Study warns of cleaning product risks

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When used indoors under certain conditions, many common household cleaners and air fresheners emit toxic pollutants at levels that may lead to health risks, according to a new study by researchers at the University of California, Berkeley, and Lawrence Berkeley National Laboratory.

Exposure levels to some of the pollutants - and to the secondary pollutants formed when some of the products mix with ozone - may exceed regulatory guidelines when a large surface is cleaned in a small room or when the products are used regularly, resulting in chronic exposure, according to the study.

The study is the first to measure emissions and concentrations of primary and secondary toxic compounds produced by these products under typical indoor use conditions, and it examines the potential hazards of small-scale yet widespread utilization of an array of products designed for household use.

"We've focused a lot of effort in the last decades on controlling the big sources of air pollution and on the chemicals in consumer products that contribute to outdoor ozone formation. However, now we've learned that we need to pay attention to other aspects of pollution sources that are right under our nose," said William Nazaroff, a UC Berkeley professor of environmental engineering and the study's lead author.

To comply with its mandate to protect public health and welfare, for the past four decades the California Air Resources Board (ARB) has been developing and implementing regulatory programs to reduce air

pollution in the state. These regulations also cover emissions of volatile organic compounds from consumer products used in homes and institutions.

Several years ago, when a handful of new studies raised the concern that consumer products may be contributing to indoor pollution levels in ways that were not fully understood, the ARB commissioned Nazaroff and his team to study the problem.

Four years in the making, the team's 330-page study and report, "Indoor Air Chemistry: Cleaning Agents, Ozone and Toxic Air Contaminants," was posted online by the ARB on Wednesday, May 10, at http://www.arb.ca.gov/research/apr/past/indoor.htm.

The ARB asked Nazaroff and his team to focus their work in two areas: an investigation of toxic air contaminants in household cleaning products and air fresheners, especially a class of chemicals known as ethylene-based glycol ethers; and an examination of the chemistry that occurs when such products are used indoors - in particular, products that contain a reactive group of chemicals called terpenes.

Ethylene-based glycol ethers are common, water-soluble solvents used in a variety of cleaning agents, latex paints and other products. They are classified as hazardous air pollutants under the U.S. Environmental Protection Agency's 1990 Clean Air Act Amendments and as toxic air contaminants by California's Air Resources Board. Their toxicity varies with their chemical structure.

Terpenes are a class of chemicals found in pine, lemon and orange oils that are used in many consumer products either as solvents or to provide a distinctive scent. Although terpenes themselves are not considered toxic, some recent studies have shown that they may react with ozone to produce a number of toxic compounds. (The primary constituent of

smog, ozone enters the indoor environment from infiltration of outdoor air, but is also produced indoors by some office machines such as copiers or printers, and by some devices marketed as "air purifiers" that purposely emit ozone into the indoor environment.)

The research team's first task was to determine which household products contain terpenes and glycol ethers, and in what quantities. It compiled a list of the household cleaners and air fresheners available at any of five chain retail outlets in Northern California, then examined the labels and advertising claims (e.g. "pine-scented") for these products and reviewed available product data sheets. Based on this information, they selected the 21 products most likely to contain significant amounts of terpenes and ethylene-based glycol ethers: four air fresheners and 17 cleaning products, including at least one each of disinfectants, general-purpose degreasers, general-purpose cleaners, wood cleaners, furniture maintenance products, spot removers and multi-purpose solvents.

A complete chemical analysis of these 21 products revealed that:

• Twelve contained terpenes and other ozone-reactive compounds at levels ranging from 0.2 to 26 percent by mass.

• Six contained levels of ethylene-based glycol ethers of 0.8 to 9.6 percent by mass.

• Among the four air fresheners studied, three contained substantial quantities of terpenes (9-14 percent by mass)

When the researchers tested the terpene-containing products in the presence of ozone, they found that reactions produced very small particles with properties like those found in smog and haze; other oxidation products; and formaldehyde, a respiratory irritant that is classified as a Group 1 carcinogen. (This designation by the International

Agency for Cancer Research is reserved for substances for which there is sufficient evidence to conclude that they cause cancer in humans.) The amounts of terpenes that were converted into these pollutants was dependent on the amount of ozone present.

After completing their chemical analyses, the researchers ran a series of 18 experiments to determine the levels of exposure people might be subjected to when using the products in a confined space. The tests were conducted in a 230-square-foot room with ventilation at an ordinary level which provided approximately one air change every two hours. In some tests of terpene-containing products, ozone was introduced into the room at levels mimicking those that could occur in households or offices.

The products were used in various ways according to package directions: some at full-strength and others at various dilutions as recommended on their labels. In some tests, used cleaning supplies such as paper towels and sponges were left in the room. In others, supplies were promptly removed.

The tests produced various results - some reassuring, and some raising concerns.

The good news, the researchers reported, is that when people use the products under ordinary circumstances, their exposure to ethylene-based glycol ethers, formaldehyde and fine particles will normally not reach guideline values: that is, levels set by regulatory agencies as the maximum exposure levels believed to be safe. However, the authors pointed out, because formaldehyde is also released from other sources such as plywood and pressed wood products that are found in most buildings, any increase in formaldehyde emissions is undesirable.

In several realistic use scenarios, the tests showed that people could be

exposed to potentially dangerous levels of toxic pollutants. The scenarios included:

• Cleaning in a small, moderately ventilated bathroom. In calculations based on emissions from one of the glycol-ether containing products, the team found that a person who spends 15 minutes cleaning scale off of a shower stall could inhale three times the "acute one-hour exposure limit" for this compound set by the California Office of Environmental Health Hazard Assessment.

• Air freshener and ozone in a child's bedroom. This scenario could occur when people use both air fresheners and ozone-generating devices simultaneously in a room. This could lead to exposures to formaldehyde that are 25 percent higher than California's guideline value. Because other sources of formaldehyde could also be present in the room, exposure to formaldehyde would probably be even higher, the report states.

• Cleaning when outdoor ozone levels are high. This scenario simulates an apartment in Southern California on a day when the mid-afternoon outdoor ozone concentration is high. A person who stays in the kitchen for two hours after using a moderate amount of one of the terpene-containing products would breathe in about one quarter of the total daily guideline value for particulate matter.

• Multi-house cleaning by a professional home cleaner. Under this scenario, a person who cleans four houses a day, five days per week, 50 weeks per year, would take in about 80 micrograms per day of formaldehyde, double the guideline value set by California's Proposition 65. In addition, the person's intake of fine particulate matter during the hours spent cleaning would exceed the average federal guideline level for an entire year. These quantities are in addition to the formaldehyde and particulate matter that the person would be exposed to from all other

sources and activities during the year.

The take-home message from these studies, according to Nazaroff, is that everyone - but especially cleaning professionals - should be cautious about overuse of products with high levels of ethylene-based glycol ethers and terpenes. Rooms should be ventilated during and after cleaning, some products should be used in diluted solutions as opposed to full-strength, and cleaning supplies should be promptly removed from occupied spaces once cleaning is done. Also, people should avoid the use of ozone generators or ionizing air cleaners, especially in the same space where terpene-containing cleaning products or air fresheners are being used.

The report is an important milestone that highlights the need to investigate potential health effects of ultrafine particles produced in such reactions, said Bart Croes, chief of the ARB's Research Division.

"Dr. Nazaroff and his team have done a very thorough scientific assessment of the emissions from cleaning products and how they contribute to exposures of the users," Croes said. "Their results indicate that we need to look beyond the directly emitted compounds."

Source: UC Berkeley, By Liese Greensfelder