SNF Health-Safety Environment

anionic polyacrylamide

Flopam™ AN 900
range of products

Health and Environmental Safety

hes/anpam/en/dm/1601-01

Health and environmental profile

Anionic polyacrylamide is the generic name for a group of very high molecular weight macro-molecules produced by the free-radical polymerization of acrylamide and an anionically charged comonomer, mainly the sodium salt of acrylic acid, sodium acrylate. The combination of molecular weight and ionic charge results in extremely viscous aqueous solutions, one of the main properties of these polymers.

Both the charge density (ionicity) and the molecular weight can be varied. By varying the acrylamide/anionic monomer ratio, a charge density from 0 to 100% along the polymer chain can be obtained. The molecular weight is determined by the type and concentration of the reaction initiator and the reaction parameters.

Anionic polyacrylamide has no systemic toxicity to aquatic organisms or micro-organisms. The polymer is much too large to be absorbed into tissues and cells. The functional anionic groups do not interfere with the functioning of fish gills or daphnia respirators. Any adverse effects observed in laboratory tests are always seen at concentrations of over 100 mg/L and are probably due to the resulting viscosity of the test medium. The preparation of the test solutions at such concentrations requires high-energy stirring for long periods of time, sometimes several hours. Therefore, it can be concluded that these harmful concentrations will not exist in the natural environment.

The test data given on page 4 of this document was obtained using a highly charged anionic polyacrylamide. Low charge density polymers demonstrate even lower toxicity to aquatic and micro-organisms. The results of assays on anionic polyacrylamides are determined mainly by the viscosity of the test solution.

Anionic polyacrylamide has no potential to bioaccumulate, being completely soluble in water (solubility is only limited by viscosity) and insoluble in octanol. Additionally, being a flocculant, it adsorbs onto suspended m tter and, in this way, is removed from the water phase.

Chemical identity

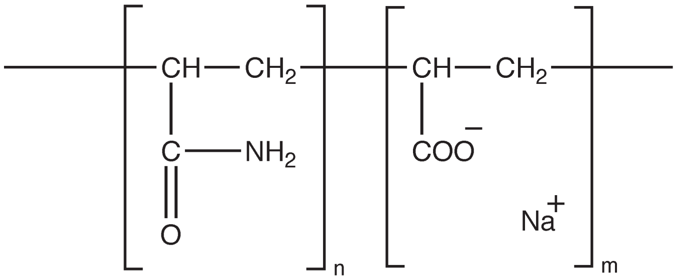
A. Chemical identity

Chemical name : . . . . 2-propenoic acid, sodium salt polymer with 2-propenamide

Other names : . . . . Copolymer of acrylamide and acrylic acid, sodium salt
Acrylamide, sodium acrylate copolymer

CAS number : . . . . 25085 - 02 - 3

B. Molecular structure



Anionic polyacrylamide: copolymer of acrylamide and acrylic acid, sodium salt

C. Physical-chemical properties

Molecular weight : . . . greater than 1,000,000 daltons, usually greater than 5,000,000

Solubility : . . . . totally miscible in water, insoluble in n-octanol and other solvents

pH : . . . . 6 to 8 in solution at 5g/L

Apparent density : . . . ~1.08

Melting point : . . . . . >150°C

Log Pow : . . . . < –2

Mammalian toxicology

A. Acute tests

LD50/oral/rat . . . . **> 5000 mg/kg**

SNF test F134 : OECD 401/GLP/Report dated December 28, 1991

B. Irritation

Acute dermal irritation . . . . **Not irritating**

Acute eye irritation . . . . **Not irritating**

Guillot, J.P., *et al*. "Safety Evaluation of Gums and Thickeners in Cosmetic Formulations." Int. Journ. Cosmet. Sci., 1982. 4: p. 53-65.

C. Mutagenicity

Ames Test with and without liver S9 .... **Not mutagenic**

Mallevialle, J., Brucher, A., and Fiessinger, F. "How Safe are Organic Polymers in Water Treatment?" Journal AWWA, 1984: p. 87-93.

D. Long-term studies

No long term adverse effects in a lifetime feeding study in rats at 10% of diet.

No long term adverse effects in a 2-year feeding study in dogs at 6% of diet.

No effects on reproduction in a feeding study in rats at 10% of diet.

No carcinogenicity in any of the long-term animal studies.

McCollister, D.D., Hake, C.L., Sadek, S.E., and Rowe, V.K. "Toxicologic investigations of polyacrylamides." Toxicol Appl Pharmacol, 1965. 7(5): p. 639-51.

Aquatic toxicology

A. Toxicity to fish

LC50 / *Brachydanio rerio* / 96 hours . . . . = **357 mg/L**

LC0 / *Brachydanio rerio* / 96 hours . . . . = **178 mg/L**

SNF test F242 : OECD 203/GLP/Report dated December 21, 1995

B. Toxicity to daphnia

EC50 / *Daphnia magna* / 48 hours . . . . = **212 mg/L**

SNF test F243 : OECD 202/GLP/Report dated December 21, 1995

C. Toxicity to algae

$EC50_A$ (I) / *Chlorella vulgaris* / 96 hours . . . . > **1,000 mg/L**

$EC50_\mu$ (I) / *Chlorella vulgaris* / 96 hours . . . . > **1,000 mg/L**

No Observed Effect Concentration (NOEC) . . . . = **708 mg/L**

SNF test F244 : OECD 201/GLP/Report dated December 21, 1995

D. Toxicity to bacteria

EC10 / *Pseudomonas putida* / 18 hours . . . . = **127 mg/L**

EC50 / *Pseudomonas putida* / 18 hours . . . . = **892 mg/L**

SNF test F245 : OECD 301F, DIN 38412-27, ISO 7027/GLP/Report dated December 21, 1995

Environmental fate

A. Bioaccumulation

log P_{ow} < −2

SNF test 0911-01 : EC Method A8 (2008) & OECD 107 (1995)/GLP/Report dated November 19, 2009

This very low value demonstrates that anionic polyacrylamide is totally soluble in water and insoluble in organic solvents. Thus, it has no potential to bioaccumulate.

Based on this, the Biocncentration Factor (BCF) = 0

B. Abiotic degradation

Anionic polyacrylamide is sensitive to ultra-violet light which breaks down the polymer backbone into oligomers. A positive correlation is observed between the length of exposition to light and the degree of breakdown (*i.e.*, reduction in molecular weight).

C. Biodegradation

Non-degraded anionic polyacrylamide has been shown to be recalcitrant to microbial degradation. This is related to the extremely high molecular weight which renders microbial attack very difficult. However, the polymer can been degraded by UV light (photolysis) and the action of hydroxyl radicals (•OH) both of which are abundant in nature. Once the macromolecule is broken down to a molecular weight under 10,000 daltons it will be indistinguishable from the organic background in the soil/marine environment and will eventually degrade to a size where it can be biomineralized.

A study using C^{14} labelling, designed to evaluate the potential of anionic polyacrylamide to biodegrade demonstrated that a combination of photolysis and microbial attack leads to natural attenuation of these polymers. After 48 hours of exposure to UV, the oligomer (MW < 3,000daltons) increased from under 2% to 80%. This enabled after 38 days incubation for the polymer to be biodegraded at least 29% aerobically and 17% anaerobically (El Mamouni *et al*, 2002).

Residual monomers

SNF takes the utmost care to ensure that the constituant monomers (in this case acrylamide and sodium acrylate) are as completely reacted as possible during polymerization. However, technically unavoidable traces can and do remain in the finished polymer, especially in powder products. For standard products, our quality assurance guarantees that all Floerger polyacrylamides contain less than 0.1% w/w (< 1000 ppm) of residual acrylamide monomer and less than 0.5% w/w (< 5000 ppm) of residual sodium acrylate. In fact, on average, there is about 0.04% (400 ppm) of residual acrylamide and about 0.2% (2,000 ppm) of residual sodium acrylate. Special applications, such as for the treatment of drinking water, food contact paper and agriculture may have lower residual monomer specifications.

Both acrylamide and sodium acrylate are readily biodegradable under aerobic conditions at over 90% in 28 days. Even at operating doses as high as 50 mg/L, the residual monomers released into the environment will never reach concentrations which could constitute a risk to the aquatic life. Their high biodegradibility negates the possibilty of accumulation in the natural environment.