COMMITTEE ON TOXICITY OF CHEMICALS IN FOOD, CONSUMER PRODUCTS AND THE ENVIRONMENT (COT).

Horizon Scanning 2007: Overview of information on Air Fresheners

Introduction

1. Members will wish to consider the short overview paper prepared by the DH Toxicology Unit with some comments from HPA COT secretariat and the HPA Air Pollution Unit.

2. It is notable that exposures to volatile organic chemicals (VOCs) derived from air fresheners can be very complex. However, other sources of VOCs may be more important with regard to indoor air pollution.

3. There are comparatively few epidemiological and other toxicological data available on air fresheners.

4. The Committee on the Medical Effects of Air Pollutants (COMEAP) subgroup on Asthma will review all relevant data on VOCs including air fresheners.

5. There is also a proposal by the WHO to develop indoor air quality guidelines (http://www.euro.who.int/air/activities/20070510_2)

Questions on which the views of the Committee are sought

The COT is asked for comments on the paper in Annex A which can be forwarded to the HPA Air Pollution Unit for consideration by the COMEAP subgroup on Asthma.

Secretariat
March 2008

Overview of information on Air Fresheners

A brief review of the available data on air fresheners and whether their indoor use is or may be associated with respiratory effects (e.g., irritation, asthma, sensitization) has been undertaken.

Document acquisition

Documents considered were obtained via:

- UK Department of Health (DH), Committee on the Medical Effects of Air Pollutants (COMEAP)
- Screening level PubMed search
- Searching the Institute of Environment and Health (IEH) web site (www.silsoe.cranfield.ac.uk/ieh/)
- Searching the EU Health and Consumer Protection web site (ec.europa.eu/dgs/health_consumer/)
- Searching the U.S. Environmental Protection Agency (USEPA) web site (www.epa.gov/)

The general categories of relevant documents identified include:

- Epidemiological studies looking at health effects associated with i) volatile organic chemicals (VOCs) measured in indoor air, ii) the use of household chemical products, or iii) VOC exposure (e.g., as measured using personal air samplers, in exhaled breath or in blood)
- Reviews on the health effects of air odorants or fresheners
- Laboratory studies evaluating the impact of air freshener-ozone reactions on perceived indoor air quality
- Animal toxicity data on air freshener emissions or components
- Papers on air freshener composition, emissions, potential for emissions to undergo chemical reactions
- Studies on human exposures to air fresheners (e.g., use, personal air sampling, expired breath, blood)
- UK Department of Health (DH), Committee on the Medical Effects of Air Pollutants (COMEAP).
- European Union (EU) documents on air fresheners (e.g., EU/Scientific Committee on Human and Environmental Risks (SCHER)
- Fragrance industry documents on air fresheners
- United States National Institutes of Health (NIH) documents on air fresheners
- U.S. or California Environmental Protection Agency (USEPA or CalEPA) documents on air fresheners
- Studies of indoor air quality (e.g., by the IEH and the Building Research Establishment (BRE))
- Review papers on indoor air quality

What products are considered air fresheners?

The term “air fresheners” is variably defined across the published literature. As one example, the European Consumers’ Organization (BEUC) 2005 study

(as cited by the EU SCHER, 2006) considered air fresheners to include: incense, natural products, scented candles, aerosols, liquid fresheners, electric diffusers, and gels. However, not all researchers use such a broad ranging definition. Based on market data prepared by Mintel (2007), the estimated ranking for 2007 air freshener sales in the UK by product type is: plug-in (29.3%), time-release (14.2%), aerosol (13.7%), click spray (13.7%), scented candle (10%), gel (8.8%), potpourri (1.7%), liquid wick (1.4%), and other (1.1%; oils, oil burners, incense).

Are chemicals released from air fresheners into the indoor air?
Yes. The EU SCHER, UK COMEAP, and U.S. EPA all consider air fresheners to be one of multiple sources of volatile organic chemicals (VOCs) in the indoor (e.g., home) environment. Examples of other sources of VOCs in the indoor environment include cleaning products, new carpet/furniture/flooring/paint, toiletries/perfume, smoking, as well as VOCs originating from outdoor sources. Although UK-specific data were not identified, the CalEPA (2006) report includes the findings of an earlier report showing that cleaning product use in California generates roughly 3-fold greater atmospheric (and by inference indoor) emissions than air freshener use.

In terms of VOCs released from air fresheners, the Indoor Air Quality in Homes in England study (BRE, 2002) found bedroom air freshener use to be associated with the measured levels of xylenes, but not with the levels of the other six VOCs analyzed in detail. Several other specific volatile air freshener components that may be of interest include additional aromatic hydrocarbons, dichlorobenzenes (e.g., 1,4-), terpenes, alcohols, aldehydes, and esters.

Air fresheners can also be a source of fine and ultrafine particulates in indoor air. See report by the EU SCHER (2006). However, like VOCs in the indoor environment, there are other sources of particulates within the home. A relative ranking of the various sources of indoor air particulates was not identified as part of this screening review.

In addition, data (e.g., CalEPA, 2006; Singer, 2006a, 2006b; USEPA, 2004) confirm that certain air freshener components (e.g., terpenes) can react with ozone (which has entered homes from outdoors or been generated from “air purification” devices) to produce respiratory irritants such as formaldehyde. Such reactions can also result in particle formation. Similar to direct VOC and particulate emissions, the formation of ozone reaction products is not unique to air fresheners. For example, while terpenes may be present in air fresheners, other products such as cleaning agents also may contain terpenes (e.g., Nazaroff, 2004). As estimated by CalEPA (2006), the mass-fraction of ozone-reactive VOCs in air fresheners is 9.2 to 14.0%, based on three products. However, cleaning products also contain ozone-reactive VOCs (0.22 to 26%; CalEPA, 2006) and, as mentioned above, cleaning product usage may be a greater source of VOC emissions.

The chemistry of reactions regarding indoor air pollution is very complex. One recent paper highlighted the potential variability in chemical reactions and

thus the importance of tailoring a model for particular conditions of use and the need for future air measurements (Carslaw, 2007).

What groups of people may be exposed and/or susceptible to air fresheners?
Both adults and children within the home may be exposed to substances from air fresheners. Susceptible individuals may include i) children due to their higher potential for accidental exposures and ii) subjects who are asthmatic, have a respiratory illness/disease, or are otherwise sensitive to chemicals/odorants.

What are the potential exposure pathways?
The predominant exposure pathway for household air fresheners is the inhalation of VOCs and/or particulates. However, adults and children may have skin or eye contact with liquid or solid freshener material and potentially also to particulates. Accidental ingestion of freshener material by children has been reported.[1] While air freshener emissions also could potentially contaminate food or drink left open to the indoor air, information on this potential exposure route was not identified during this screening review.

What is the level of consumer exposure to air freshener emissions in the UK?
As discussed in the literature (e.g., EU SCHER, 2006), data are limited on the pattern and extent of air freshener use by consumers, and more importantly on the potential magnitude of their exposures to the individually emitted chemicals/particulates and their possible reaction products. One difficulty is the variability in chemical emissions observed across different air freshener categories (i.e., incense, liquid fresheners,) and across different products within a given category. In addition, frequency of use, the indoor ventilation rate, indoor ozone levels, the amount of time consumers spend in different rooms and door/window opening behaviour will impact on their potential exposures to air freshener emissions. Despite these uncertainties, the California data indicate that consumer exposures may be higher from cleaning products than through their use of air fresheners.

Are there respiratory effects associated with exposures to VOCs from the indoor use of air fresheners?
Human. Limited data available, with almost no exposure data.

- In a U.S. cross-sectional study of 1054 individuals, 17.6% reported "headaches, breathing difficulties, or other health problems" when exposed to air fresheners (Caress and Steinemann, 2004, 2005). Among the 148 asthmatic study participants, 29.7% reported that air fresheners "make it difficult to breathe", while 37.2% reported finding "scented products" irritating. This was a descriptive study without control subjects. Further, while the study presented a tabulation of various participant demographics, it did not consider other factors such as cleaning product use that could account or contribute to the findings. However, the authors state that the results for chemical sensitivity (as

[1] U.S. Consumer Product Safety Commission (CPSC), 2007, Hazard screening report: Home and family maintenance products – household chemicals, July. [Child died from ingesting an air freshener; liquid versus solid not specified]

determined by questionnaire) are in line with other estimates for the U.S.

- Looking at 170 homes within the Avon Longitudinal Study of Parents and Children (ALSPAC), no association was found between air freshener use and respiratory effects among mothers or infants postpartum (Farrow et al, 2003). However, the ALSPAC data did indicate an association between high (>90th percentile) maternal chemical body burden and persistent wheezing during childhood (Sheriff et al., 2005). It is not possible though to elucidate what fraction of maternal body burden was linked to air freshener usage, if any. It is noted that an alternative explanation of these results might be suggested by the 'hygiene hypothesis'. This proposed that if children are not exposed to micro-organisms when young (as might occur in households using a lot of cleaning agents), their immune system is diverted to a more allergic type response (Liu, 2007) This particular article will be considered by the DH Committee on the Medical Effects of Air pollutants (COMEAP) during preparation of their report 'Does Air Pollution Cause Asthma'?
- A low percentage (7%) of individuals with asthma reported that air fresheners "often or almost always" make them "feel ill" (Baldwin et al, 1999). This 7% finding is less than reported for nine of the 11 other product groups considered (i.e., 8% for chlorine to 50% for tobacco smoke). It is also lower than found in the Caress and Steinemann study. For the other two product groups (natural gas and soft plastics), no asthmatics reported feeling ill. The percentages of people with hay fever and chemical intolerance feeling ill from air fresheners were 1% and 10%, respectively. Data were not presented on the rates of healthy individuals (without asthma, hay fever, or chemical intolerance) that feel ill from air fresheners.

Animal. Data available on individual chemicals, but there is only limited information specific to air freshener emissions.

- Mouse chamber studies on a single solid air freshener (Anderson, 1997, 1999) indicate a possibility for sensory and pulmonary irritation, decreased airflow velocity, and altered functional observational battery scores. However, exposure was defined as the mass air freshener added to the chamber since some inconsistencies were noted between air freshener weight and TVOC measurements. Only one air freshener product investigated.
- Pulmonary irritation has also been observed in rats exposed to limonene[2]:ozone reaction products (Sunil, 2007). In this experiment, rats were exposed for 3 hours to 6 ppm limonene (a common component of air fresheners) and 0.8 ppm ozone. In a single chamber study (Singer, 2006) however, limonene was only measured at 0.009 ppm (peak; 0.006 ppm 3-day average) for a plug-in scented oil air freshener and a 50 m^3 chamber. In the U.S. TEAM studies (Wallace, 1989, 1991), the 24-hour averages for limonene in indoor air were 0.001 ppm (summer; max 12-hour = 0.012 ppm) and 0.007 ppm

[2] Limonene is a terpene found in air fresheners and other household products (e.g., cleaners)

(winter; max 12-hour = 0.041 ppm). Thus, based on these limited comparison data, the Sunil (2006) limonene level appears high. Further, like other terpenes, limonene can be found in various household products besides air fresheners (e.g., cleaners) (Nazaroff, 2004). Thus, the data suggest a potential mode of action for respiratory effects of ozone-limonene interaction products but this action would not be specific to air fresheners.

Are there respiratory effects associated with exposures to VOCs from any source in indoor air?

Yes. Epidemiological data indicate an association between VOC exposure and respiratory effects (e.g., asthma, impaired pulmonary function) (e.g., Rumchev, 2004; Saijo, 2004). And, indoor VOC exposure typically exceeds outdoor exposure by up to 10-fold (e.g., Wallace/U.S. TEAM studies).

Of special note, 1,4-dichlorobenzene[3] (a component of many air fresheners) in the blood was the only VOC found to be associated with decreased lung function in a 2006 study using Third National Health and Nutrition Examination Survey (NHANES) data (n=953; U.S. National Institute of Environmental Health Sciences (NIEHS/NIH), 2006). Of note, the statistics were adjusted for gender, body weight/height, smoking, and physician-diagnosed emphysema. In addition, an association also was seen between the urinary metabolite of 1,4-dichlorobenzene (2,5-dinitrophenol) and decreased pulmonary function. The authors do note that the separate statistical analyses by chemical could produce an association by chance, but suggest that the consistent analyses across subgroups (gender, race) and urinary metabolite data minimize this possibility. However, while the results were significant for both genders combined, they were not significant for "all males" or "all females". And, only some races evaluated showed a significant change. Thus, the data suggest a possible effect, but independent confirmation is needed.

Other chemicals (also found in air fresheners or formed when freshener components interact with ozone) are considered respiratory irritants: as examples, formaldehyde, toluene, terpenes.

In the news

October 23, 2007: The U.S. EPA has received a petition from several concerned groups to assess and reduce human health and environmental risks from air fresheners[4]

Conclusion

While data are available to indicate that exposure to VOCs *from all sources combined* in indoor air may result in respiratory effects, there are insufficient

[3] 28.1% of 1,4-dichlrobenzene in Europe is used in moth balls, 21.9% in toilet blocks or air fresheners, and the rest mostly as a chemical intermediate in manufacturing (EU Chemicals Bureau, 2004).

[4] U.S. EPA. 2007. Air fresheners; TSCA Section 21 Petition; Notice of receipt. Federal Register, 72(204):60016-60018. October 23.

data to adequately assess the potential effects from the indoor use of *air fresheners specifically*. Data are needed on the patterns and extent of air freshener use, the levels and variation of indoor air concentrations of specific VOCs and, in some cases, inhalation toxicity data for individual chemicals i) emitted from air fresheners or ii) possibly resulting from the reaction of emitted chemicals with ozone. However, overall based on the limited data reviewed, it seems air freshener use may provide lower exposures than cleaning agents.

Despite the above data gaps, the available data on air freshener emissions establish that VOCs and particulates are released, with varying emission rates across (and within) product types. Further, several of the specific VOCs have the potential to cause respiratory effects if sufficient concentrations are reached. The potential for respiratory effects from air fresheners may be heightened among certain individuals (e.g., children, elderly, people with respiratory conditions, or odor/chemical intolerant individuals). However, it is not possible to reach a specific conclusion on this aspect for air fresheners.

It is noted the Asthma subgroup of COMEAP will review VOCs from various sources including air fresheners.

DH Tox/HPA COT
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