Clearing the Air of Toxic Moth Repellents

Highly hazardous fumigants in mothballs have consumers looking for ways to protect clothes without contaminating homes.

By Nichelle Harriott

The scent of toxic moth poisons containing the fumigants naphthalene or p-dichlorobenzene is a familiar springtime smell in closets, chests, and clothes storage areas. The two major ingredients in mothballs, used individually or in combination, are extremely dangerous petroleum-based chemicals that can cause a range of short and long-term health effects, including cancer, blood, kidney, and liver effects.[1-4] In 1991, the state of California canceled all pesticide uses of naphthalene due to known health effects and inadequacies in existing data. However, it is registered with the U.S. Environmental Protection Agency (EPA) and is in use in other states.[5,6] With striking hazards linked to these fumigants, the use of management practices, insect traps, and other repellents takes on an important urgency.

Health Concerns

Moth repellents are pesticides used to kill the larvae of clothes moths and/or carpet beetles. These insects lay their eggs on fabric and other textiles, and when hatched, their larvae feed on organic matter trapped within the fibers, chewing away to leave gapping holes in favorite sweaters or clothing. The moth larvae feed on wool, feathers, fur, hair, leather, lint, dust, paper, and occasionally cotton, linen, silk, and synthetic fibers.[7] Mothballs, usually placed in closed or sealed closets and containers, sublime –meaning they transform from a solid directly into a gas, and the vapors build up and kill moths and their larvae.

However, direct and indirect exposures to these vapors are harmful. Mothballs are made with either, or a combination of, naphthalene and p-dichlorobenzene as the active ingredient. Note: p-dichlorobenzene has been replacing naphthalene in the formulation of moth repellents, and is also used as the primary ingredient in many restroom deodorizers.

Product labels state "avoid prolonged breathing of vapors,"[8] however, since the vapors can fill an entire home, this is literally impossible in an indoor environment. When placed in closets or rooms with poor ventilation, these vapors build up to high concentrations where they are absorbed, not only by clothes, but by beds, sofas and other soft textiles in the room, resulting in greater risks for indirect exposures.

Naphthalene

Naphthalene, also called mothballs, moth flakes, white tar, and tar camphor,[2] is an aromatic hydrocarbon that appears as a white solid in crystalline or marble-like form.[9] Naphthalene is naturally present in fossil fuels such as petroleum and coal, and is a natural constituent of coal tar and crude oil. Apart from mothballs, crystalline naphthalene is used as a deodorizer for diaper pails and toilets. It is also used as an intermediate in the manufacture of a wide range of products including phthalate plasticizers, resins, dyes, pharmaceuticals, insect repellents, and other products.[9] Since naphthalene easily vaporizes, its gas has a variety of other fumigant uses, including use as an insecticidal soil fumigant.

p-Dichlorobenzene

p-Dichlorobenzene, or 1,4-dichlorobenzene, is a colorless or white crystalline solid used as a fumigant insecticide, which is marketed as a variety of indoor products like crystals, cakes, balls, sachets, impregnated strips, blocks, varpel rope, and flakes. It is also used in attics to repel snakes, mice, rats, squirrels, and attic wombats, and repels lice and mites from birdcages.[10] It is also widely used to make deodorant blocks used in garbage cans and restrooms.[4,11] Approximately five million pounds of p-dichlorobenzene are used in the U.S. each year, the majority of which are in moth repellent products.[10] Like naphthalene, p-dichlorobenzene is also used as a fungicide on crops, and in the manufacture of other organic chemicals, and in plastics, dyes, and pharmaceuticals.[11]

Routes of exposure to moth repellents

I. Inhalation exposure. Once mothballs can be smelled, exposure is occurring. Even though most mothball applications are made within chests and closets, studies have found that mothball vapors leak from these storage units and are emitted into the indoor environment.[12,13] Vapors are rapidly absorbed when inhaled.[14] Breathing in the vapors of moth repellents can cause headaches, dizziness, irritation to the nose and throat, nausea, and vomiting. In one incident eight adults and one child reported gastrointestinal (nausea, vomiting, abdominal pain) and neurological (headache, malaise, confusion) symptoms after exposure to large numbers of naphthalene mothballs in their home.[9,15]

Intentional inhalation of mothball vapors (as a recreational drug) have been documented in twin 18-year old girls who suffered with anemia, skin lesions, mental sluggishness, and other neurocutaneous symptoms, which abated once they stopped "sniffing" mothballs.[16] Other instances of mothball abuse have resulted in peripheral neuropathy and chronic kidney failure.[14]

Inhaled vapors have resulted in histopathological changes (anatomical changes in diseased tissue) in the lungs of acutely exposed rats and guinea pigs and the nasal olfactory epithelium (nasal cavity tissue) of chronically exposed rats and mice.[1,4,15] Furthermore, a study conducted by the National Toxicology Program (NTP) in 2000, found increased incidences of two types of nasal tumors in naphthalene-treated animals. These results indicate evidence of carcinogenic activity.[9] Subsequent studies find that inhalation of mothball ingredients results in an increased incidence of benign and malignant tumors in the nasal cavity, as well as toxicity in the liver and kidneys in rodents.[17] Increased numbers of alveolar/bronchiolar adenomas and carcinomas are also reported in female mice exposed by inhalation of naphthalene.[18] A thirteen-week laboratory study also found that inhalation exposure induces liver toxicity (hepatotoxicity}, kidney and blood (hematological) toxicity in mice and rats.[19]

II. Oral exposure. Mothballs, because of their appearance, can be easily mistaken for candy and can tempt young children to touch and play with them. As a result, they pose a hazard to young children. If ingested, mothballs can be fatal. Most mothball poisonings have occurred in children.[14,18] Symptoms of poisoning include blood in urine (hematuria), anemia, restlessness, liver enlargement and sometimes gastrointestinal bleeding.[15] Naphthalene can remain in the body for several days after ingestion. Case studies have detected naphthalene metabolites, such as naphthol, in urine two weeks after oral exposure, suggesting that this chemical can linger within the gastrointestinal tract for some time, prolonging its

Least-Toxic Clothes Moth Management

1. Do not use mothballs when storing clothing.
2. Practice good housekeeping. Periodically clean areas of a home (preferably with a vacuum) that may harbor clothes moths to prevent or control infestation. Target areas include along baseboards and in cracks where hair and debris accumulate, under heavy pieces of furniture, heaters, the areas behind them, and vents.
3. Launder clothes before storage - moth larvae are attracted to sweat, dandruff, hair, food and beverage stains, and other organic materials. If possible, iron or brush clothing and other fabrics to remove any eggs or larvae.
4. Store clothing in airtight chests or containers and make sure storage containers are clean before storing clothing. Plastic bags that use vacuum suction to remove air is also a good way to store clothing.
5. If possible, air clothing in sunlight before storing. Bright sunlight and wind will reduce larvae on fabrics.
6. Avoid storing clothing in dark areas, like attics. Larvae prefer to feed in secluded, dark places.
7. Use least toxic options to control moths. Store clothes with herbs such as cloves, fresh rosemary, eucalyptus, lavender, lemon, sweet woodruff, cinnamon sticks and bay leaves also repel moths. Herbal sachets are available at most health food stores. Cedar oil (sold as blocks or shavings) is a botanical oil that can also be used to repel moths.
8. Infested fabrics can be treated by heating the infested object for at least 30 minutes at temperatures over 120°F, freezing the object for several days at temperatures below 18°F, or fumigating with dry ice.
9. Pheromone traps are available and trap certain species of moths. These can be placed in closets and other areas where clothes are stored. It is also important to launder clothes that have been exposed to the trapped moths. Note: Use traps only if there is an established moth infestation.
10. Humidity should be kept low inside buildings or storage rooms, since this type of environment is not attractive to moths..
11. Read the label first on all pesticide products to identify product ingredients!
12. On a related note, do not use toilet deodorizers that contain p-dichlorobenzene.

excretion from the human body.[9] Other acute symptoms include impaired vision and urethral swelling.

There are several cases of mortality among infants and young children that have accidentally ingested mothballs and one case documents a 17-year-old male who died five days after exhibiting symptoms that included vomiting, gastrointestinal bleeding, blood-tinged urine, jaundice, and coma.[9,15]

III. Dermal exposure. Clothing and other textiles absorb large concentrations of mothball chemicals,[12-13] which remain within cloth fibers for long periods of time, even after prolonged airing.[13]Skin irritation, and even severe dermatitis, can occur after being in contact with mothballs.[14]

Wearing clothing that has absorbed mothball chemicals can induce red blood cells destruction (hemolysis), especially in young children. Hospitals have observed hemolytic anemia in infants, including newborns, who wore clothing, or were wrapped in blankets, stored with mothballs.[2] Children are especially susceptible to this effect on the blood, because their bodies are less able to get rid of naphthalene and p-dichlorobenzene. These chemicals are easily absorbed by the skin during the handling of mothballs, and particularly when oil-based lotions have been used on the skin.[2,14] A three-year old patient whose symptoms of jaundice and pale mucous membranes, indicative of liver damage, were attributed to dermal absorption of p-dichlorobenzene given that the toddler played with crystals containing the chemical.[4]

Children who suffer from a glucose-6-phosphatedehydrogenase (G6PD) deficiency are prone to hemolysis induced by mothball exposure. Two Greek infants with this deficiency died as a consequence of acute hemolysis that resulted from exposure to naphthalene (mothballs)- treated materials. Both infants exhibited a severe form of jaundice, which often causes brain damage.[2] Higher rates of inherited G6PD deficiencies are found more often in defined subpopulations with African or Mediterranean ancestry than in other groups, and these populations are therefore more susceptible to oxidative damage from naphthalene exposure.[2,9,15]

Repeated exposure to naphthalene can cause clouding of the eye's lens (cataracts) and impair vision.[20] Researchers have also found a significant correlation between mothball exposures and non-Hodgkins lymphoma,[21] which further emphasizes mothball induced hematologic toxicity.

IV. Pre-natal exposure.

Mothball chemicals have been identified in placentas,[4] fatty tissue and breast milk.[2,22] Anemia and jaundice have been reported in infants born to mothers who "sniffed" and/or ingested mothballs during pregnancy.[14,18] This means that transplacental transfer of naphthalene and/or p-dichlorobenzene occurs during pregnancy and adversely impacts newborns.[14]

References

[1]International Agency for Research on Cancer (IARC). 2002. Some Traditional Herbal Medicines, Some Mycotoxins, Naphthalene and Styrene. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, 82.

[2]ATSDR. 2005. Toxicological Profile For Naphthalene, 1-Methylnaphthalene, And 2-Methylnaphthalene. Agency for Toxic Substances and Disease Registry, Division of Toxicology/Toxicology Information Branch, GA.

[3]IARC. 1999.Volume 73: Some Chemicals that Cause Tumours of the Kidney or Urinary Bladder in Rodents and Some Other Substances. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans- Summary of Data Reported and Evaluation.

[4]ATSDR. 2006.Toxicological Profile for Dichlorobenzenes. Agency for Toxic Substances and Disease Registry Division of Toxicology and Environmental Medicine, GA.

[5]OEHHA. 2000. Memorandum: Proposed Notification Level For Naphthalene. [cited Office of Environmental Health Hazard Assessment; Available from: http://www.oehha.org/water/pals/naphthalene.html.

[6]Scorecard. Naphthalene. [cited; Available from: http://www.scorecard.org/chemical-profiles/html/naphthalene.html.

[7]Lyon, W.F. Clothes Moths. Ohio State University Extension Fact Sheet [cited; Available from: http://ohioline.osu.edu/hyg-fact/2000/2107.html.

[8]Purdue Univ. 2005. Harzadous Products in the Home: Mothballs. [cited April 3 2008]; Available from: http://www.purdue.edu/envirosoft/housewaste/house/mothball.htm.

[9]US EPA. 2003. Health Effects Support Document for Naphthalene. Office of Water (4304T) Health and Ecological Criteria Division, Washington, DC.

[10]US EPA. 2007. Reregistration Eligibility Decision for Para-dichlorobenzene. Office of Prevention, Pesticides and Toxic Substances, Washington DC.

[11]US EPA. 2006. Consumer Factsheet on: PARA-DICHLOROBENZENE (p-DCB). National Primary Drinking Water Regulations: Drinking Water and Health pages, Washington DC.

[12]Shinohara, N., K. Ono, and M. Gamo. 2008. p-Dichlorobenzene emission rates from moth repellents and leakage rates from cloth storage cases. 18(1): p. 63-71.

[13]De Coensel, N., et al. 2007. Domestic sampling: Exposure assessment to moth repellent products using ultrasonic extraction and capillary GC–MS. Chemosphere, doi:10.1016/j.chemosphere.2007.10.040.

[14]IPCS, Naphthalene. INCHEM, 2000. International Programme on Chemical Safety.

[15]California Office of Environmental Health Hazard Assessment (OEHHA), Chronic Toxicity Summary: Naphthalene. Air Toxicology and Epidemiology- Chronic Reference Exposure Levels (cRELs).

[16]Feuillet, L., et al. 2006. Twin Girls with Neurocutaneous Symptoms Caused by Mothball Intoxication. New England Journal of Medicine, 355(4): p. 423.

[17]Aiso, S., et al. 2005. Carcinogenicity and chronic toxicity in mice and rats exposed by inhalation to para-Dichlorobenzene for two years. Journal of Veterinary Medical Science, 67(10): p. 1019-1029.

[18]US EPA. 2000. Hazard Summary: Naphthalene. Air Toxics [cited; Available from: http://www.epa.gov/ttn/atw/hlthef/naphthal.html.

[19]Shigetoshi et al. 2005. Thirteen-week Inhalation Toxicity of p-Dichlorobenzene in Mice and Rats J. of Occupational Health, 47: p. 249-260.

[20]Wisconsin Department of Health and Family Services. 2003. Information on Toxic Chemicals: Naphthalene. Division of Public Health, Madison, WI.

[21]Tenenbaum, D.J. 2004. The Monster in the Closet: Mothballs' Link to Non-Hodgkin Lymphoma. Environmental Health Perspectives, 112(13): p. A758.

[22]Hill, R.H., Jr., et al. 1995. p-Dichlorobenzene exposure among 1000 adults in the United States. Archives of Environmental Health, v50(n4): p. p277(4).