



Bisphenol A in Building Materials: High Performance Paint Coatings

It is impossible to turn one's attention to recent news on environmental health issues without reading about the health concerns associated with bisphenol A (BPA) in baby bottles and/or food can liners. Few, however, are as aware that BPA is a chemical component of epoxy resins used in a wide range of building materials, including high performance coatings (paints, floor sealers, and other protective coatings), adhesives and fillers (caulk, grout, mortar, and putty), fiberglass binders, and cement additives. Epoxy resins are also in some wind energy applications, generators and other electronic equipment, industrial tooling applications, and materials used in the art, aerospace and marine industries.

Policymakers, purchasers, and scientists are just beginning to get an understanding of the toxicity and exposure concerns associated with BPA in building materials made from epoxy resins and the alternatives that exist to replace BPA. This fact sheet provides information about the chemical components of epoxy resins, with a focus on high performance paint coatings. Based on studies looking at occupational exposure to BPA in epoxy paint, purchasers should look for alternatives that meet their performance needs that are BPA-free, as well as those that contain low VOCs and other toxicants.

Epoxy Resins

Epoxy resins are used in many high performance paint coatings (those that are durable, anticorrosive, and/or that can withstand chemical spills and repeated scrubbing).

A wide range of chemicals may be used to manufacture epoxy resin. Identifying all of the chemicals in an epoxy resin is a difficult and uncertain task.

Material Data Safety Sheets (MSDS) and Technical Data Sheets (TDS) are notoriously inconsistent in their level of detail and generally fail to reveal proprietary blends and processes.

Notwithstanding the failure of manufacturers to disclose the ingredients of the epoxy resins used in high performance paint coatings, research indicates that many epoxy-based high performance paint coatings are made from bisphenol A diglycidyl ether, otherwise known as BADGE. BADGE, in turn, is made from two primary chemicals: bisphenol A (BPA) and epichlorohydrin. Both of these chemicals pose significant occupational hazards. They are intermediary chemicals only—used in the manufacture of the resin but not intentionally included in the final product. This fact sheet only deals with health and exposure risks associated with BPA and not epichlorohydrin. (Detailed information about the health concerns associated with epichlorohydrin can be found at <http://www.healthybuilding.net/healthcare/Alter>

native%20Resin%20Binders.pdf.)

Bisphenol A

Bisphenol A (BPA) (CAS number 80-05-7). More than 6 billion pounds of BPA are produced globally annually.¹ It is a chemical compound much in the news recently. Scientists have generally studied and raised concerns about BPA found in food can liners made from epoxy resin and baby and water bottles made from polycarbonate plastic (bisphenol A is the primary compound of this plastic), because these applications are likely to be sources of BPA exposure in the general public. It is also a component of dental sealants, some medical and dental devices, and thermal paper receipts.

Recent biomonitoring studies have raised concerns about widespread human exposure to BPA—a National Health and Nutrition Examination Survey (NHANES) study found that more than 90% of people in a representative sample of the general population have BPA residues in their urine.² For vulnerable populations, the exposures raise greater concerns. Scientists looking at exposure to BPA in premature infants treated in the neonatal intensive care unit (NICU) found those patients undergoing intensive therapies to have urinary BPA concentrations one order of magnitude higher than the general population.³ Whether or not the levels of exposure are sufficient to raise health concerns is a matter of considerable debate.

The primary endpoints of concern for BPA in animal studies are reproductive (prostate cancer) and neurodevelopmental (alterations in behavior).⁴

In addition, in limited human studies, scientists have raised concerns about

miscarriages and other birth defects.⁵

Other effects that are emerging of concern are alterations in fat metabolism (an endocrine effect).

Health impacts

Cancer

Recent animal studies link early-life BPA exposure to increased risk of prostate⁶ and breast cancer.⁷

Studies have also found that BPA may interfere with chemotherapeutic treatment for both prostate and breast cancer.^{8 9} BPA has also been shown to cause normal but “at risk” breast tissue to express genes that are only found in highly aggressive and often fatal breast cancers.¹⁰ The levels of exposure in these studies are within the range of exposures that are already occurring in the general population.

Non-cancer

BPA is an endocrine disrupting chemical, which means it can interfere with hormone communication among cells controlling metabolism, development, growth, reproduction and behavior. BPA can alter the expression of multiple genes.¹¹ In animal studies, low levels of BPA exposure alter prostate gland and urinary tract development.¹² Animal studies also indicate that BPA interferes with brain development,¹³ and can affect fat metabolism, potentially increasing risk of diabetes and obesity.¹⁴

Additionally, in low dose animal studies, BPA accelerates the onset of puberty in female mice,¹⁵ decreases sperm quantity and/or quality, is linked to obesity,¹⁶ and may change reproductive hormone levels.¹⁷ Emerging science indicates that BPA exposure also may increase the risk of cardiovascular disease and diabetes in

humans.¹⁸

Based primarily on animal studies and the few limited studies conducted on humans, the National Toxicology Program's (NTP) Center for Environmental Risks to Human Reproduction (CERHR) concluded that there was sufficient evidence to raise concern about BPA's effects on the development of the brain, behavior and prostate gland in humans and the reproductive systems of human newborns and fetuses.¹⁹

Much of the current debate centers on the extent to which the results from numerous animal studies are relevant to humans, since BPA is generally believed to be rapidly metabolized and excreted after oral exposures. Moreover, some people have expressed concern that subcutaneous administration of BPA used in many animal studies might not be relevant to understanding the effect via oral exposure of humans. Follow up studies in neonatal mice, however, have shown that the route of exposure has no effect on blood BPA levels.²⁰ A recent study in humans also has challenged the assumption that BPA is rapidly metabolized.²¹ Further, the active, non-metabolized form (the most toxic form) of BPA has been identified in the blood of pregnant women²² and in amniotic fluid, indicating fetal exposures.²³

Occupational exposures

Little information is available on the level of direct exposure of workers to BPA in occupational settings, however two factors make this an issue of significant concern. One is that scientific work referred to above indicates that BPA may have harmful effects at levels of exposure that are already occurring in the general

population.

Furthermore studies of products made from BPA, including those used in epoxy resins, indicate that workers using those secondary products metabolize or breakdown the secondary products back into BPA (see BADGE section below). OSHA has not yet established regulatory levels for occupational exposure.²⁴

User exposures

Theoretically, BPA is consumed entirely in the production of epoxy resins and does not show up in the final product so should not be a user exposure problem. However, there is some indication that this is not the case, but rather some epoxy resin products produced from BPA can be metabolized back into BPA (see BADGE section below).

What do we know about BPA-based epoxy resins like BADGE?

Many high performance paint coatings use epoxy resins made from Bisphenol A diglycidyl ether or BADGE (CAS No. 1675-54-3), a resin manufactured by reacting BPA and epichlorohydrin.

Health impacts

Cancer

BADGE is not classifiable as a human carcinogen by the International Agency for Research on Cancer (IARC), which means IARC did not have enough data to make a determination about BADGE's carcinogenicity.²⁵

Non-cancer

In a DOW Chemical company's product safety sheet for BADGE, the overview states, "[b]roadly speaking, direct contact with these materials should be avoided.

Although BADGE is not acutely irritating to the skin, it is capable of causing skin sensitization in some individuals.²⁶ BADGE's most significant direct impacts may be on non-human environmental health. DOW chemical acknowledged that BADGE is moderately toxic to aquatic organisms and has a moderate bioconcentration potential. Additionally, DOW's product safety data sheet for BADGE states that "[i]f a BADGE-based material does reach soil and/or surface water, it can pose a flammability and health concern."²⁷

Conversion to BPA

The most significant concerns about BADGE may not be the direct health impacts of BADGE itself, but rather its metabolic breakdown products. A Japanese study of workers spraying BADGE in an epoxy resin factory at least three hours per day found that BADGE may break down to BPA in the human body and further that the bisphenol A may disrupt secretion of sex hormones in men and suggested that the "[c]linical significance of the endocrine disrupting effects of bisphenol A should be further investigated in male workers."²⁸ A subsequent study of workers applying paint consisting of 10-30% BADGE reported significantly higher urinary levels of total BPA and alterations in sex hormones in painters than nonpainter controls. Other confounding factors make it hard to determine the clinical significance of this study.²⁹

Occupational exposures

BADGE has a low vapor pressure,³⁰ so inhalation from vapors from standing liquid in occupational settings is not likely to be of concern. However, applicators

of epoxy coatings may be exposed by inhalation of aerosol mist as indicated in the previous study and should use appropriate respiratory protection. One National Institute for Occupation Safety and Health (NIOSH) investigation found BADGE could cause dermatitis after direct contact with 2-bisphenol-A type epoxy resins (including Cas. No. 25085-99-8).³¹ Another study showed that BADGE was absorbed through the skin and metabolized to BPA.³² These occupational studies raise concerns that could apply to workers undertaking field application of epoxy resins, as well as other building occupants.

User exposure

The low vapor pressure minimizes the likelihood of exposure for occupants of rooms with epoxy products to BADGE through vapor inhalation.

However, as with other semi-volatile compounds in building materials, such as phthalates, there is a potential for exposure to BADGE through migration of dust from products over time. Except for its use in dental sealants, we are not aware of any studies of potential exposure to BADGE or of contact dermatitis occurring in users of consumer products containing cured resin.

Conclusion

While the NTP raised only minimal concern for worker exposures and reproductive toxicity, early indications from the research are that workers spraying paints containing epoxy resins are exposed to bisphenol A with uncertain, but potentially significant effects on sex hormone levels and the reproductive system. Scientific research has only recently begun to address potential exposures to bisphenol A from building materials.

Regulatory bodies are only slowly and haltingly moving forward to investigate and act on toxicity concerns associated with epoxy resins and BPA.

However, with 90% of the population testing positive for BPA and a growing body of science raising increasing concern, responsible specifiers do not need to wait for regulatory action, but can take a precautionary approach to protect building occupants and manufacturing and installation workers. Low VOC products are available that can replace epoxy paints and other epoxy-based products and still meet the needs of health care.

In response to concerns about the potential health effects of bisphenol A in building materials—particularly in workers—specifiers and purchasers should seek safer alternatives.

ENDNOTES

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