SPRAY ADHESIVE SOLVENT UPDATE

A summary of the regulatory and health issues surrounding the use of n-propyl bromide in foam-fabricating adhesives

By Steven E. Adams, Worthen Industries, Upaco Adhesives Division, Richmond, VA

Adhesive solvents solvate and act as a carrier for adhesive resins (solids), carrying them to the materials to be bonded. Once the adhesive is applied, the solvent evaporates, leaving only the solids behind to produce a lasting bond. Solvents are also instrumental in providing adhesion to materials. This is achieved by lowering the adhesive's surface tension or by solvating any contaminants that are on the surface of the substrate, such as oils or mold-release compounds. This action allows the adhesive to wet into the surface of the material to be bonded, an action fundamental in creating the bond.

Solvents also influence adhesives' wet tack and open time. It is important that a solvent evaporate quickly, so as to provide the quick strength (wet tack) that is needed for the fast handling of bonded-foam parts. However, if the solvent evaporates too quickly, the adhesive will dry and be tack free before a larger part can be assembled. It is critical that the adhesive have a long working time in order for the spray operator to assemble a variety of parts. An adhesive with the proper working window allows a sprayer to fabricate large and small parts, as well as high-tension parts or simple parts that have little "spring open" force.

REGULATORY STATUS OF NPB

The 1990 Montreal Protocol of Substances that Deplete the Ozone Layer banned the production of methyl chloroform (also known as 1,1,1 trichloroethane) by January 1, 1996.[1] Methyl chloroform was a non-flammable and non-toxic solvent for use in foam-fabricating spray adhesives. Eliminating methyl chloroform created an immediate need for alternatives. One solution was methylene chloride, or dichloromethane. This solvent was also non-flammable, but was considered to be a suspected carcinogen. As such, the Occupational Safety and Health Administration (OSHA) set a time-weighted average (TWA) exposure limit of 25 parts per million (ppm). Installing air-handling equipment capable of maintaining an airborne TWA concentration of 25 ppm or below was very difficult and became impractical. Water-based and hot-melt adhesives were used in many spray applications, but many foam fabricators were not satisfied with their performance. A non-flammable, non-toxic, fast-drying and inexpensive solvent was needed, as well as a good solvent for the adhesive resins used to formulate spray adhesives.

In the late 1990s, n-propyl bromide was introduced in adhesive formulations as such a material. N-propyl bromide (also known as normal propyl bromide, NPB, 1-bromopropane and 1-BP) was non-flammable and fast-drying, and worked well in foam-fabricating formulations. These adhesives quickly gained popularity and were successful in replacing methylene chloride, as well as water-based and hot-melt formulations. NPB is not considered a hazardous air pollutant (HAP) by the EPA, nor is it a hazardous waste under the Resource Conservation and Recovery Act (RCRA).[2] NPB is a volatile organic compound (VOC), therefore its use is controlled

under state and local regulations implementing federal clean-air requirements at 40 CFR Part 51.[2] NPB was submitted to the EPA's Significant New Alternatives Policy Program (SNAP) in hopes that it would be approved for use as a replacement for ozone-depleting methyl chloroform. (The SNAP program was developed by the EPA after it was given the authority by the Clean Air Act in Section 612 to develop a program for evaluating alternatives to ozone-depleting substances. Under this program, any materials to be used as replacements for known ozone depletors are either accepted or are deemed unacceptable. It is unlawful to use a material in place of an ozone depletor if it is deemed unacceptable by the SNAP program.[2])

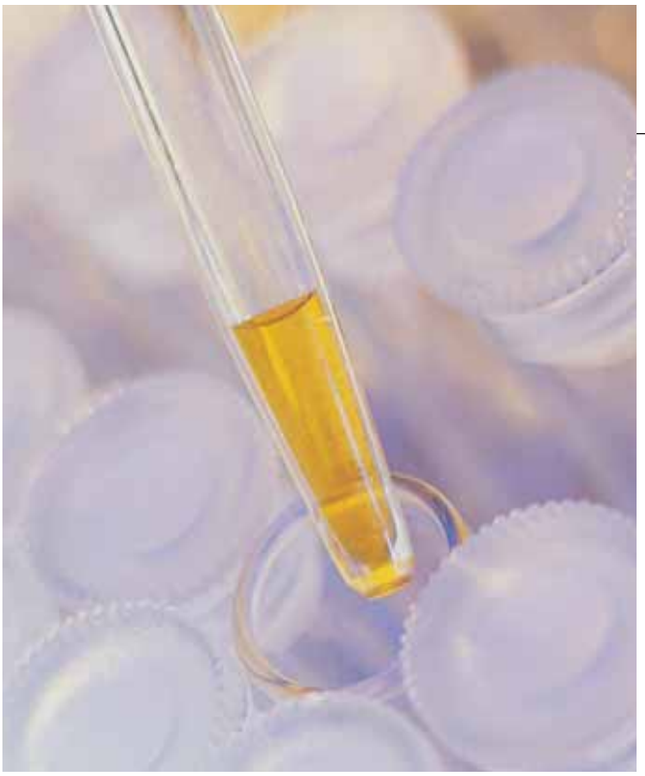
Foam fabricators were allowed to use NPB-based adhesives while waiting for approval under the SNAP program. As of the June 3, 2003, proposed rule, the only use condition that the EPA proposed for use in adhesives was that the NPB does not contain any more than 0.05% isopropyl bromide (2-bromopropane) by weight before adding stabilizers or other chemicals.[2] In addition, the EPA proposed that the TWA exposure level be kept below 25 ppm; however, the EPA expected users to defer to any permissible exposure limits ultimately established by OSHA. OSHA is studying the issue and has yet to outline a TWA exposure limit for NPB.

NPB HEALTH CONCERNS

As foam fabricators began using NPB-based adhesives, health issues began to arise, particularly in the area of neurotoxicity (causing damage to nerves). A request was made on March 17, 1998, by the North Carolina Department of Labor (NCDOL) for the National Institute for Occupational Safety and Health (NIOSH) to perform a health-hazard evaluation (HHE) at a North Carolina foam seat cushion company. Adhesive spray operators at this factory reported in medical surveys that they had a headache at least once per week, painful tingling in hands or feet, a tremor, and the sensation of being drunk when not drinking.[3] The initial TWA exposures to NPB were measured to be 60.0-381.2 ppm.[3] After installation of new spray booths, TWA exposures were 1.2-58.0 ppm.[3]

In April 1999, the NCDOL responded to reports that four employees of a North Carolina foam-fabricating company had been treated at a local hospital for neurological symptoms of an unclear cause.[4] The four had previously been hospitalized in March 1999 for complaints of lightheadedness and/or dizziness, lower extremity weakness, varying degrees of difficulty standing or walking, and varying degrees of bilateral lower extremity numbness, as well as abnormal sensations such as burning, prickling, or tingling in the lower extremities.[4] NCDOL issued a request for a health-hazard evaluation to NIOSH, which found the initial NPB TWA exposures of 18.1-253.9 ppm.[4]

On August 28, 2000, employees of another North Carolina foam-fabricating company made a confidential request to NIOSH for an HHE.[5] Two sprayers had been admitted to the emergency room of a local hospital in June 2000. One of the sprayers had been using NPB adhesive for about one year; the other had been using it for about six months.[6] The first sprayer developed a sore throat, difficulty swallowing, stumbling, incontinence of urination, numbness in the perineum, and numbness with a burning sensation in the legs, thighs, hips, and lower back, and ultimately became unable to stand up by herself.[6] The second sprayer developed a staggering gait, urinary incontinence, slurred speech, difficulty swallowing, and tingling, burn-



ing or numbness in the hands, legs, lower back, hips, and perineum.[6] Air sampling was performed by an independent party before the initial NIOSH visit. At the end of October 2000, this party determined the TWA exposure to NPB to be in the range of 60-261 ppm, after the ventilation had already been improved.[6] During the initial NIOSH visit in mid-November 2000, the TWA exposure to NPB was found to be in the range of 41.3-143 ppm.[5]

In February 2003, The Occupational Safety and Health Division of The Utah Labor Commission performed a site visit at a foam-cushion fabricator in Utah.[7] Several sprayers had been admitted to the emergency room with many of the symptoms listed in the above cases. This case, however, provided some interesting follow-up information. Three of the most severely affected sprayers were followed up as outpatients for two years. The most affected sprayer was a 29-year-old female whose ability to walk was so impaired that she needed a cane even two years after her initial examination in the emergency room.[8] This sprayer and another female, age 43, were still not able to work two years after their initial visits to the ER.[8] A male sprayer, 46, had originally visited the ER with mild-to-moderate lower extremity weakness, difficulty walking and tingling, burning or numbness in the lower extremities. At his two-year follow-up evaluation, he reported experiencing headaches and mild weakness in his lower extremities with debilitating pain.[8] The TWA exposure to NPB during the Utah OSHD inspection was found to be in the range of 91.8-126.7 ppm.[7]

Neurotoxicity is not the only health concern regarding NPB. The Center for the Evaluation of Risks to Human Reproduction (CERHR) issued a report in October 2003 that stated, "There is sufficient evidence to conclude that inhaled 1-BP causes reproductive toxicity in male and female rats...These results are assumed relevant for human hazard assessment. The human data on potential effects of 1-BP are too limited in content to conclude that 1-BP is a human reproductive or developmental toxicant."[9] Based on this conclusion, the Office of Environmental Health Hazard Assessment (OEHHA) listed NPB on Proposition 65 effective December 7, 2004.[10] Therefore, NPB is listed as a chemical known by the State of California to cause reproductive toxicity.

CONCLUSION

The EPA has issued a new proposed rule under the SNAP program. This notice, in the *Federal Register,* "proposes to list NPB as an unacceptable substitute for methyl chloroform, chlorofluo-

rocarbon (CFC)-113, and hydrochlorofluorocarbon (HCFC)-141b when used in adhesives or in aerosol solvents because NPB in these end uses poses unacceptable risks to human health when compared with other substitutes that are available."[11] As stated in the new proposed rule, this action to eliminate NPB in adhesives has been taken because of the rising health issues that occur with the elevated exposure levels that are typically seen in adhesive spraying operations.

As previously mentioned, OSHA has yet to issue an exposure limit for NPB in the workplace. The American Conference of Governmental Industrial Hygienists (ACGIH) set a threshold limit value (TLV) of 10 ppm for NPB; the EPA had proposed an exposure level of 25 ppm. Although the EPA and ACGIH exposure values are highly respected values that employers can target for protecting their employees' health and safety, the ultimate authority of enforcement is with OSHA.

So where does this leave suppliers and manufacturers in the foam-fabricating industry who must answer to employees, the government, and the bottom line? Consider this thought from the Occupational Safety and Health Act of 1970, Public Law 91-596, sec. 5(a)(1): "OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm." Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits. An employer is still required by OSHA to protect their employees from hazards, even in the absence of an OSHA exposure limit.[5] So, with the increasing threat of employee lawsuits and the pending rejection by the EPA, it would behoove any user of NPB-based adhesive to switch to an alternate as soon as possible.

For more information, contact Steven E. Adams, Worthen Industries, Upaco Adhesives Division, 4105 Castlewood Road, Richmond, VA 23234; phone (804) 275-9231, ext 113; or e-mail sadams@upaco-richmond.com.

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