

Potential explanation for fluorinated compounds' persistence

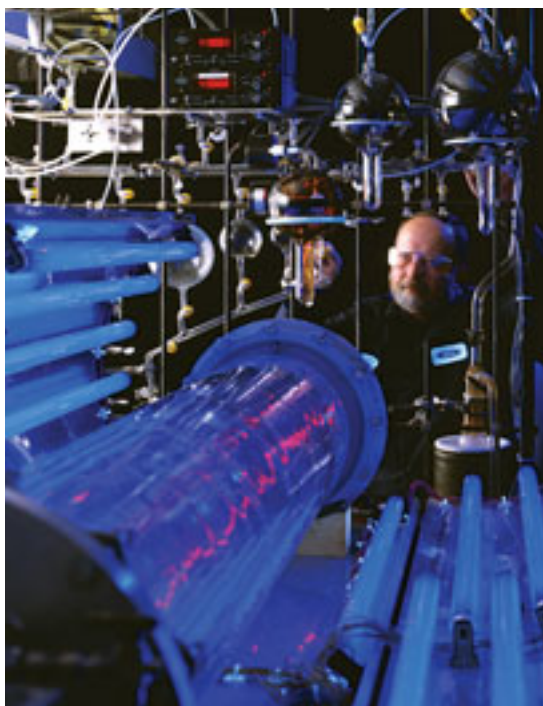
The first assessment of the atmospheric lifetime of an important class of fluorinated chemicals, fluorotelomer alcohols (FTOHs), indicates that they persist for 20 days before breaking down, according to scientists from the Ford Motor Co. and the University of Toronto.

In research in this issue of *ES&T* (p. 3816), the group concludes that FTOHs merit further study as a potential source of the persistent, bioaccumulative, and potentially toxic perfluorocarboxylic acids (PFCAs) that are being discovered worldwide.

PFCAs have been found in locations as remote as the Canadian north Arctic. Because the molecules are fairly large, with molecular weights between 350 and 550 atomic mass units, it is surprising that they persist for so long in the atmosphere, says Scott Mabury, chair of the University of Toronto's chemistry department and co-author of the paper. He points out, however, that FTOH lasts long enough in the atmosphere to be transported to remote locations. "By most international [regulatory] conventions, 20 days is a long time in the troposphere," Mabury says.

FTOHs are already under increasing scrutiny because of their suspected connection with one PFCA, perfluorooctanoic acid (PFOA), which is used to make Teflon and causes reproductive toxicity in rats. The U.S. EPA is pursuing enforceable consent agreements with telomer manufacturers through the Telomer Research Program, an industry group that represents the major FTOH pro-

ducers. EPA "has identified potential human health concerns from exposure to [PFOA] and its salts, although there remains considerable scientific uncertainty regarding potential risks," according to a *Federal Register* notice published on April 14, 2003.



Scientists at the Ford Motor Co.'s Scientific Research Laboratories use a smog chamber to measure the atmospheric lifetime of fluorotelomer alcohols.

The Telomer Research Program estimates that 5 million kilograms of FTOHs are used annually as intermediates in a wide variety of products, including paints, polymers, adhesives, waxes, polishes, metals, electronics, and caulks.

Scientists had previously estimated the lifetime of FTOHs on the basis of structure-activity relationships, but such estimates can be off by up to a factor of 5, says Tim Wallington, an atmospheric chemist at Ford Motor Co.'s Scientific

Research Laboratories and the *ES&T* paper's lead author.

Because of the chemical similarities, some activists have compared perfluorochemicals (PFCs) as a whole to polychlorinated biphenyls, dubbing them the "PCBs of the 21st

century". "We think that the whole family of perfluorinated compounds [is] highly toxic, and we think the science more than justifies phasing out the telomers," says Kris Thayer, senior scientist at the Environmental Working Group, an environmental nonprofit association.

"We don't know a lot about the environmental fate of larger fluorinated organic compounds," Mabury says. "They're relatively persistent because the carbon-fluorine bond is so stable. And when you polyfluorinate something, it tends to be far more volatile on a mass basis than a heavy molecule that doesn't have fluorine."

The experiments described in the *ES&T* paper looked at how three generic FTOH molecules behave in the gas phase in the presence of chlorine atoms and OH radicals.

The experiments showed that, as is the case with PFCAs, the "fluorinated tail" of the FTOH molecules makes them less susceptible than other compounds to attack by both OH radicals and chlorine atoms.

Wallington says that these results indicate that FTOHs can survive in the atmosphere long enough to reach the remote locations where PFCAs are being found. "There is some literature to suggest that FTOH will biologically oxidize to perfluorinated acids [like PFOA] in rats," Mabury

says. "It is clear that at least some FTOHs break down," Thayer adds, noting that DuPont has shown that telomer 82 degrades to PFOA.

"The vast majority [80%] of the FTOHs...are incorporated into polymeric materials, and we have no data on whether those polymeric materials break down, and if so, under what conditions or how fast," Mabury says. "We hypothesize that the polymers are degrading because people often have to reapply their coatings, on carpets, for example. That seems to suggest that they don't last forever," he continues, adding that he and his fellow researchers are

testing these hypotheses.

It's too early for companies like Ford to remove FTOHs from use in their products or supply chains, Wallington says. "Clearly, we need to understand the environmental impacts of our products and processes, and that's what we're trying our best to do," he adds. "If we have a complete understanding of what these compounds do in the atmosphere and why they do it, we can perhaps make suggestions as to how one might alter the structure of these compounds such that they would be more environmentally friendly. That's the goal." —KELLYN S. BETTS

Estrogen knocks out fish in whole-lake experiment

For the first time, scientists have demonstrated in a natural lake ecosystem that the synthetic estrogen found in birth control pills can cause the collapse of fathead minnow populations. The findings support lab studies, which over the past 10 years have linked natural and synthetic estrogen in wastewater to feminization of male fish but have been unable to show whether these changes would alter population dynamics of fish and their food webs.

From May to October over the past three years, 17-ethynylestradiol was added to Lake 260 in the Experimental Lakes Area of north-

western Ontario—a pristine wilderness of lakes and boreal forest on granite bedrock known as the Canadian Shield, says Karen Kidd, ecotoxicologist with the Canadian Department of Fisheries and Oceans (DFO) and coordinator of the study. Until now, Lake 260 has not been manipulated for any experiments. The average estrogen concentration, 5–6 nanograms per liter, in the lakes was similar to levels found downstream of wastewater treatment plants in North America, Kidd explained at a June 24 symposium of the American Chemistry Council, a manufacturers' association.

Dozens of researchers in academia and government in the United States and Canada tracked changes in the populations and physiology of fish, bacteria, phytoplankton, zooplankton, and insects in Lake 260 and several reference lakes both before and during estrogen additions, Kidd says. Although preliminary results do not yet point to dramatic changes in the lower levels of the food web, fish are clearly stressed.

Fathead minnows, which live just 2–3 years, once numbered



A researcher adds estrogen to Lake 260, a pristine lake in Canada.

JOHN SHEARER

News Briefs

Effectiveness of voluntary initiatives questioned

Governments are increasingly turning to voluntary approaches in environmental policy, but such initiatives seldom result in improvements beyond what would have occurred anyway under a business-as-usual scenario, finds a report by the Organisation for Economic Cooperation and Development (OECD). The report analyzes several voluntary initiatives being implemented across OECD member countries, focusing on the environmental and economic effectiveness of such approaches used in isolation or as part of policy mixes.

Voluntary Approaches for Environmental Policy: Effectiveness, Efficiency, and Usage in Policy Mixes can be purchased at www.oecd.org.

NGOs are a global force

Taken together, all the world's non-profits are worth more than \$1 trillion a year, according to SustainAbility, an international consultancy specializing in business strategy and sustainable development. As a result, environmental nongovernmental organizations (NGOs) can have a profound effect on business and markets, SustainAbility argues in its new report, *The 21st Century NGO in the Market for Change*.

"International NGOs powerfully shape and drive the corporate responsibility and sustainability agendas," according to the report. NGOs have been able to focus attention on the environment in Latin America and South Africa despite civil strife, and the growing ranks of environmental non-profits in China, Russia, and Central Asia are beginning to change those countries' policies. For more information, go to www.sustainability.com.

OECD