

FACT SHEET:

Alkylphenols in Biosolids

What are alkylphenols?

Alkylphenols are a family of chemicals that form when another group of chemicals, the alkylphenoethoxylates (AP ethoxylates) partially biodegrade. The most important member of the alkylphenol family is nonylphenol. Approximately 80 percent of the alkylphenols in commerce are nonylphenols. AP ethoxylates are high volume chemicals that have been used for over 50 years as commercial and consumer detergents. These compounds have been in the news lately because new developments in analytical chemistry have enabled chemists to detect them at very low levels in the environment.

Why are some people concerned about alkylphenols?

AP ethoxylates and alkylphenols are widely and safely used in personal and health-care products. Issues about alkylphenols in the environment have been raised recently, primarily in Europe, where some governmental agencies and researchers have speculated that alkylphenols are endocrine disruptors (chemicals that interfere with natural hormones) that may cause reproductive and growth problems to aquatic life, particularly fish. Reproductive problems in some species of fish have been found at alkylphenol levels near those recently measured in natural waters, however, these problems have only been seen in laboratories and not in the environment and it appears that alkylphenols are 100,000 times less active than the natural hormone, estradiol.

Where do alkylphenols come from?

AP ethoxylates are found in a wide range of consumer and commercial products. The products with the highest amounts of AP ethoxylates include face makeup, fragrances, hair bleach, hair conditioner, hair dye, shampoo, manicure products, skin moisturizers and cleansers, and liquid laundry detergents. Smaller, but still significant, amounts come from bath gels, eye makeup, contraceptives, deodorants, stain removers, spray cleaners, and latex paints. Most of the AP ethoxylates in the environment come from the use of these products in the home or small businesses like beauty parlors. AP ethoxylates also come from industrial use of detergents and from textile and pulp and paper mills.

Are alkylphenols harmful to humans?

Some cosmetic and birth control products that contain alkylphenols cause local irritation, which usually disappears after use of the product stops. There is no evidence from humans or lab mammals that alkylphenols are carcinogenic, mutagenic, or cause reproductive or developmental effects in mammals. Spermicides containing nonylphenol are the most direct route of human exposure. There have been reports of vaginal irritation and itching, irritation of the urinary tract and contact dermatitis. Studies

have failed to show a causal link between alkylphenol spermicides and congenital malformations in people. On some skin-care products, there has been erythema (skin reddening), contact dermatitis, and photosensitivity. Alkylphenols are not likely to bioaccumulate in human tissues because they are readily metabolized and excreted.

Environment Canada (the Canadian equivalent of the US Environmental Protection Agency) conducted a comprehensive risk assessment of alkylphenols. They looked at human exposure from air, water, biosolids-amended soil, food, and various consumer products. They rated the risks associated with each potential exposure route and calculated a "Margin of Exposure" (MOE), akin to a "Margin of Safety," for each exposure route. If the MOE was less than "1", there was a potential health problem, and if it was greater than "1", there was no potential health problem. Therefore, the higher the MOE number, the higher the level of safety associated with that exposure route. Exposures from biosolids-soil, air, and water were all rated as extremely safe with MOEs greater than 10,000. Packaged food had an MOE of 700, still safe, but not as safe as the environmental exposures. Skin moisturizer failed, with an MOE less than 1, and fragrances and spermicides were borderline with MOEs between 1 and 10. All other consumer products had MOEs of 200 or better. Environment Canada found that adult Canadians are exposed to 7,000 times more alkylphenols in food (mostly from food packaging materials) than in biosolids. The agency also determined that the levels of alkylphenols in biosolids used for land application are over one million times lower than the amounts needed to cause a human health problem.

How do alkylphenols get to surface waters?

Alkylphenols are discharged in effluents from industrial and municipal wastewater treatment plants directly to surface waters.

AP ethoxylates from consumer products can represent up to 10 percent of the total dissolved organic carbon entering a wastewater treatment plant (WWTP). In the WWTP, most of the AP ethoxylates biodegrade (break down by the action of natural microorganisms) into alkylphenols. Alkylphenols breakdown to carbon dioxide and other low-toxicity chemicals. Estimates for AP ethoxylate biodegradation in a secondary treatment plant run from 45 percent to over 99 percent. The amount of alkylphenol degradation depends on a variety of factors, particularly whether the treatment process operates under high oxygen (aerobic) conditions or low oxygen (anaerobic) conditions. Degradation of alkylphenols is slower in anaerobic processes. Generally, wastewater effluents contain very low levels (e. g. less than 5 parts per billion) of nonylphenol. Alkylphenols are not very water soluble, and therefore have a strong tendency to become adsorbed onto WWTP solids, so low levels (100-900 parts per million) have been measured in biosolids. Alkylphenols have been found in both Class A and Class B biosolids derived from composting, lime stabilization, thermal treatment, and anaerobic digestion. Alkylphenols are destroyed if sludge or biosolids are incinerated, but will not break down if sludge or biosolids are land filled.

What happens to alkylphenols in biosolids?

Alkylphenol in land-applied biosolids generally degrade rapidly. Typically, 90 percent of alkylphenols biodegrade in one to three months. Biodegradation rates may be slower in situations when soils are waterlogged and have lower levels of oxygen. Because alkylphenols bind to solid particles, the movement of alkylphenols from land where biosolids have been applied will not occur unless there is enough rainfall to cause erosion and sediment runoff. Land application sites will normally not be a source of alkylphenols to surface water if best management practices (BMPs) for controlling erosion and runoff as required by state and federal regulations are followed.

Conclusions about alkylphenols in biosolids

Although alkylphenols have been measured in biosolids, there is no cause for concern about environmental impacts due to land application of biosolids. Due to the rapid rate of degradation in the natural soil environment, and the limited potential for alkylphenols to be transported off-site, biosolids are not likely to be a significant source of alkylphenols to surface water. And, to put things in context, any contributions of alkylphenols from biosolids would be extremely minor when compared to the amounts discharged into lakes and streams each day from wastewater effluents and other sources.

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