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The Truth About Toxic Cleaning Agents

Responses to Industry's Misinformation about Nonylphenol Ethoxylates

Nonylphenol (NP), the chemical used to make the cleaning agent nonylphenol ethoxylates (NPEs), is used in many industries. In 2004 alone, more than 260 million pounds of NP was used in the U.S. Over 80% of NP is used in cleaning products, most notably laundry detergents. Metabolites of NPEs, which enter the aquatic environment through wastewater treatment effluent, are present in over 61% of tested U.S. streams.[1-5]

Extensive research indicates that NPE metabolites interfere with the hormones of fish and shellfish, thus affecting nearly every cell and organ in the body. Exposure to NPE metabolites causes organisms to develop both male and female sex organs; increases mortality and damage to the liver and kidney; decreases testicular growth and sperm counts in male fish; and disrupts normal male to female sex-ratios, metabolism, development, growth, and reproduction.[1-2, 6-7]

Canada and the European Union have banned the use of NPEs in detergents, as NPE metabolites are toxic and their use "may have an immediate or long-term harmful effect on the environment or its biological diversity."[1-2, 6]

In contrast, the U.S. has taken no action to address NPE pollution, perhaps because of a misinformation campaign by the Alkyphenol Ethoxylates Research Council (APERC). APERC "represents the major producers and processors of alkylphenols and alkyphenol derivatives including nonylphenol ethoxylates (NPEs) [and octylphenol ethoxylates (OPEs)]."[8] This document is intended to correct the misinformation APERC has disseminated.

NPE Metabolites Are Toxic and Estrogenic

APERC Myth #1: "Since all surfactants [cleaning agents] exhibit toxicity to aquatic organisms, targeting NP/NPEs for replacement…is not necessarily appropriate."[9]

Fact #1: While all cleaning agents are toxic to aquatic organisms, NPEs are by far the most toxic cleaning agent. First, NPEs are the only cleaning agents that become *more* toxic when they degrade. Second, NPEs take longer to degrade than any other cleaning agent and are more difficult to degrade during wastewater treatment. Third, NPEs are the only cleaning agents that have been identified as endocrine-disruptors.[1-2, 6-7, 10]

APERC Myth #2: "Commercial APEs [alkylphenol ethoxylates] do not show estrogenic effects when evaluated in the classic laboratory test." [11]

Fact #2: Extensive research has proven that certain APEs (NPEs and OPEs) and their metabolites mimic the natural estrogen hormone and disrupt the endocrine system. Aquatic organisms exposed to certain NPE metabolites can develop both male and female sex organs, display decreased survivorship, and more. APERC contends that it has done "classic live animal tests for estrogenic activity" and that APEs "have not demonstrated estrogenic activity."[12] Perhaps APERC should have studied the *lower ethoxylated* APE metabolites, which *have been shown* to display estrogenicity in dozens of non-partisan scientific studies. APERC instead tested the *higher ethoxylated*, less metabolized APEs so that the findings could show what scientists already know: parent APEs that have an ethoxylate chain of 4 or greater do not display estrogenicity. However, scientists also have proven that these very compounds further degrade and their metabolites, the lower ethoxylated APEs, do cause endocrine disruption. [1-2, 6-7, 10]

APERC Myth #3: APERC "does not refute the contention that APEs [alkylphenol ethoxylates] can cause reproductive effects in aquatic species exposed to high concentrations but…these effects are not observed at relevant concentration levels typically found in the [aquatic] environment."[8]

Fact #3: In Myth #2 above, APERC argues that APEs have not shown estrogenicity in laboratory tests. In this statement, APERC agrees that APEs (including NPEs) *can* cause endocrine disruption, but claims that the concentrations of APEs in the environment usually are too low to cause harm to aquatic organisms. APERC also notes that "NPE concentrations in discharges after treatment are low, varying between 50 parts per billion and 200 parts per billion."[13] Meanwhile, studies show that at concentrations less than 1 part per billion, NPE metabolites can cause serious harm to aquatic organisms. In one study, oyster embryos and larvae showed delays in development, abnormalities in the shell hinge, and increased death rates when exposed only once to 0.1 parts per billion of NP, an NPE metabolite.[11-17] When oysters were exposed only once to 1 part per billion of NP, 17% of the oyster larvae developed both male and female sex organs. This study indicates that NPE metabolites can seriously harm oysters, and other aquatic organisms, even at levels below those present in our waterways.[14, 15]

APERC Myth #4: "Only NP has been associated with endocrine-related activity, not NPE. Yet, NPE is the ingredient used in cleaning products." [1]

Fact #4: NP is both the parent compound and degradation metabolite of NPEs. When NPEs are used in cleaning products, they degrade into more toxic, estrogenic metabolites, such as NP. Scientific studies confirm that certain NPE metabolites (NP1EO, NP2EO, NP1EC, and NP2EC) *and* NP are toxic, endocrine-disruptors. To determine the dangers of NPEs, the EPA must consider their metabolites. [1-2, 6-7]

APERC Myth #5: "Protecting against toxic effects should also protect against potential estrogenic effects."[12]

Fact #5: Estrogenic effects occur only at lower concentrations. Endocrine-disrupting chemicals like NPEs often harm the endocrine system at a level below the threshold level for conventional toxicity. In fact, at very high levels, NPE metabolites are unlikely to exhibit estrogenicity, because organisms are often affected by the conven-

tional toxicity of the chemical (i.e. unconsciousness, reduced growth, death) instead of the estrogenicity of the chemical. Higher concentrations of a chemical are needed to induce the dramatic physical states that conventional toxicity studies typically test. At much lower concentrations, the endocrine system of organisms accept NPE metabolites as if they are natural hormones. As a result, reducing the concentrations of a chemical to protect an organism from toxic effects *does not* also protect an organism against estrogenic effects. In fact, it is the other way around – chemicals like NPEs must be reduced to levels low enough to inhibit estrogenic effects, and at this level, organisms will also be protected from toxic effects.[16]

APERC Myth #6:"APs, APEs and APE biodegradation intermediates are highly biodegradable."[17]

Fact #6: NPEs will ultimately biodegrade, but unlike alcohol ethoxylates (a safer alternative), NPEs do <u>not</u> readily biodegrade. NPEs take longer to degrade than other cleaning agents. Half-lives for NPEs range from 16 to 56 days. A number of factors can also influence the biodegradation of NPEs. First, NPEs degrade at a faster rate with higher temperatures. One laboratory study found that 50-60% of biotransformation occurred in 12 days when water was 20°C, while only 10-20% of biotransformation occurred in the same time period with a temperature of 4°C.[1-2, 6-7] Second, ultimate degradation takes longer in seawater.[7, 18] When compared to other cleaning agents, NPEs are much more persistent in the environment. [1-2, 6-7]

The Presence of Other Estrogenic Pollutants Does Not Absolve NPEs

APREC Myth #7: "Studies finds human waste is the principal source of estrogens [endocrine-disrupting chemicals] in treated sewage."[19]

Fact #7: APERC is falsely placing blame on other endocrine-disrupting chemicals in an attempt to minimize the estrogenic problems associated with NPEs. Regardless of the amount of human waste present in sewage, NPE metabolites have been found in U.S. waterways at a concentration shown to cause endocrine disruption in laboratory studies. Furthermore, an important United States Geological Survey (USGS) study found that APEs are present in our waterways much more frequently and at higher concentrations than other endocrine-disrupting chemicals, such as those found in human waste. In waters where NPE metabolites were found, concentrations ranged from 0.2 parts per billion to 40 parts per billion. Meanwhile, concentrations of eight different reproductive hormones found in human waste (including 17*B*-estradiol) ranged from 0.019 parts per billion to 0.831 parts per billion. Clearly, APEs pose a greater threat to the aquatic environment than human waste – they are present more frequently in our waters and in higher concentrations. Additionally, the presence of other estrogenic chemicals should *increase* concern over the use of NPEs, because these chemicals act together to increase endocrine disruption in aquatic organisms.[3]

Conventional Wastewater Treatment Is Ineffective

APERC Myth #8: NPEs are effectively removed in well-functioning sewage treatment plants.[20]

Fact #8: Most wastewater treatment facilities cannot fully degrade all NPEs. A number of factors make it difficult for sewage treatment plants to effectively treat NPEs. Plants with a lower sludge retention time are less effective in treating NPEs. Activated sludge treatment is also less effective at lower, more variable temperatures. To remove more NPEs during treatment, many otherwise effective treatment plants would need to change their operating procedures, which is costly and time-consuming.[21-23] Environment Canada, Canada's environmental protection agency, estimates that "at least 63% of the total mass of all NP compounds entering wastewater treatment plants is released into the environment." Furthermore, the *highest* concentrations of certain NPE metabolites come from wastewater treatment plants with *more* treatment. Thus, even highly effective sewage treatment plants may discharge NPE metabolites into waterways. [1-2]

Safer Alternatives Are the Solution

APERC Myth #9: "The solution to pollution isn't necessarily [chemical] substitution." [3]

Fact #9: The easiest way to reduce pollution is to use an alternative cleaning agent. Alcohol ethoxylates (AEs) are an effective, less toxic alternative to NPEs that do not cause endocrine disruption. Why spend the time and money to find ways to reduce the problems associated with NPEs, when the root of the problem can be addressed by switching to an alternative? The answer is clear: product substitution is not cost-effective for the NPE industry's profits.[1-2, 10]

Literature Cited

(1) Environment Canada. 2001. *Nonylphenol and Its Ethoxylates: Priority Substances List Assessment Report.* Minister of Public Works and Government Services.

(2) Environment Canada. 2002. *Canadian Environmental Quality Guidelines for Nonylphenol and its Ethoxylates (Water, Sediment, and Soil).* Scientific Supporting Document. Ecosystem Health: Science-based Solutions Report No. 1-3. National Guidelines and Standards Office, Environmental Quality Branch, Environment Canada, Ottowa.

(3) United States Geological Survey. 2002. *Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams.* Retrieved from http://pubs.acs.org /cgibin/jtextd?esthag/36/6/html/es011055j .html in 5/2005.

(4) World Wildlife Federation. 1999. *Briefing: Nonylphenol Ethoxylates*.

(5) Chemical Market Reporter. 2001. *Chemical Profile: Nonylphenol*. Vol. 260, No. 2. Schnell Publishing Company.

(6) European Union. *4-Nonylphenol (branched) and Nonylphenol Risk Assessment Report.* Institute for Health and Consumer Protection, European Chemicals Bureau, Vol.10.

(7) U.S. EPA. 2004. *Draft Ambient Aquatic Life Water Criteria for Nonylphenol. Retrieved* from http://www.epa.gov/water science/criteria/nonylphenol/draftnonylphenol.pd f in 5/2005.

(8) Alkylphenol Ethoxylates Research Council. 2004. *APERC's Comments on EPA's Draft Environmentally Preferable Purchasing Product Guide.* Letter. Retrieved from http://www.aperc.org/docs/ aperccomments_eppcleaning.pdf in 5/2005.

(9) Alkylphenol Ethoxylates Research Council. 2004. *Great Cleaning Products Through Great Chemistry*. Retrieved from http://www.aperc.org/docs/cleaning_product s_final_english.pdf in 5/2005.

(10) Toxecology Environmental Consulting Ltd. 2002. *Alternatives to Nonylphenol Ethoxylates: Review of Toxicity, Biodegradation, & Technical-Economic Aspects*. Prepared for Environment Canada.

(11) Alkylphenol Ethoxylates Research Council. 1999. *The Endocrine Theory*. Retrieved from http://www.aperc.org/docs/ endocrineissue.pdf in 5/2005.

(12) Alkylphenol Ethoxylates Research Council. 1999. *The Endocrine Theory: Health-Related Findings*. Retrieved from http://www.aperc.org/docs/endocrineinfoshe et.html in 5/2005.

(13) Alkylphenol Ethoxylates Research Council. 1999. *An Overview of Safety Issues*. Retrieved from http://www.aperc.org /docs/whitepaper-overview.html in 5/2005.

(14) Natural Environmental Research Council. 2003. *Pollutant Threat to Oyster Industry.* Royal Holloway, University of London. Retrieved from http://www.nerc.ac.uk/pub lications/latestpressrelease/2003-13oysters .asp in 5/2005.

(15) Nice, H., D. Morritt, M. Crane and M. Thorndyke. 2003. *Long-term and Transgenerational Effects of Nonylphenol Exposure At a Key stage in the Development of Crassostrea gigas. Possible Endocrine Disruption?* Marine Ecology Progress Series, Vol. 256, p. 293. Retrieved from

http://www.ourstolenfuture.org/NewScience/wildlife/inverts/2003/2003-0717niceetal.htm in 5/2005.

(16) Colborn, T., D. Dumanoski, J. Myers. 1999. *Our Stolen Future*: *How We Are Threatening Our Fertility, Intelligence, and Survival – A Scientific Detective Story.*

(17) Alkylphenol Ethoxylates Research Council. 2001. *Alkylphenols and Alyklphenol Ethoxylates: Highlights of Environmental Safety*. Retrieved from http://www.aperc.org/docs/bulletin06-01.htm in 5/2005.

(18) Ekelund, R., A. Granmo, K. Magnusson, M. Berggren. 1993. *Biodegradation of 4-Nonylphenol in Seawater and Sediment*. Environmental Pollut., Vol. 79, p. 59.

(19) Alkylphenol Ethoxylates Research Council. 2001. *Studies Find Human Waste Is Principal Source of Estrogens In Treated Sewage*. Retrieved from http://www.aperc.org/docs/finalbuletin_human_hormones_wwt112904.pdf in 5/2005.

(20) Alkylphenol Ethoxylates Research Council. 2001. *Safety of APEs*. Retrieved from http://www.aperc.org/docs/safetyofapes.html in 5/2005.

(21) Birch, R. 1991. *Prediction of Fate of Detergent Chemicals During Sewage Treatment*. Chem. Tech. Biotech., Vol. 50, p. 411.

(22) Ahel, M., W. Giger, and M. Koch. 1994b. *Behaviour of Alkylphenol Polyethoxylate Surfactants in the Aquatic Environment – I. occurrence and Transformation in Sewage Treatment*. Water resources, Vol. 28, p. 1131.

(23) Field, J., and R. Reed. 1996. *Nonylphenol Polyethoxycarboxylate Metabolites of Nonionic Surfactants in U.S. Paper Mill Effluents, Sewage Treatment Plant Effluents, and River Waters*. Environ. Sci. Tech., Vol. 30, p. 3544.

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