Environmental Stewardship Program for Polymers Used in Cleaning Products—Polycarboxylate Polymers

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The potential ecological risk associated with current uses of polycarboxylate polymers in cleaning products in North America is low.

Introduction

Water-soluble polymers are important ingredients providing multiple functions and unique performance benefits to cleaning products. Polycarboxylate polymers are found in laundry products and automatic dishwashing products to improve performance by preventing redeposition of soil. They have played an important role in recent years replacing phosphates, which have been phased out of laundry and dish care products. The American Cleaning Institute is supporting an environmental stewardship program for key polymers used by its members in the formulation of cleaning products in North America. The present effort illustrates a screening level ecological risk assessment for two polycarboxylate polymer families used in cleaning products: acrylic acid (AA) homopolymers and acrylic acid-maleic acid (AA-MA) copolymers.

1. What polycarboxylate polymers are used in cleaning products?

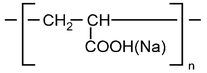


Figure 1. Structure of AA Homopolymers

Example compound:
2-Propenoic acid, homopolymer
(CAS No.: 9003-01-4)
MW range: 1,000–78,000
Typical MW: 4,500

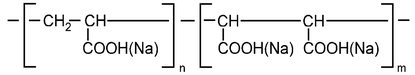
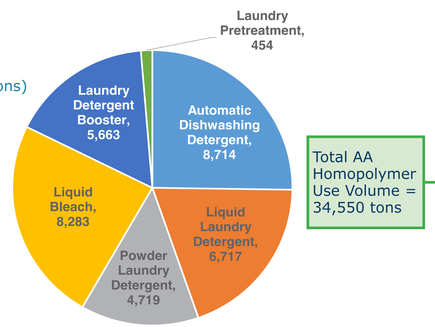


Figure 2. Structure of AA-MA Copolymers

Example compound:
2-Butenedioic acid (2Z)-, polymer with 2-propenoic acid
(CAS No.: 29132-58-9)
MW range: 12,000–100,000
Typical MW: 70,000

2. What is the national use volume and use pattern of polycarboxylate polymers in cleaning products in the U.S.?

Figure 3. AA Homopolymer Use Volume (tons)



Use volume of AA homopolymers is estimated based on information from ACI (2019) and CARB (2019).

Use volume and use pattern data for AA-MA copolymers are not as readily available, so a conservative estimate of **55,000 tons** was used based on previous relative use of the two families of polymers.

Total AA Homopolymer Use Volume = 34,550 tons

3. What is the environmental fate of polycarboxylate polymers used in cleaning products?

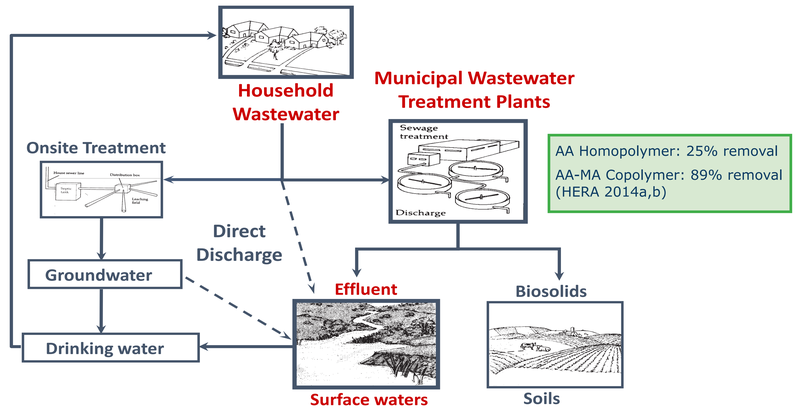


Figure 4. Conceptual Model with Primary Environmental Emission to Surface Waters via Down-the-Drain Disposal of Products

4. What are the predicted environmental concentrations (PECs) of polycarboxylate polymers?

Table 1. PECs for Cleaning Product Use of Polycarboxylate Polymers in the U.S. from EPA E-FAST Model

Chemical Name	Use Volume	Removal Rate	$PEC_{effluent}$	PEC_{river} 90th Percentile Mean Flow	PEC_{river} 90th Percentile Low Flow
AA homopolymer	34,550 tons (3.13×10^7 kg)	25%	0.57 mg/L	0.07 mg/L	0.57 mg/L
AA-MA copolymer	55,000 tons (4.99×10^7 kg)	89%	0.13 mg/L	0.02 mg/L	0.13 mg/L

5. What are the ecological hazards and associated predicted no effect concentrations (PNECs) of polycarboxylate polymers?

The chronic aquatic toxicity of polycarboxylate polymers is generally low. More detailed data regarding the acute and chronic ecological hazards are available in HERA (2014a,b).

Table 2. Summary of Chronic Aquatic Toxicity Data

Chemical Name	Organism	Exposure Period	NOEC (mg/L)	Lowest Chronic Toxicity Study (mg/L)	Assessment Factor	PNEC (mg/L)
AA homopolymer	Fish	14–32 days	56–>450	12	10	1.2
	Aquatic invertebrate	21 days	12–100			
	Algae	96 hours	32.8–180			
AA-MA copolymer	Fish	14–42 days	100	3.75	10	0.375
	Aquatic invertebrate	21 days	3.75–350			
	Algae	72 hours	37.2			

6. Are there environmental risks associated with the current use of polycarboxylate polymers in cleaning products?

Table 3. Summary of Aquatic Risk Ratios (PEC/PNEC) for Polycarboxylate Polymers

	PEC (mg/L)		PNEC (mg/L)	Risk Ratio (PEC/PNEC)	
Chemical Name	90th Percentile Mean Flow	90th Percentile Low Flow	PNEC (mg/L)	90th Percentile Mean Flow	90th Percentile Low Flow
AA homopolymer	0.07	0.57	1.2	0.06	0.48
AA-MA copolymer	0.02	0.13	0.375	0.05	0.35

Summary

AA homopolymers have low inherent aquatic toxicity, and AA-MA copolymers, while having low to moderate aquatic toxicity, are highly removed during wastewater treatment resulting in low environmental exposures. Consequently, the potential ecological risk associated with current uses of polycarboxylate polymers in cleaning products in North America is low. The results of this conservative screening level risk assessment are consistent with government assessment of these polycarboxylate polymers (ECCC/HC 2018; NICNAS 2019; USEPA 2019).

References available upon request.