Perfluorinated Compounds (PFCs) and Human Health Concerns

Perfluorinated compounds (PFCs) are manmade compounds, based on the element fluorine, which are widely used to create water and soil repellency in fabrics such as Crypton® and Crypton Green®, Teflon®, Gore™, Stainmaster®, Scotchgard™, and in nanotech products such as Nano-Tex™ and GreenShield™. PFC finishes are popular for their performance in the high traffic environment associated with hospitals and medical facilities. They are also used in a variety of specialty applications like insecticides and fire fighting foams. Scientists have raised concerns about PFCs because they are persistent, bioaccumulative, and toxic.

Moreover, biomonitoring studies confirm widespread human exposure to this class of compounds. This fact sheet briefly summarizes hazard and exposure data for the two most widely used PFCs and concerns related to alternatives.

Widespread Human Exposure to PFCs

Most international research about the environmental and health impact of PFCs has focused on just two of the many perfluorinated compounds available on the market—perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). Other more volatile PFCs, including fluorinated alcohols, are beginning to come under greater scrutiny, with research indicating that some that were considered less harmful are breaking down in the environment into PFOA and other more harmful chemicals.

PFCs are extremely persistent and bioaccumulative chemicals. Studies of the persistence of PFOS, for example, show that under *no conditions* does the chemical show any evidence of breaking down in the environment.[1] Analysis by the Organization for Economic Co-operation and Development found that PFOS does not "hydrolyse, photolyse or biodegrade in any environmental condition tested."[2]

Human and wildlife exposure to PFCs is nearly ubiquitous. Studies by the U.S. Centers for Disease Control (CDC), and others, have detected PFCs in humans throughout the U.S. and the world.[3] PFCs are known to cross the placenta, directly exposing the developing fetus.[4] Scientific studies finding PFCs in humans are causing increased focus on reducing the sources and transmission of PFC chemicals.

Perfluorooctane Sulfonate (PFOS) Health Effects Include Cancer, Developmental and Reproductive Toxicity

Most of the research regarding health outcomes associated with PFCs has been done in animal studies. Human data are sparse. Species differences in metabolism and toxic profiles of PFCs create challenges in extrapolating data to humans.[5]

PFOS is the most intensively studied PFC. PFOS accumulates in the liver and blood, where it is primarily attached to proteins.[6]

In animal studies, PFOS is linked to bladder cancer,[7] liver cancer,[8] and developmental and reproductive toxicity (including neonatal mortality).[9]

In humans, researchers have found that PFOS is able to cross the placenta.[10] Another study looking at fetal exposure found that increased levels of PFOS are associated with lower growth measurements in newborns,[11] though this finding is not consistent.[12] Emerging science suggests that PFOS may be associated with infertility in women.[13]

PFOS is also known to be a breakdown chemical of other fluorinated compounds.[14]

Current Status of PFOS

In 2000, 3M voluntarily ceased production of PFOS, used to make its Scotchgard™ product, after researchers raised issues with the build-up of PFOS in wildlife[15] and evidence of reproductive damage in animal studies.[16] Public attention focused on 3M after it was discovered that 3M was aware of the toxic effects of PFOS long before ceasing production.[17] Recent research found extremely high levels of PFOS polluting waterways in Minnesota and other areas where 3M plants were located.[18]

Other companies followed 3M's lead, voluntarily ceasing production of PFOS. In 2005, Sweden proposed listing PFOS and 96 PFOS-related substances under the Stockholm Convention on Persistent Organic Pollutants (POPS).[19] A listing under the POPs treaty would require elimination or reduction in use of PFOS internationally. In December 2007, a risk evaluation of PFOS concluded that PFOS should be slated for elimination in most use categories (with some exceptions, including photo imaging and semi-conductors).[20] An official decision on whether or not to list PFOS is scheduled for May 2009. If listed, it will join a small group of chemicals that scientists have identified as some of the most hazardous chemicals ever produced.

PFOA: Similar Environmental and Health Damage as PFOS

Perfluorooctanoic acid (PFOA, also known as C8) is used to aid in the manufacture of other PFCs. PFOA is used as a surfactant, a substance that reduces the surface tension of a liquid in which it is dissolved.[21]

Like PFOS, PFOA is an extremely stable chemical compound, resisting degradation in the environment. PFOA also accumulates in the liver, blood and milk.[22] PFOA has been associated in animal studies with developmental toxicity,[23] cancer,[24] and impairment of thyroid, liver and immune system functions.[25] Scientists have discovered that PFOA "readily crosses the placenta and is secreted in milk"[26] in humans. Like PFOS, emerging science suggests that PFOA may be associated with infertility in women.[27]

There is evidence that PFOA, like PFOS, is also a breakdown product of other fluorinated compounds. PFOA is released into the environment during the breakdown or metabolism of polytetrafluorethylene (PTFE) a repellent or non-stick compound ("Teflon"). PTFE has been shown to break down at high heat levels, killing birds in confined spaces and resulting in flu-like symptoms in humans.[28] Fluorinated alcohols (FTOH), also used to make fluorinated polymers,

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Production funded by the Global Health and Safety Initiative with the support of Health Care Without Harm.

also breakdown to release PFOA.[29]

The U.S. EPA conducted a risk assessment of PFOA and found "suggestive evidence "that PFOA could cause cancer in humans.[30] The EPA's Science Advisory Board (SAB), in turn, recommended that the agency should classify PFOA as a "likely" carcinogen in humans.[31] While eight of the companies currently using PFOA have voluntarily agreed to reduce PFOA releases by 2010 and eliminate them by 2015,[32] indications that many of the PFCs they are using as replacements can breakdown into PFOA, means the potential for PFOA to remain in circulation in the environment remains high.

Alternatives to PFOS and PFOA

Some alternatives being proposed to replace PFOS and PFOA appear to be based on perfluorohexanoic acid (PFHxA also known as C6). These are also fluorinated compounds and may pose health and environmental problems of their own. Many of the new alternatives are virtually unstudied. Studies indicate that many of them can also breakdown to PFOS and PFOA, which would add to the reservoir of these persistent contaminants in the general environment.[33]

Meanwhile, companies such as DuPont are demanding confidentiality about their products and won't disclose the chemical make-up of the compounds that they are using to replace PFOS and PFOA. In June 2008, the Environmental Working Group (EWG) released a report on PFCs.[34] The reporting team acquired Toxic Substances Control Act (TSCA) documents addressing the potential toxicity of those chemicals being used to replace PFOS and PFOA.

Section 8(e) of TSCA requires chemical manufacturers and others to notify the EPA of any "new, unpublished information on their chemicals that may lead to a conclusion of substantial risk to human health or to the environment."[35] Through a review of redacted TSCA documents, EWG uncovered nineteen TSCA notices in an eighteen-month period (January 2007 through April 2008). While most of the notices concealed the official chemical name, and in many cases the name of the manufacturer, the publicly available data reported by the manufacturers under TSCA identified the following range of health effects of the alternatives under consideration to replace PFOS and PFOA, including:

> *irregular breathing, muscle incoordination, lowered fertility, birth defects, increased numbers of stillborn pups, absence of pupilary light reflex in the eye, lack of normal startle response, dermal sensitization, and changes in the weights and/or size of the heart, kidney, liver, spleen, thymus, prostate, ovaries, and/or adrenal glands.*[36]

EWG's report concludes that because the reporting mechanism requires reports within 30 days of the negative outcomes,

> *[w]hat this means is that these studies showing dramatic adverse health effects are probably PFCs designed to be replacements for PFOA, PFOS and/or their higher homologues. And there is a decent chance that they are C6 fluorinated chemicals since market trends and FDA records indicate that many fluorochemical producers and secondary business users are shifting to the C6 PFC chemistry (Asahi Glass Co 2007; Clariant 2008; DuPont 2008a; DuPont 2008b; FDA 2006; FDA 2008; Nanowerk 2008; Sanitized AG 2008). But we will likely never know. Because the identity of the compounds found toxic in*

these 8(e) TSCA studies are held secret, not only from the general public, but even from regulators in state agencies that may be making decisions about these same compounds.[37]

Conclusion

Perfluorinated chemicals are persistent, bioaccumulative toxicants (PBTs). Widespread human exposures, including in fetuses, is well documented. PFOS is considered unusually persistent, unable to breakdown under any known conditions, thus remaining in our environment forever, posing threats of ongoing exposure and toxicity to humans and wildlife.

The most scrutinized PFCs have toxic profiles in animal studies that include cancer and reproductive/developmental effects. Initial studies in humans show an inverse relationship between PFOS exposures and growth parameters in newborns, although the findings are inconsistent. More recently, scientists have identified a potential link between PFCs and infertility, although this requires further study.

While the federal government is slowly beginning to acknowledge the hazards associated with fluorinated chemicals, their response so far has been limited primarily to further study and voluntary agreements with manufacturers on only a few of the chemicals of concern. International bodies that are reviewing some of these same chemicals are poised to include only one of them, PFOS (and some of its precursors) as persistent organic pollutants, targeted them for elimination worldwide under the Stockholm Convention.

The failure to provide adequate safety testing and oversight is troubling, given the fact that studies of the persistence of PFOS, for example, show that under no conditions does the chemical show any evidence of breaking down in the environment. Any opportunities to reverse the negative health impacts associated with PFCs may be lost, if we wait for more science to scrutinize the links between this family of chemicals and negative human health outcomes.

While some companies are standing by, awaiting more science and regulation before they end their use of PTFE, PFOS, PFOA, and other members of the PFC family of compounds, other companies are taking a precautionary approach based on the weight of available evidence and reducing or removing PFCs from their products.38 The data are sufficient to identify this class of chemicals as problematic for the reasons stated.

Buyers and specifiers will need to continue to take responsibility and urge companies to eliminate the use of perfluorinated compounds that are extremely persistent, bioaccumulative, and linked to negative health outcomes and to avoid using fluorinated alternatives unless and until safety testing can demonstrate options that are harmless to humans and the environment.

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Production funded by the Global Health and Safety Initiative with the support of Health Care Without Harm.

ENDNOTES

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PFOA and other fluorinated compounds. In 2004, an out of court settlement was reached, where in addition to cash payments, an independent panel was established to undertake medical monitoring and to review the existence of a link between PFC exposure and damaging health effects and birth outcomes of the class. The court ordered report indicates that individuals participating in the project showed a median serum PFOA of 28.2, as compared to the median of 5.2 in the 2007 NHANES body burden study. As well, the report indicated a link between PFOA and several health outcomes in the affected population.)

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