Polyurethane Foam Association

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What Regulators Need to Know: Free Toluene Diisocyanate (TDI) and Exposure Risk Are *Not* Present in Cured Flexible Polyurethane Foam Products

TDI in Cured vs. Uncured Foam

There is confusion about the potential for end user exposure to Toluene Diisocyanate (TDI) used by companies in the manufacture of flexible polyurethane foam (FPF); and how FPF differs from other types of polyurethane foam in its applications and safe use in consumer products.

Open cell FPF is the primary foam used for comfort in furniture, bedding, and car seating, as well as for carpet cushioning. It also makes ink in printer cartridges flow better, cushions sports equipment and shoes, and provides safety, healing benefits, and filtration in various medical applications.

TDI is one of three key raw materials used to produce FPF (the others are polyol and water). TDI reacts efficiently with water and polyol, creating a chemical reaction which consumes essentially all of the TDI to form FPF polymers. Tests show that during the reaction, for each metric ton (2,200 lbs) of foam produced, no more than 1.6 ounces (0.1 lbs) of TDI remain after the initial reaction. During curing, any trace of remaining TDI is managed through controlled production ventilation systems.

In fact, numerous tests demonstrate that after the curing process is complete, TDI levels are below the level of detection and, as a result, there is very little potential for exposure from normal use of consumer products containing cured FPF materials. This conclusion has been verified by:

- Peer-reviewed research by the International Isocyanates Institute which found no available TDI in finished polyurethane foam products and no opportunity for TDI exposure.[1, 2]
- Studies by foam producers and others which came to the same conclusions as those by the International Isocyanates Institute.[3, 4]
- An extensive report, published by California's Air Resources Board Research Division, which stated that "the absence of detectable TDI emissions in the screening tests indicates that release of TDI to air from common residential products is negligible." [5]
- A study published in *Applied Occupational and Environmental Hygiene* found that it is not likely that TDI would be released from three-day post-production polyurethane foams in amounts likely to produce air concentrations of concern.[6]

Polyurethanes are not all alike

Like "plastics," polyurethanes is a broad category with many types of products. Not all plastics are alike, and the same is true for polyurethanes and polyurethane foam products. There are other types of polyurethane products, such as certain adhesives, sealants, coatings, and spray products that are not cured until they are used. These types of products are typically applied in the field, and not in a manufacturing facility. FPF products are always cured in a manufacturing facility prior to further use, and there is no opportunity for exposure to unreacted TDI raw materials or other isocyanates in finished FPF end-products.

Regulatory decisions about the use of raw materials in manufacturing, as well as safeguards related to the use of finished products, should be based on good science and a thorough understanding of product differences, along with factual information about the presence or absence of emissions of concern from finished products.

[1] Scott M. Arnold, Michael A. Collins, Cynthia Graham, Athena T. Jolly, Ralph J. Parod, Alan Poole, Thomas Schupp, Ronald N. Shiotsuka, Michael R. Woolhiser, "Risk Assessment for Consumer Exposure to Toluene Diisocyanate (TDI) derived from polyurethane flexible foam," Regulatory Toxicology and Pharmacology, 64 (2012) 504-515.

[2] Erik Vangronsveld, S. Berkmans, M. Spence,"Toluene Diisocyanate Emission to Air and Migration to a Surface from a Flexible Polyurethane Foam," Annals of Occupational Hygiene 57:5 (2013) 650-651.

[3] Rocco P. Triolo, Ph.D., "Analysis for Free TDI in Flexible Polyurethane Foams," presentation at Polyurethane Foam Association Technical Conference, Point Clear, Alabama October 1992.

[4] "Assessment of Potential Health Risks Resulting from Chemical Emissions from New Bedding Sets," Research Triangle Institute, December 1995.

[5] Thomas J. Kelly, "Determination of Formaldehyde and Toluene Diisocyanate Emissions from Indoor Residential Sources,"report for Air Resources Board Research Division, California Environmental Protection Agency, Contract No. 93-315, November 1996.

[6] J. M. Hugo, M. W. Spence, and T. D. Lickly, "The Determination of the Ability of Polyurethane Foam to Release Toluene Diisocyanate into Air," Applied Occupational and Environmental Hygiene, June 2000, 15:6, 512-519.

Government studies have found no health concerns to communities from TDI emissions from slabstock foam manufacturing facilities.

Government and regulatory agencies have studied potential release of TDI from flexible polyurethane foam manufacturing plants extensively and over long periods of time.

For seven years, the state of North Carolina, in cooperation with the U.S. Centers for Disease Control and Prevention, studied air quality and collected biological samples from local residents in communities where there are flexible polyurethane foam manufacturing plants. This study confirmed that there was no evidence of adverse health effects associated with potential exposure from TDI emissions at flexible polyurethane foam manufacturing plants. In fact, with respect to air quality, out of hundreds of air measurements, only one possible detection of TDI was recorded, at one trillionth of a part in the air, and this reading was so low, researchers surmised it may have been due to instrument error. [7]

A similar air monitoring study conducted by the U.S. Environmental Protection Agency to measure TDI emissions at sites near schools in several states, also reported no detectable results. [8]

Conclusion

Polyurethanes and polyurethane foam products are numerous and the broad category contains many types of products with differing applications and characteristics. In the case of cured flexible polyurethane foam products, there is no opportunity for individuals to be exposed to TDI when the products are used as intended by the manufacturer.

[7] Lynn C. Wilder, Ricky L. Langley, Dan C. Middleton, Kathleen Ernst, Zana L. Lummus, Robert P. Streicher, Douglas S. Campbell, Wendy A. Wattigney, Jonathan A. Bernstein, David I. Bernstein, Steve M. Dearwent, "Communities Near Toluene Diisocyanate Sources: An Investigation of Exposure and Health," Journal of Exposure Science & Environmental Epidemiology, November/December 2011, 21(6):587-94.

[8] "Assessing Outdoor Air Near Schools," U.S. Environmental Protection Agency, 2009 (Reports listed by school).

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