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HAZARDS OF POLYVINYL CHLORIDE (PVC) CHILDREN'S PRODUCTS

Toxic Additives in PVC Children's Products

Polyvinyl chloride (PVC) requires the addition of chemical softeners (plasticizers such as phthalates) and stabilizers (for example, heavy metals such as lead and cadmium) among numerous other necessary additives. These additives are generally not chemically bound to the polymer, meaning they have the ability to leach out during normal use. In some products, plasticizers alone these additives can account for half the weight of the product. Evidence for the health impacts for some of these chemicals have been known for many years while it is increasing for some others.

Lead poisoning is a serious concern – very small quantities of lead can cause permanent damage to children's developing brains. Knowledge of this heavy metal's impact on the brain and nervous system has led to bans in various products. Yet, some PVC products contain lead, and their use can expose children to this toxic chemical.

The most commonly used plasticizers in PVC come from the chemical family called phthalates and can make up to 60% by weight of a product[1]. One widely used phthalate in PVC, DEHP, is listed by the California EPA as a known reproductive toxin. The evidence of human health effects of phthalates comes from studies on neonates exposed to DEHP through medical devices linking this exposure to lung and liver damage.[2, 3] Evidence of other effects such as early puberty, sperm damage, and asthma and allergic reactions are increasing. Other phthalates have not been as closely studied as DEHP, however, their effects are generally considered to be qualitatively the same. Phthalates are found in a large number products leading to aggregate exposure causing significant levels of these chemicals in our bodies. In the second CDC exposure testing, phthalates levels in urine were found to be highest in children (6 to 11 years of age) and in non-caucasian populations[4]. These higher levels may be due to differences in exposure and/or metabolism. The FDA expressed concerns that patient exposure to DEHP in medical devices may be putting them at risk as human exposure levels, especially those of children, approach those found to be toxic in rats.[5]

Other toxic chemicals can be present in PVC products including other heavy metals such as antimony, barium, cadmium, organotins, and zinc. Cadmium is a carcinogen and causes kidney damage[6]. Most common use of organotins until recently was as pesticides for use on boat hulls – concern over their reproductive and immune system effects has led to bans. Formaldehyde was detected by independent lab test in a Greenpeace investigation of Disney children wear bearing PVC prints. Organochlorines and other halogenated flame retardants are also added to PVC for some uses.

Aside from the potential toxic effects of PVC additives, PVC production and disposal also present significant problems and potential for exposure to other toxic chemicals such as dioxins and hydrogen chloride gas. Also, because of these various additives and the presence of the chlorine molecule itself, PVC is difficult to recycle and has been reported as the least recycled of all plastics. PVC-free plastics are affordable and widely available.

Lack of US Regulations and Absence of Enforcement

Combined and Cumulative Impacts

Children can come into contact with the toxic additives in PVC products through chewing or sucking, normal hand-to-mouth behavior, and through their release in air and dust as the products age. Most if not all risk assessments of PVC children's products consider one chemical at a time and have not evaluated the risks of exposure to the mixtures of chemicals typically found in PVC. They also do not consider exposure to those same chemicals from other sources (for examples, phthalates are found in PVC products other than toys as well as in cosmetics, pesticides, etc.). The phthalates risk assessments have focused on ingestion through sucking and chewing and most do not include inhalation nor ingestion through normal hand-to-mouth behavior common in kids. Recent testing of PVC flooring found significant levels of volatilization of these compounds[7] and they have been detected in air and dust in all houses tested[8]. A large degree of uncertainty remains in the characterization and quantification of children's exposures to environmental contaminants that has not been adequately addressed.[9]

Lead and Cadmium

"*Federal law allows limited use of lead in children's toys, so long as the toxin is safely sealed and inaccessible, said Ken Giles, spokesman for the U.S. Consumer Product Safety Commission, "There should be no accessible lead in any child's product. Period*," he said.[10]

In half the toys CPSC tested, detectable amounts of lead and cadmium were detected through wiping or extraction (meant to simulate mouthing). Despite their finding that lead did leach, CPSC concluded that this did not present a hazard.[11] When Greenpeace had the same toys tested at an independent lab, they found that after weathering, lead levels exceeded CPSC standards (between 177 to 28,600 ppm) and that cadmium levels were between 2 and 597 ppm (the international standard is 75 ppm).

The CPSC lead standards in toys (910 ppm per weight and 97.8 ppm by extraction) exceeds the international standard for allowable amount of releasable lead in children's toys (90 ppm) and are less stringent than CPSC's own limits on lead content in paint (600 ppm) and vinyl miniblinds (200 ppm). CPSC has not set a cadmium standard.

Phthalates

The US has no enforceable standard on phthalates in toys, while many countries have taken regulatory action (see below.). In 1986, the CPSC brokered a voluntary agreement with the toy industry to limit the phthalate known as DEHP. The industry quickly switched to DINP, another phthalate with toxic effects. In 1998, CPSC was petitioned by 12 consumer, public health, environmental and religious groups to ban PVC products intended for children under five years of age. Despite the fact that in a preliminary hazard assessment, the CPSC stated that DINP phthalate exposure was associated with "toxic effects in the liver, kidney, and other organs of mice and rats," CPSC eventually denied the petition in 2002. Instead, in December 1998, CPSC issued a "voluntary ban" on young children's teethers and rattles made of PVC plastic containing phthalates such as DINP. CPSC acknowledged that children are exposed to toxic chemicals from mouthing soft PVC toys and that DINP is more toxic than previously thought and somewhat arbitrarily lowered the maximum amount of DINP that could be consumed without potential health effects by 20%[12]. Voluntary agreements such as the ones on phthalates are not enforceable.

International Bans and Other Efforts

New European Union legislation will ban three phthalates (DEHP, DBP and BBP) classified as toxic to reproduction from all toys and child care articles. It also bans three other phthalates (DINP, DIDP, and DNOP) in toys for children under three years of age that could be placed in their mouths. It was introduced this fall and is expected to become law in the next few months. It has already received unanimous votes from both the Council of the European Union and the Competitiveness Council. This law will replace the emergency ban first implemented and continuously renewed since 1999.[13]

This latest development follows in the footsteps of a number of other countries' initiatives on phthalates in PVC Children's products including France, Germany, Japan, Mexico and Greece. See *AHT's Sample of International Actions on Polyvinyl Chloride (PVC) Children's Products* for further information.

Various limits also exist on other PVC additives in certain types of products or for chemical content of products including some components that can be used as additives in PVC, for example lead limits exist whether they are part of PVC or of other materials.

Products of Concern

- Children's toys: Teethers, bath and squeeze toys, balls, watchbands, etc.
- Childcare products: stroller covers, diaper covers, bibs, mattress covers, etc.
- Other consumer products: aprons, raincoats, hats, shoes and boots, bags, backpacks, luggage, "pleather" clothing, children's swimming pools, inflatable furniture, etc.
- Medical devices: colostomy bags, catheters, tubing, gloves, bed liners, mattress covers, etc.

Affordable and Available Alternatives to PVC

Research indicates that there are readily available, cost-competitive alternatives to PVC in toy production and some are already replacing PVC. Traditional materials such as wood, cloth and natural rubber are among the best alternatives. Hard PVC applications, such as block letters, can be directly and immediately substituted with numerous alternatives (e.g., polyethylene and polypropylene). PVC alternatives in "soft" toys, such as inflatable toys, teethers and squeeze toys, dolls, etc. also exist.The alternatives to PVC can be divided into thermoplastic and elastomeric alternatives. Many of the alternatives are co-polymers (two different polymers linked together) or alloys blends (polymer mixtures).

Thermoplastics

- Polyethylene: Polyethylene (PE) is the most widely used plastic in the world today. The polyethylenes are extremely versatile and can be made from hard to soft as soap by modifying hydrocarbon chain length or cross-linking. No additives are needed to soften polyethylene.
- Polypropylene: Polypropylene (PP) is easily processed by all methods and offers good material properties, such as low density, good mechanical, temperature, flexing/fatigue, and stress-crack resistance, and rigidity. As with polyethylene, polypropylene requires no plasticizers for flexibility.

Thermoplastic Elastomers (TME)

An elastomer is a material which exhibits rubber-like properties of high extensibility and flexibility, is available in a wide range of hardness, and has the ability to snap back quickly after being extended to at least twice its length. TMEs in general have very good flexibility, high tensile strength, are compatible with a wide range of colors, are relatively easy to process, and do not require plasticizers. Traditional thermoplastics can be added to elastomers to increase impact resistance or tear strength.

- Styrene-Ethylene-Butylene-Styrene (SEBS): SEBS can be used for possible injection and rotational molding of hollow bodies (e.g., dolls heads). Its advantages also include surface quality as desired; permanent colors after painting; durability; lack of breakage (crumbling). No plasticizers are needed.
- Ethylene Vinyl Acetate (EVA): EVA is a copolymer of polyethylene and vinyl acetate. It is flexible, resilient, resistant to cracking and contains no plasticizers or other additives.
- Polyethylene Ethyl Acrylate Copolymer (PEEA): PEEA is a copolymer of polyethylene and ethyl acrylate. PEEA is tough and rubbery and at room temperature has about the same flexibility as plasticized PVC and about four times the flexibility of low density polyethylene (LDPE). PEEA can be used as a PVC alternative in flexible and squeeze toys.
- Styrene-Butadience Block Copolymers (SBS). SBS were the first of the thermoplastic elastomers and have a wide range of hardness, good low-temperature performance, rubbery feel, resistance to cutting and cracking, and good abrasion and environmental resistance. These copolymers could be used as alternatives to PVC in flexible toys.

The majority of the alternatives mentioned above are of high strength and durability. As product safety is a critical concern for toy manufacturers, alternative materials must be thoroughly investigated in terms of cracking and breakage; toxicity and leachability of additives (if necessary for the material); and lifecycle hazards (production, use, and final disposal).

Children products manufacturers that have or are eliminating PVC: Brio, Chicco, Childlife, Evenflo, First Years, Gerber, International Playthings (Primetime & Early Start), Lamaze Infant Development, Lego, Little Tikes, Ravensburger, Sassy, Small World Toys, Tiny Love, Yomega.

Mattel Inc., the world's largest toy manufacturer is planning to replace all PVC in their products by plant-based plastics.

US retailers have withdrawn or are withdrawing PVC children products
In December 1997, Target agreed to remove two PVC products identified by Greenpeace as containing significant quantities of lead. Toys R Us, in November 1998, announced its 'immediate plans for the worldwide removal of all direct-to-mouth products for infant use containing phthalates, such as teethers, rattles and pacifiers.' K-Mart, Sears, Target and Walmart were listed on a CPSC's press release (December 2 1998) as retailers that had 'removed phthalate-containing teethers, rattles, pacifiers and bottle nipples from store shelves. Giant Eagle Inc. and Generations (MI) also no longer carry PVC children mouthing products.

These voluntary efforts while commendable leave children unprotected from the toxic additives in dozens of other everyday PVC products produced by other manufacturers and on the shelves of most retailers.

References

a. Greenpeace. What's Wrong with PVC Toys? http://archive.greenpeace.org/comms/97/pvctoys/whatswrong/f_pvc1.html
b. Consumer Product Safety Commission Allows Toxic Toy Production to Continue http://www.causesthatmatter.com/Environment/Environment.cfm?ID=452&c=16
c. Toxic Toys Petition http://environet.policy.net/health/products/toypetition.vtml
d. Greenpeace "Background on PVC toys" http://archive.greenpeace.org/comms/97/pvctoys/documents/background.html
e. Canadian Child Care Federation http://www.cfc-efc.ca/docs/cccf/rs047_en.htm
f. Oregon Toxics Alliance http://www.oregontoxics.org/toys.html
g. ATSDR Barium Toxicological Profile http://www.atsdr.cdc.gov/toxprofiles/tp24.html
h. ATSDR Zinc Toxicological Profile http://www.atsdr.cdc.gov/toxprofiles/tp60.html
i. International Programme on Chemical Safety, Tin and Organotin Compounds, preliminary review http://www.inchem.org/documents/ehc/ehc/ehc015.htm#SubSectionNumber:1.6.2
j. Toy Industry Association
k. http://www.toy-tia.org/Content/NavigationMenu/Library/Publications_Resources1/Vinyl_Toys_are_Safe/Vinyl_Toys_are_Safe__Find_Out_Why.htm
l. US CSPC report: The Risk of Chronic Toxicity Associated with Exposure to Diisononyl Phthalate (DINP) in Children's Products http://www.cpsc.gov/phth/dinp.html
m. Phthalate Panel Statement on Vinyl Toys http://www.phthalates.org/mediacenter/panelstatement.asp?ID=51
n. Greenpeace: Determination of the Composition and Quantity of Phthalate Ester Additives in PVC Children's Toys http://www.greenpeaceusa.org/index.fpl?article=534&object_id=8270
o. Greenpeace: 2003 Toy Report Card http://www.greenpeaceusa.org/index.fpl?article=287&object_id=7434

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[1] Danish Technical Institute (1995) *Environmental Aspects of PVC.*
[2] Agency for Toxic Substance and Disease Registry Toxicological Profiles http://www.atsdr.cdc.gov/toxpro2.html
[3] Health Care Without Harm http://www.noharm.org/pvcDehp/issue
[4] Center for Disease Control (CDC)(2003) *Second National Report on Human Exposure to Environmental Chemicals* http://www.cdc.gov/exposurereport/2nd/
[5] www.fda.gov/cdrh/ost/dehp-pvc.pdf
[6] US EPA (2003) *Cadmium compounds factsheet.* http://www.epa.gov/ttn/atw/hlthef/cadmium.html
[7] *Measuring Concentrations of Volatile Organic Compounds in Vinyl Flooring* http://www.awma.org/journal/ShowAbstract.asp?Year=&PaperID=551
[8] Rudel, R.A., D.E. Camann, J.D. Spengler, L.R. Korn, J.G. Brody. 2003. *Phthalates, alkylphenols, pesticides, polybrominated diphenyl ethers, and other endocrine-disrupting compounds in indoor air and dust.* Environmental Science & Technology, 37(20): 4543-4553. doi:10.1021/es0264596.
[9] http://www.net.org/proactive/newsroom/release.vtml?id=26575
[10] http://www.duluthsuperior.com/mld/duluthsuperior/news/7257224.htm
[11] CPSC Staff Report on Lead and Cadmium in Chidren's Polyvinyl Chloride (PVC) Products http://www.cpsc.gov/CPSCPUB/PUBS/lead/Pbcdtoys.pdf
[12] http://www.net.org/proactive/newsroom/release.vtml?id=26575
[13] European Commission (September 27, 2004) *press release* http://europa.eu.int/rapid/pressReleasesAction.do?reference=MEX/04/0927&format=HTML&aged=0&language=EN&guiLanguage=en