Council for LAB/LAS Environmental Research

LAS BIODEGRADATION AND SAFETY IN RIVERS AND STREAMS

Field studies, which monitor the real-world behavior of a substance, indicate that linear alkylbenzene sulfonate (LAS) biodegrades rapidly and completely and does not accumulate in the environment. Extensive aquatic toxicity and risk assessment data from more than 50 years of use as a detergent surfactant confirm that LAS is safe for aquatic populations, based on levels confirmed through field studies.

- Effective biological treatment, such as activated sludge, removes 99 percent of the LAS present in wastewater, leaving only trace amounts that continue to biodegrade in rivers and streams receiving treated wastewater.[1][2]

- "Half-life" refers to the amount of time it takes for microbes to completely break down half the amount of a chemical in water. A study in Rapid Creek, South Dakota, found LAS half-lives ranging from 0.15 to 0.5 days, demonstrating rapid biodegradation following treatment. Using higher test concentrations, a similar study of surface waters near Austin, Texas, confirmed that LAS quickly disappears in the aquatic environment.[3-5]

- LAS concentration is further decreased by dilution in the receiving waters where it is found in the <0.002-0.047 mg/l concentration range. LAS degrades rapidly aerobically (half-life in rivers about 3 hours).[6]

- LAS aerobic biodegradation proceeds with degradation of both the alkyl chain and the aromatic ring. Low toxicity sulfophenylcarboxylates (SPCs) are formed as degradation intermediates which are ultimately converted to water, carbon dioxide and sulfate salts[6]. This degradation route has been demonstrated in sewage treatment plants (STPs) and in laboratory studies using a ^{14}C ring-labelled commercial product and some pure unlabeled homologues (Nielsen and Huddleston, 1981).[6]

- Recently published studies have demonstrated anaerobic biodegradation of LAS in marine sediments and bio-reactors. For additional information on anaerobic biodegradation of LAS, see the fact sheet LAS BIODEGRADATION UNDER ANAEROBIC CONDITIONS.

- Using standard laboratory tests to measure aerobic biodegradation, the primary biodegradation (loss of surfactant function) of LAS, measured by MBAS (Methylene Blue Active Substance) or by specific analytical methods such as HPLC (High Performance Liquid Chromatography), in any OECD tests (OECD, 1993), is >99% (EU Commission, 1997).[6]

- The ultimate (complete) biodegradation (or mineralization) measured by DOC (Dissolved Organic Carbon) is in a range going from 80% to >95% for CAS (Continuous Activated Sludge) simulation tests (OECD 303 A), and in the 95-98% range for inherent tests (OECD 302) (EU Commission, 1997). Note that measurements of 80% or more mineralization are considered complete mineralization because the remaining 20% is likely incorporated into bacterial biomass and is not available for conversion to DOC.[6]

- CAS simulation tests (OECD 303 A) were run for the commercial LAS product in the 9-25°C temperature range.[7] Although acclimation times were significantly different at various temperatures, being longer at lower temperatures, the percent LAS removal, measured by MBAS and HPLC, was always similar and high (>95%) in all cases, indicating that the microorganism community can also reach a proper acclimation and that kinetics are also adequate at low temperatures.[8,9] These results are in agreement with some stream mesocosm studies which concluded that the mineralization of surfactants under realistic environmental conditions, where various algal species are acclimated following natural temperature fluctuations, was at least maintained and often increased during significant seasonal decreases in temperature.[9]

- A comparison between study results and data from a 1973-1986 U.S. monitoring study confirm that LAS is not accumulating in the environment. Even though greater use has increased concentrations of LAS entering sewage treatment plants, LAS concentrations in outgoing water (effluent) have actually diminished. Thus, the low levels of LAS in streams and rivers are not increasing over time, despite greater LAS usage.[1,10]

- The U.S. Geological Survey's Mississippi River monitoring studies indicate that under normal conditions (effective treatment and normal river flow) LAS concentrations rarely exceed 0.005 milligrams per liter (mg/L), due to effective wastewater treatment and continued biodegradation in surface waters.[11] Immediately downstream of sewage treatment plants that discharge into low dilution streams, LAS concentrations averaged 0.043 mg/L.[1]

- LAS concentrations in rivers and streams can also be predicted using water quality models such as iSTREEM®.[12] iSTREEM® predicts mean and low-flow (7Q10) conditions for all U.S. rivers based on per capita daily product use, removal rates by the various types of wastewater treatment plants, and effluent dilutions by the receiving water for each treatment plant. The 7Q10 values represent the lowest 7-day average flow that occurs during a 10-year period. Based on the iSTREEM® model and the extensive monitoring data available on LAS, 90% of the river miles in the U.S. are expected to have LAS concentrations <0.074 mg/L under low flow (7Q10) conditions.[2]

- LAS is one of the most extensively tested chemicals for acute and chronic toxicity to algae, invertebrates and fish. Using laboratory testing, chronic freshwater aquatic toxicity values, based on effects on growth, survival, and reproduction, and evaluated in 19 different species, ranged from 0.23 mg/L (rainbow trout) to 4.15 mg/L (*Elimia*, snail).[(2)] However, under more real-world conditions (as represented by mesocosm testing), an LAS concentration of 0.395 mg/L has no observed effects on the biological population.[(2,13)] Given the quality of the mesocosm study, as well as the supporting data available from the single-species chronic toxicity values, the mesocosm value of 0.395 mg/L is used as the definitive predicted no effect concentration (PNEC) for risk assessment.[(2)]

- Measured LAS concentrations immediately downstream of sewage treatment plants that discharge into low dilution streams averaged 0.043 mg/L.[(1)] Based on the iSTREEM® model and the extensive monitoring data available on LAS, 90% of the river miles in the U.S. are expected to have LAS concentrations <0.074 mg/L under low flow (7Q10) conditions.[(2)] Comparison of these concentrations with the PNEC (predicted no effect concentration) for LAS based on testing of biological populations under real world conditions (0.395 mg/L)[(2)] demonstrates that LAS concentrations in rivers and streams, even under worst case conditions, such as low dilution streams immediately downstream of sewage treatment plants, will not harm aquatic organisms.

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