

Perils of plastics: Risks to human health and the environment

March 19 2010, by Richard Harth

Plastics surround us. A vital manufacturing ingredient for nearly every existing industry, these materials appear in a high percentage of the products we use every day. Although modern life would be hard to imagine without this versatile chemistry, products composed of plastics also have a dark side, due in part to the very characteristics that make them so desirable -- their durability and longevity.

Now Rolf Halden, associate professor in the School of Sustainable Engineering at Arizona State University and assistant director of Environmental Biotechnology at the Biodesign Institute has undertaken a survey of existing scientific literature concerning the hazards of [plastics](#) to human health and to the [ecosystems](#) we depend on. His findings, which appear in the latest issue of the *Annual Review of Public Health*, are sobering.

Today, plastics accumulate in garbage dumps and landfills and are sullyng the world's oceans in ever-greater quantity. And plastics and their additives aren't just around us, they are inside virtually every one of us— present in our blood and urine in measureable amounts, ingested with the food we eat, the water we drink and from other sources.

Halden's study reiterates the fact that the effects to the environment from plastic waste are acute. Measurements from the most contaminated regions of the world's oceans show that the mass of plastics exceeds that of plankton sixfold. Patches of oceanic garbage—some as large as the state of Texas—hold a high volume of non-biodegradable plastics.

Aquatic birds and fish are increasingly victims because biodegradation processes are inadequate to eliminate this durable refuse.

The magnitude of society's burden of plastic waste is only beginning to be fully appreciated. In the U.S., the average person produces a half-pound of plastic waste every day. Around the world, some 300 million tons of the material are produced each year—a figure poised to expand, as new forms of plastics are devised to serve a voracious global appetite. As Halden points out, this annual production alone would fill a series of train cars encircling the globe. "We're doomed to live with yesterday's plastic pollution and we are exacerbating the situation with each day of unchanged behavior," he said.

Adverse effects to human health remain a topic of fierce controversy, though a growing consensus is emerging that plastics and their additives are not always the benign companions we once assumed them to be. Halden says he accepted the invitation to write about plastics and human health "because the topic showcases the bigger problem of how to create a sustainable future for modern civilization."

Two broad classes of plastic-related chemicals are of critical concern for human health—bisphenol-A or BPA, and additives used in the synthesis of plastics, which are known as phthalates. Halden explains that plastics are polymers—long chains of molecules usually made of carbon, hydrogen, oxygen and/or silicon, which are chemically linked together or polymerized. Different polymer chains can be used to create forms of plastics with unique and useful properties.

BPA is a basic building block of polycarbonate plastics, such as those used for bottled water, food packaging and other items. While it has been considered benign in the form of a heavily cross-linked polymer, its bonds can break down over time, when plastics are repeatedly washed, exposed to heat or other stresses, liberating the building blocks of the

chemical, which are toxic. BPA has been recognized since the 1940s as an endocrine disrupting chemical that interferes with normal hormonal function.

Adding to the health risks associated with BPA is the fact that other ingredients—such as plasticizers—are commonly added to plastics. Many of these potentially toxic components also can leach out over time. Among the most common is a chemical known as di-ethylhexyl phthalate or DEHP. In some products, notably medical devices including IV bags or tubing, additives like DEHP can make up 40 or 50 percent of the product. "If you're in a hospital, hooked up to an IV drip," Halden explains, "the chemical that oozes out goes directly into your bloodstream, with no opportunity for detoxification in the gut. This can lead to unhealthy exposure levels, particularly in susceptible populations such as newborns."

What are the overall effects of the plastics we unwittingly ingest? The literature Halden surveyed is ambiguous on this point, despite more than half a century of study. Part of the difficulty lies in the absence of good controls for studying health outcomes, as plastic exposure is a global phenomenon, and finding unexposed subjects for comparison is nearly impossible. It is known however that health effects vary depending on who is exposed—and when. Infants and pregnant or nursing mothers are at heightened risk for toxic exposure or passage of BPA and additives like DEHP.

This January, the FDA announced an important reversal of its 2008 claims regarding the safety of bisphenol-A, expressing new concern about "potential effects of BPA on the brain, behavior and prostate gland of fetuses, infants and children," and pledging to collaborate with other federal health agencies to reevaluate the chemical's safety.

Studying the effects of low-dose exposure is tricky, usually requiring a

very large number of study subjects. Instead, epidemiologists tracking the problem frequently base their conclusions on data gathered from individuals known to have unusually high levels of a chemical—often the result of high-level occupational exposure. Halden insists that further study on low-dose exposure is essential to settle the matter of health risks, noting some evidence in the literature suggests that high-dose studies may be inadequate to properly understand toxic effects from continuous low-level exposures.

Halden explains that while plastics have legitimate uses of benefit to society, their brazen misuse has led to a radically unsustainable condition. "Today, there's a complete mismatch between the useful lifespan of the products we consume and their persistence in the environment." Prominent examples of offending products are the ubiquitous throwaway water bottles, Teflon-coated dental floss and cotton swabs made with plastic PVC sticks. All are typically used for a matter of seconds or minutes, yet are essentially non-biodegradable and will persist in the environment, sometimes for millennia.

Despite the scourge of discarded plastics and the health risks these substances pose, Halden is optimistic that society can begin to make wiser choices and develop more sustainable products, formed from biodegradable, non-toxic chemical building blocks.

New forms of polymer, some made from renewable materials that are digestible by microorganisms, are being explored.

Ultimately, converting to petroleum-free construction materials for use in smart and sustainable plastics will become a necessity, driven not only by health and environmental concerns but by the world's steadily declining oil supply. As Halden emphasizes, the manufacture of plastics currently accounts for about 8 percent of the world's petroleum use, a sizeable chunk, which ultimately contributes to another global

concern—the accumulation of carbon dioxide in the atmosphere.

"We are at a critical juncture," Halden warns, "and cannot continue under the modus that has been established. If we're smart, we'll look for replacement materials, so that we don't have this mismatch—good for a minute and contaminating for 10,000 years."

Provided by Arizona State University

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