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BIODEGRADABILITY OF NONYLPHENOL AND NONYLPHENOL ETHOXYLATES

Laboratory and field studies clearly demonstrate that nonylphenol ethoxylates (NPEs) are easily biodegraded. Removal rates of 95% and over can be achieved in sewage treatment plants. Nonylphenol (NP) itself is one of several biodegradation intermediates of NPEs that further degrade to carbon dioxide and water. It is not persistent, as often claimed. Uptake of NP by aquatic species is reversible, it is metabolised and eliminated by mammals, and there is no evidence for build-up of the substance in the food chain.

Nonylphenol (NP) is a biodegradation intermediate of nonylphenol ethoxylates (NPEs). NP has been alleged to be non-biodegradable, bioaccumulative and persistent in the environment. However, these allegations do not hold up if results from recent research are taken into account.

The biodegradability of NPEs has been assessed in a variety of different studies according to OECD guidelines. The results indicate that NPEs are easily biodegraded and clearly demonstrate that they are "inherently biodegradable" i.e. that they are degraded to carbon dioxide and water. Some studies even show them to be "readily biodegradable" i.e. that 60 to 70 % is converted into carbon dioxide and water within 28 days.

Studies also show that NPEs have several biodegradation pathways to ultimate conversion to carbon dioxide and water. In the absence of oxygen, NP is a significant biodegradation intermediate. Laboratory tests have now clearly demonstrated that NP is inherently biodegradable under aerobic conditions ([1], [2]). In one study it almost met the "readily biodegradable" criterion. Thus proper biological sewage treatment will reduce NP residues arising from NPEs to carbon dioxide and water.

The removal of NPEs in both industrial and domestic sewage treatment plants under actual environmental conditions has been assessed in several monitoring studies. The reported results vary widely, but over 90% removal is generally achievable, ([2], [3]) with removal rates as a rule higher in summer compared to winter, as is to be expected.

[1] Risk Assessment of 4-Nonylphenol (Branched) and Nonylphenol;
report currently being prepared by UK under EU Existing Substances Regulation (793/93/EEC).
[2] Hager, C.D. (1998): Alkylphenol ethoxylates. Biodegradability, aquatic toxicity and environmental fate,
in: New products and applications in surfactant technology. Vol. 1, Karsa, D.R. (ed.), CRC Press.
[3] Naylor, C.G. et al. (1992): Alkylphenol ethoxylates in the environment,
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The EU NP risk assessment report recognises these facts with the conclusion: *"The data available indicates that nonylphenol undergoes biodegradation in water, sediment and soil systems. The results from standard biodegradation tests are variable but indicate that nonylphenol is probably inherently biodegradable."*

Laboratory studies which measure the tendency of a substance to concentrate in fatty tissues of aquatic species show a very wide spread of results with NP, from low to very high ([1]). But the uptake is reversible and rapid elimination is observed when the exposure is removed. Further, there is evidence that NP is metabolised by aquatic species, and mammals rapidly metabolise and eliminate the substance from the body. Therefore build-up of NP in the food chain is highly unlikely and has never been observed.

The conclusions are that (a) both nonylphenol and nonylphenol ethoxylates are easily biodegradable and break down ultimately to carbon dioxide and water, (b) nonylphenol ethoxylates and their biodegradation intermediates including nonylphenol can be effectively treated and removed in sewage treatment plants with biological treatment, and (c) nonylphenol is not persistent and there is no evidence that it affects the food chain.