Abstract

[Project Information]

Project Title :	Model Development for Predicting Concentrations of Cationic Surfactants in Japanese Rivers
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[Abstract]

The management of cationic surfactants is crucial for the sustainability of ecosystems and public health. To develop a methodology for predicting concentrations in Japanese rivers, we monitored 14 cationic surfactants (benzalkonium chloride [BAC] C8, C10, C12, C14, C16, C18; benzethonium chloride; cetylpyridinium chloride; dialkyldimethylammonium chloride [DDAC] C8, C10, C12; and alkyltrimethylammonium chloride [ATAC] C12, C16, C18) once a season over 1–2 years, in five sewage treatment plants, 15 major rivers across Japan, the Tatsuta and Katsuge river catchments, which are densely populated but still largely unsewered, and the Kimotsuki river catchment, where swine outnumber humans. We also conducted biodegradation and sorption experiments, and used the G-CIEMS watershed model to predict river-water concentrations.

A large proportion of the consumption of most cationic surfactants entered sewers, whereas a substantial proportion of DDAC-C10 did not, attributable to its use in animal husbandry. The oxidation ditch process removed more cationic surfactants more stably than the activated sludge process. Biodegradation was the main pathway of removal of most cationic surfactants, but sludge withdrawal removed substantial fractions of longer-alkyl-chain compounds. Among 15 major rivers across Japan, per-capita mass flows of most cationic surfactants had positive correlations with the fractions of population whose gray water is discharged untreated to surface waters, while that of DDAC-C10 had a positive correlation with the swine-to-human population ratio. The Tatsuta and Katsuge river catchments were seriously polluted by cationic surfactants, most of which were linked with untreated or poorly treated household wastewater, and some with both household and

commercial wastewaters. The Kimotsuki river catchment was dominantly polluted by DDAC-C10, which likely entered surface waters mainly with effluent from swine farms. The biodegradation rate constants of the 14 cationic surfactants in river waters significantly increased and their sorption coefficients to sediments significantly decreased with increasing hydrophobicity. Although the model slightly to moderately overestimated mass flows of the cationic surfactants, mean errors among the 15 rivers were mostly within the range of ±1 log unit. The sediment-to-river-water concentration ratios of most cationic surfactants had positive correlations with the sediment organic carbon content, indicating that both their river-water concentrations and sediment organic matter played important roles in sediment concentrations. These findings will be helpful for managing the environmental risks of cationic surfactants.

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