

NAPHTHALENE MOTHBALLS: A HEALTH HAZARD



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INTRODUCTION

Mothballs are small balls containing smell of a deodorant and are used for storing clothing and articles susceptible to damage from mold or moth larvae. It is also used as a repellent to keep away mice, snakes, or other pests and for use as a stovepipe cleaner.¹ Mothballs have been used by drag racers to enhance the octane rating of fuel, by dissolving the mothballs in some of the fuel and filtering out the remains with a filter paper. Generally mothballs are made from ingredients containing either naphthalene or para-dichloro benzene. Due to health risks of naphthalene and para-dichloro benzene, these chemicals have been prohibited for the use in mothballs. Nowadays, camphor is being used as a substitute for these chemicals. Though in India, the use of para-dichloro benzene is prohibited as pesticide, however naphthalene mothballs are very commonly available in India.

ABOUT NAPHTHALENE

Naphthalene is a polycyclic aromatic hydrocarbon (PAH) compound, derived from crude oil or coal tar during steel production. Typical coal tar is 10% naphthalene by weight. It is crystallised from coal tar fraction at boiling point 210-220°C. It is a component of crude oil and a product of natural combustion. Naphthalene is naturally found in fossil fuels. Burning tobacco or wood produces naphthalene.² It has a strong, but not an unpleasant smell.

Naphthalene³ is used mainly as a precursor to other chemicals. Naphthalene sulfonic acids and sulfonates are used as surfactants while amine and sulfonic acids substituted naphthalenes are used in preparation of synthetic dyes. Some hydrogenated naphthalenes are used as solvents with low volatility. It is also used as



FACTS AT A GLANCE....

- Single box of mothballs (396 g naphthalene) released within an indoor residential environment is capable of raising the indoor air concentration to an average 200 µg/m³ for one year
- Occupational Safety and Health Administration (OSHA) in the United States has established a Permissible Exposure Limit (PEL) of 10 ppm for naphthalene
- National Institute of Occupational Safety and Health (NIOSH) established an Immediately Dangerous to Life or Health (IDLH) value of 250 ppm for naphthalene
- Naphthalene has been classified as being possibly carcinogenic (Group 2B) in humans by International Agency for Research on Cancer (IARC)
- Environmental Protection Agency (EPA) recommends children not to drink water with over 0.5 ppm Naphthalene for more than 10 days
- EPA recommends adults not to drink water with more than 1 ppm for more than 7 years

a solubilising medium for poorly soluble aromatic compounds in laboratories and as a fumigant. Naphthalene⁴ is used to make moth repellents, dyes, resins, leather, tanning agents, explosives and lubricants and toilet deodorant blocks⁶. Naphthalene sublimates at approximately 80 °C (176 °F).



...naphthalene entering into the environment include its use as moth repellent, wood and tobacco burning...

ISSUES SURROUNDING MOTHBALLS

Initially, mothballs consisted naphthalene but due to its high flammability, many modern mothball formulations instead use 1, 4 di-chlorobenzene. The latter formulation may be less flammable, although both chemicals have the same NFPA 704 (National Fire Protection Association) rating for flammability.⁵ We can smell naphthalene in air at a concentration of 84 parts naphthalene per billion⁶ (ppb) of air and while we can smell it in water at a concentration of 21 ppb⁶.

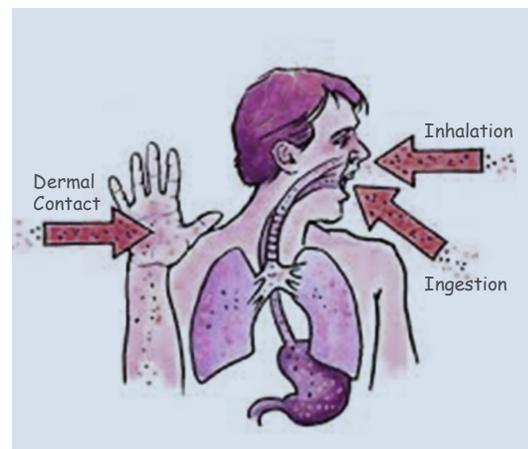
Both of these formulations have strong, pungent, sickly-sweet odour often associated with mothballs. Both naphthalene and 1, 4-dichlorobenzene undergoes the process of sublimation by virtue of which they evaporate from solid state directly into gas. This gas is toxic to moths and moth larvae.

The combination of both naphthalene and 1, 4-dichlorobenzene should not be used together because the mixture may cause damage to items being preserved. Due to the health risks of 1, 4-dichlorobenzene and flammability of naphthalene, other substances like camphor are sometimes used although it has its own toxicity issues.

Most of the naphthalene entering into the environment is from burning of woods and fossil fuels while the second largest release of naphthalene is due to use in moth repellants⁶.

HEALTH AND ENVIRONMENTAL IMPACTS OF NAPHTHALENE BALLS

The sources of naphthalene entering into the environment include its use as moth repellent, wood and tobacco burning and from accidental spills⁶. At waste sites and landfills, it can dissolve in water. It can bind weakly to soil and sediments. Therefore, it easily passes through sandy soils to reach underground water. In soil, due to the presence of certain micro-organisms naphthalene can be broken down, and when it is at surface of soil, it is easily evaporated into air. It takes about 1-3 months for micro-organisms in soil to break down molecules of naphthalene⁶.



EXPOSURE ROUTES

Naphthalene released into the atmosphere can be transported to surface water and/or soils by wet/dry deposition. This deposition is predicted to be very slow (0.04-0.06 cm/sec)⁶ since naphthalene is in vapour form. Naphthalene from surface water may volatilize into the atmosphere. In atmosphere, naphthalene is subjected to degradation processes among which it tends to react with photochemically produced hydroxyl radicals. The half life based on this reaction is < 1 day for naphthalene. 1- and 2-naphthol and 1- and 2- nitro naphthalene are major products of the reaction. Naphthalene also reacts with N_2O_5 , nitrate radicals and ozone in the atmosphere. Photolysis of naphthalene is also likely to occur. Naphthalene is degraded due to photolysis and biological processes in water. Naphthalene after photolysis in surface water has a half life of about 71 hours and in deeper water of about 5m, it is estimated to be 550 days⁶.

Most naphthalene in the environment will turn into a gas. Some of it may be bound to soil, where it can be taken up by plants. It can also be deposited on plant leaves from the air. Naphthalene is broken down by bacteria, fungi, air and sunlight. It has been found in wastewater treatment plant discharge. The half-life of naphthalene in the environment may range from less than one day in air to over 80 days in soil.⁷ The latter half life in soil is sufficient enough for naphthalene to dissolve in water and thus pollute the underground water and ultimately affecting the plants and human beings and wildlife after entering in the food chain.

INDIAN MARKET

According to India Naphthalene Market Forecast & Opportunities 2019, India's naphthalene market is expected to witness high growth at a Compound Annual Growth Rate (CAGR) of 18% during 2014-19. It is a matter of investigation if mothballs banned in other countries is being dumped in India.

Naphthalene containing mothballs are potential health and environmental hazards. In humans, naphthalene is broken down to alpha-naphthol, which is linked to the development of hemolytic anemia leading to damaged kidney and liver. In animals, naphthalene breaks down into other compounds including alpha-naphthol, which may affect lungs and eyes.

INDIAN SCENARIO

In India, the use of mothballs are very common and is found in every nook and corner. Despite grave health and environmental danger from naphthalene balls, there is no public information on the possible impacts from these mothballs. Citizens are not only affected from these naphthalene balls directly through its exposure, but there are possibilities of impact of such chemicals in water bodies and the entire ecosystems. Globally, the use of naphthalene balls have been phased out including China, still it is quite readily available in Indian markets. There are so many international e-commerce sellers that are also selling Naphthalene balls online. It is also a matter of investigation of possible dumping of naphthalene balls from China to India due to high demand of mothballs use in India.

Generally, the cost of naphthalene balls in India varies from Rs. 30 to Rs. 100 for a packet of 100 gm. Since these balls are readily available in the market and online on e-commerce sites, inexpensive and no easy availability of its alternatives favours its increased usage among people. Lack of awareness among the citizens about its health hazards is also responsible for its high demand for storing winter clothing. There are warning messages written on the packet saying "Keep away from children."

Finally, there is an urgent action required to ban naphthalene balls in India and dispose these substances in an environmentally sound manner to prevent damage to the ecosystems. There is as such no standards for the presence of naphthalene in drinking water.

SAFER ALTERNATIVES

- Use cedar chips, satchels of lavender, bay leaves, cedar shavings, cinnamon sticks, cloves, eucalyptus leaves, peppercorns, rosemary, wormwood packed in a cloth and ensure it doesn't touch clothes.
- Store clothing in well sealed and air tight containers.
- Dry clean clothes before storing as used clothes have a higher tendency to attract moths.



Due to lack of awareness, the use of mothballs are very common in India

CALL FOR BAN!!

- Mothballs containing naphthalene have been banned in European Union since 2008
- New Zealand has banned mothballs due to their toxic risks
- In Australia, mothballs are sold in a form that prevents accidental eating
- In India, para-dichloro benzene is banned as a pesticide
- In China, the use of naphthalene in mothballs is forbidden



REFERENCES

1. <https://en.wikipedia.org/wiki/Mothball#Uses>
2. http://www.epa.ohio.gov/portals/41/p2/mercury_pbt/fact101.pdf
3. <https://en.wikipedia.org/wiki/Naphthalene#Uses>
4. <http://scienceline.ucsb.edu/getkey.php?key=4306>
5. <https://en.wikipedia.org/wiki/Mothball#Composition>
6. <https://www.atsdr.cdc.gov/toxprofiles/tp67.pdf>
7. <http://npic.orst.edu/factsheets/naphgen.html>
8. <https://www.techsciresearch.com/report/india-naphthalene-market-forecast-and-opportunities-2019/155.html>
9. <http://www.researchandmarkets.com/reports/3007434/india-naphthalene-market-forecast-and.pdf>
10. <http://www.ibtimes.com.au/new-zealand-bans-mothballs-due-significant-health-risk-women-exposed-solvents-have-high-breast>
11. Price PS, Jaycock MA. Available data on naphthalene exposures: strengths and limitations. *Regul Toxicol Pharmacol.* 2008;51:S15–21
12. https://www.osha.gov/dts/chemicalsampling/data/CH_255800.html
13. International Agency for Research on Cancer (IARC), Naphthalene, Vol 82, in IARC, Monographs on the Evaluation of Carcinogenic Risks to Humans. 2002, IARC: Lyon
14. Clearing the Air of Toxic Moth Repellents, Changing Cultural Practices, A Beyond Pesticides Factsheet
15. Wisconsin Department of Health and Family Services, 2003, Information on Toxic Chemicals: Naphthalene. Division of Public Health, Madison, WI
16. Tenenbaum, D.J. 2004, The Monster in the Closet: Mothballs' Link to Non-Hodgkin Lymphoma. *Environmental Health Perspectives*, 112(13): p. A758
17. ATSDR, 2005., Toxicological Profile For Naphthalene, 1-Methylnaphthalene, and 2-Methylnaphthalene, Agency for Toxic Substances and Disease Registry, Division of Toxicology/Toxicology Informa_ on Branch, GA
18. IPCS, Naphthalene, INCHEM, 2000, International Programme on Chemical Safety
19. US EPA, 2000, Hazard Summary: Naphthalene, Air Toxics
20. <http://www.greenlivingtips.com/articles/mothball-alternatives.html>
21. Mothball Hazards – Dangers In Using Mothballs To Repel Pests.htm
22. <https://en.wikipedia.org/wiki/Mothball#Composition>
23. <https://en.wikipedia.org/wiki/Naphthalene#Regulation>
24. Sudakin, D. L., Stone, D. L., & Power, L. (2011). Naphthalene mothballs: emerging and recurring issues and their relevance to environmental health. *Current topics in toxicology*, 7, 13

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