

Contamination of the Aquatic Environment by Pharmaceutical and Personal Care Products: Environmental Risk Assessment and Removal from Wastewater

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[Abstract]

Key Words: Pharmaceuticals and personal care products, Ecological risk assessment, Predicted no effect concentration, Bioaccumulation factor, Bioassay experiment, Oxidation process

In this study, pharmaceuticals and personal care products (PPCPs) derived from daily human life in the water environment in Japan were investigated through the following two phases:

(1) Nationwide ecological risk assessment of PPCPs.

(2) Measures to prevent PPCPs from leaking into the aquatic environment through the development of treatment technologies.

In the first phase, four regional environmental research institutes (Tokyo Prefecture, Nagoya City, Osaka City, and Hyogo Prefecture) analyzed PPCPs derived from daily life in water, sediment, and aquatic organism (fish) samples at various sites in cooperation with 19 regional environmental research institutes throughout Japan. In addition, IDEA Consultants, Inc., was in charge of gathering the predicted no effect concentration (PNEC) as toxicity information on these chemicals through reference and bioassay experiments using aquatic organisms (algae, crustaceans, and fish). Ecological risk assessments of PPCPs were conducted by comparing the analyzed data with PNECs. The results shows that concentrations of water samples at several sites exceeded the PNEC for the antibiotics clarithromycin, 14-hydroxycarithromycin, and erythromycin, as well as antibacterial agents such as triclosan. The concentrations of antibiotics tended to be higher in the winter season than in the summer. In contrast, the concentrations of insect repellents tended to be higher during the summer season. The sediment samples also indicated several sites where sediment concentrations exceeded the PNEC for the antibiotics clarithromycin and azithromycin. Additionally, differences in accumulation in organism samples, especially samples throughout the food chain, were evaluated by determining the bioaccumulation factor (BAF). The calculated BAFs ranged from 89 to 5137 for benzotriazole UV absorbers and from 8.0 to 1900 for phosphate flame retardants. In the second phase of the study, Yokohama National University and the University of Shizuoka were responsible for constructing efficient oxidation processes, such as ozone oxidation, ozone/hydrogen peroxide, and photo-Fenton reaction, using actual wastewater samples. The results indicated that these three oxidation processes were able to reduce concentrations of PPCPs that can hardly be removed by conventional sewage treatment processes by more than 99% in 15 minutes, even when considering the effect of matrices in the actual wastewater.

[References]

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