct the remaining samples.

RESULTS

On average, dust concentrations of total PFASs were 69% lower and total PBDEs were 85% lower in the building with View Smart Windows as compared to the building with blinds. In the building with blinds, concentrations were 42% and 29% lower in the core offices compared to the perimeter offices for PFAS and PBDEs respectively, indicating that source of both chemicals was located along the perimeter.





The differences in total PFAS concentrations were primarily driven by PFHpA, which was significantly higher in the building with blinds, especially along the perimeter. The other 11 PFAS chemicals that were detected had similar concentrations regardless of location. BDE-209 was by far the most abundant PBDE; however, 44 of the 77 PBDE compounds tested were detected with 36 of them present in both buildings in at least one sample.

IMPLICATIONS

Major institutions such as Harvard, Google, and Kaiser have been using their purchasing power to move the market towards healthier material options. In Harvard's case, much of the research into the health effects of these chemicals was conducted by their own faculty. Google's mission is to organize the world's data, and they saw an opportunity to tackle the lack of transparency in the products they procure. Kaiser, as a system that provides both insurance and healthcare services, believes that investing in reducing environmental exposures will ultimately reduce the burden on their health system downstream.

All three organizations and many others are dedicating resources to this issue because of their commitments to sustainability and to the wellbeing of their employees, generating demand for healthy building standards like WELL, Fitwel, and Living Building Challenge to use in ESG reporting. Cradle-to-Cradle, Healthy Building Network, and other non-profits have formed to help companies manage the complexity of product procurement.

The primary purpose of ESG reporting is to disclose environmental, social, or governance risks that could harm the company's performance. Chemicals of concern have become a major legal risk as epidemiological evidence mounts around their health risks. DuPont, Chemours, and Corteva have set aside $4 billion to cover class action lawsuits from victims of PFAS exposure, and 3M settled with the State of Minneapolis for $850 million for damages related to their production of PFAS chemicals. While legal actions currently have targeted the chemical manufactures, the focus is starting to shift downstream to procurers. Companies can be found liable for injuries that occur on the job, and building forensic scientists called to testify can connect high levels of these chemicals in the office to various health endpoints.

Creating a healthy environment requires a shift from status quo procurement practices. First, the focus needs to shift from individual chemicals to classes of chemicals. Red lists and chemical bans encourage regrettable substitution with chemicals that are likely as bad if not worse than their predecessors. Second, buildings should be designed in a way that reduces the overall material needs of the building, ideally eliminating product categories known to carry harmful chemicals. In this study, we found that the healthiest window blind is no blind at all. Innovative products that are fully transparent about their composition, simplify the building design, and reduce the material requirements should be the first course of action to create sustainable and healthy indoor environments.