Environmental Health Technical Brief

Spray Polyurethane Foam Insulation

Environmental & Occupational Health Assessment Program Issue #4 December 2010




Background

People are increasingly interested in installing insulation in their homes as a means towards saving energy. Sprayed polyurethane foam (SPF) insulation is one of a number of insulation products on the market. It is made by combining liquid chemicals that react quickly, expanding to form a foam material. SPF is a good insulator. It can be used as a continuous barrier to seal the building envelope to prevent air, moisture, and gas infiltration and exfiltration. Homeowners may purchase this expandable foam in 12 to 24 oz. spray cans to fill small openings like holes and around windows. For larger jobs like wall and ceiling cavities, a professional contractor will use a two-part product that is mixed onsite and applied with a commercial spray gun.

Recent health complaints made by workers applying the foam, and by residents in homes where the foam has been applied are causing health officials to take a closer look at these products. This technical brief will discuss the chemical composition, health concerns, marketing claims and recommendations for installation.



How Spray Polyurethane Foam Is Made

Polyurethane foam is formed during a polymerization reaction of a monomer containing at least two isocyanate functional groups (usually a diisocyanate like MDI or TDI, or a polymeric isocyanate) with another monomer containing at least two hydroxyl [alcohol] groups (called polyol) in the presence of suitable catalysts and a blowing agent. In common industry language, polyurethane foam is formed by reacting the A-side (isocyanates) with the B-side (polyol plus the other additives).

A-Side	+	B-Side	→	Spray Polyurethane Foam
(Isocyanates)		(Polyol, blowing agent, catalyst, additives)		

In addition to the isocyanates and polyol, the blowing agent plays a large part in the performance characteristics of the end product, such as whether the foam will be open cell (and softer) or closed cell (more rigid) foam. This has a direct affect on insulating ability (or R-value), sound dampening properties, and other characteristics. Chlorinated volatiles like trichlorofluoromethane (CFC-11) and other CFCs (chlorinated fluorocarbons) were commonly used as blowing agents before their phase-out in North America and the European Union in the mid to late 1990s due to concerns about greenhouse gases. While it is still possible to find these blowing agents used in developing

countries today, they have largely been replaced by carbon dioxide, pentane, 1,1,1,2-tetrafluoroethane (HFC-134a) and 1,1,1,3,3-pentafluoropropane (HFC-245fa).

The B-side also contains a catalyst, which mediates the rate of the chemical reaction. Many of the catalysts contain amines. Additional additives on the B- side may include pigments, flame retardants, fillers, and surfactants.

Health Concerns

Who Is At Risk?

Anyone exposed to vapors, aerosols and dust generated during SPF installation is at risk. High exposures may result in asthma, lung damage, chest tightness, other respiratory problems, eye and skin irritation, and other potential health effects. Both respiratory and dermal exposure to isocyanates in SPF can cause sensitization. Installation workers are typically exposed to the highest concentrations of chemicals in SPF over a short period of time. Their exposures may come from handling the chemical components, spraying, cleaning, cutting, and sweeping up dried or semi-dry foam overspray. All of these job tasks require wearing personal protective equipment (PPE) to prevent inhalation and dermal exposure. This includes respirators, eye protection, chemically impervious suits, gloves and shoe covers. Specific details can be found in the Installation and Worker Resources section at the end of this document.

Those occupying a home where SPF has been installed may be exposed to low levels of chemicals in SPF over a longer period of time. We think that in some cases, it is possible that the volatile components in the polyurethane foam may continue to off-gas after installation. Some building occupants have reported symptoms such as headache, eye, nose, throat, and upper airway irritation after re-occupying a home insulated with SPF. Further research is needed to understand more about these low level, chronic exposures.

Exposure to Isocyanates

We think that isocyanate exposure to household occupants is probably negligible. This is because once the foam is fully cured, isocyanates are not very volatile and do not linger in the air.

On the other hand, there is great concern about workers who are exposed to isocyanates, because these chemicals can cause asthma in workers who have never had asthma before. The asthma can persist even after removal from exposure. Isocyanate-induced asthma can develop from skin contact as well as inhalation. Other lung disorders like reactive airways dysfunction syndrome (RADS) and hypersensitivity pneumonitis have been reported in workers exposed to high levels of isocyanates over a short period of time.

Note: The ability to smell isocyanates does not offer good warning properties for exposure because the odor threshold is very high. This means workers could be in danger long before being able to smell isocyanates.

"Green" Marketing Claims

Some manufacturers and installers state that their brand of SPF is a "green product". While use of the product can help reduce energy consumption via its thermal insulation properties, the chemical composition cannot be considered "green" since isocyanates are a major component.

Around 2004, manufacturers began replacing petroleum-based polyols with polyols derived from vegetable oil. Soybean oil is one of the more popular oils used. When the advertisers say that SPF is made from soy beans, that is partially true. The polyols are on the B-side. However, the A-side contains isocyanates. These chemicals give health scientists great concerns because of their toxicity. Some of the other additives on the B-side may also lead to health and environmental concerns.

Exposure to Polyols, Catalysts, and Other B-Side Additives

Current thinking is that some of the chemical additives on the B-side may elicit health concerns in certain individuals who occupy homes insulated with SPF. Further research is needed to evaluate degradation and secondary byproducts formed during the reaction and curing phases of the foam. One class of degradation products formed may be aldehydes, which are known to cause mucous membrane irritation and airway constriction, even at low levels of exposure.

Many of the catalysts contain secondary and tertiary amines. Some homeowners have reported a fishy or decaying-like odor, which is one of the hallmark properties of tertiary amines. Low dose exposures to amines may be mildly irritating to some individuals. Workers exposed to high levels of amines have reported visual disturbances, such as blurriness, cloudy vision, halo vision, blue-grey vision, and decreased visual acuity. These conditions usually resolve after a day away from exposure.

Lastly, some of the additives may contain solvents, which can irritate mucous membranes and cause headache, loss of coordination, slurred speech, dizziness, nausea, impaired vision and cognition. These effects are dose-dependent.

Recommendations for Installing SPF

It is critical to avoid inhalation, skin, and eye contact with SPF chemicals. It is important to follow the manufacturer's instructions regarding how to mix and install the product, the use of personal protective equipment, and adequate ventilation.

SPF insulation should not be installed while residents or pets are present.

- Ventilation During The Job

  Professional installers doing interior applications should build a containment and run negative air machines during the application. Supply and return diffusers inside containment should be covered to prevent vapors from entering the mechanical air distribution system. The containment seams should be tested with smoke tubes to ensure that there will be no leakage of vapors into surrounding interior spaces. A manometer should be used to ensure that the pressure differential is being maintained by the negative air machine. Exhaust air should be filtered at the collection point within the containment before it enters the exhaust system. Care should be taken with location of exhaust hoses, keeping them away from building fresh air intakes, doors, windows, and locations where those passing by could be exposed.

- Ventilation After the Job Is Completed

  After the application is completed, fully cured, and all over-sprayed foam and particulates have removed, the house should be well ventilated before reoccupancy is permitted. Note that cutting or trimming the foam before it is fully cured may result in exposure to SPF chemicals and additional off-gassing. Use of fans in windows blowing outdoors can help to remove odors.

- Wait Time for Reoccupancy After The Job Is Completed

  There are a number of variables that can affect the waiting time before reoccupancy. They include the product's chemical components, type of foam, thickness of the finished product, applicator's technique, humidity level, and ambient temperature. Because of these variables, advice regarding waiting time may be based upon professional judgment. Check the manufacturer's directions regarding the length of time before re-occupying the house as a guide. Generally, manufacturers recommend waiting 24-72 hours after installing a 2-part, high pressure, "professionally applied" foam product, and 6-12 hours after using a 1-part product (12-24 oz. spray can) for small jobs like around windows or filling cracks.

After Installation Concerns

If there is a residual odor that is not remediated with ventilation after several days, homeowners should contact the contractor to ensure proper procedures were followed according to the manufacturer's instructions, and that a thorough clean-up of debris and dust from the foam installation was performed. If problems persist, homeowners should:

- File a complaint about the contractor with the Connecticut Department of Consumer Protection:
  Tel: 1 - 800 – 842-2649; Email: Trade.practices@ct.gov
  Complaint Form: http://www.ct.gov/dcp/lib/dcp/pdf/forms/occpro_complaint_form_1206.pdf
- File an online Consumer Product Incident Report with the U.S. Consumer Product Safety Commission. https://www.cpsc.gov/cgibin/incident.aspx
- Seek medical attention if occupants develop symptoms associated with SPF insulation. Residents with a known isocyanate sensitization to may choose to install a different type of insulation in their homes.

Resources and References

General Information

- Spray Polyurethane Foam. US EPA Design for the Environment: http://www.epa.gov/dfe/pubs/projects/spf/spray_polyurethane_foam.html
- NIOSH- Isocyanates: http://www.cdc.gov/niosh/topics/isocyanates
- Methylene Diphenyl Diisocyanate (monomeric MDI) and polymeric MDI (PMDI). US EPA Integrated Risk Information System: http://www.epa.gov/iris/subst/0529.htm

Installation and Worker Resources

- American Chemical Council. 2010. Health and Safety Product Stewardship Workbook for High-Pressure Application of Spray Polyurethane Foam (SPF). http://www.spraypolyurethane.org/Workbook
- NIOSH Publication No. 2008-109: Got Everything Covered? A checklist poster for workers: http://www.cdc.gov/niosh/docs/2008-109/pdfs/2008-109.pdf
- NIOSH ALERT: 2006. Preventing Asthma and Death from MDI* Exposure During Spray-on Truck Bed Liner and Related Applications. DHHS (NIOSH) Publication No. 2006–149: http://www.cdc.gov/niosh/docs/2006-149/default.html
- NIOSH ALERT: 2006. Preventing Asthma and Death from Diisocyanate Exposure. DHHS (NIOSH) Publication No. 96-111: http://www.cdc.gov/niosh/docs/96-111/

Glove & Clothing Selection Guide: (Note- Appropriate glove material differs for MDI vs.TDI)

- Permeation/Degradation Resistance Guide for Ansell Chemical Resistant Gloves, 7th ed. http://www.ansellpro.com/download/Ansell_7thEditionChemicalResistanceGuide.pdf
- ShowaBest Glove Chemrest Chemical Guide: http://www.showabestglove.com/site/chemrest/
- PMDI User Guidelines for Protective Clothing Selection. Alliance For The Polyurethanes Industry. January 2002, Technical Bulletin AX 178: http://www.polyurethane.org/s_api/bin.asp?CID=885&DID=3853&DOC=FILE.PDF

Technical Papers and Reports

- Albrecht WN, Stephenson RL. Health hazards of tertiary amine catalysts. Scand J Work Environ Health. 1988 Aug;14(4):209-19.
- Page EH, Cook CK, Hater MA, Mueller CA, Grote AA, Mortimer VD. Visual and ocular changes associated with exposure to two tertiary amines. Occup Environ Med. 2003 Jan;60(1):69-75.
- Report on the Health Effects of Aldehydes in Ambient Air. Department of Health Committee on the Medical Effects of Air Pollutants, UK: http://www.advisorybodies.doh.gov.uk/comeap/statementsreports/aldehydes-imperialcollreview.pdf