SURFACE WATER DEGRADATION BY HUMAN ACTIVITIES

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Summary

The concern of the problems caused by organic compounds in aquatic environments has been increased in the world. Surface water, which is represented by rivers, lakes and marshes, is a source of drinking water. Rain and snow that fall to the ground supply surface water. When artificially synthesized chemical substances are released into the environment, they may become part of surface runoff. Particularly, heavy metals caused by anthropogenic activities may contribute to increasing residual levels in natural waters. Furthermore, endocrine disrupting chemicals, persistent organic pollutants including dioxins and organochlorine pesticides have been extremely produced and widely used around our daily lives, since these compounds synthesized within the past 100 years. These compounds decompose slowly in the environment, and are prone to bioaccumulation in food chains. The occurrence of these chemicals in aquatic environment samples suggests harmful effects on ecosystems and human health. As clean water is essential to human health, some new analytical and treatment techniques in order to improve water quality from organic compounds are required.

1. Introduction

Surface water is the main source of drinking water. When surface waters become contaminated by pathogenic microorganisms they can cause outbreaks of infectious diseases. Recently, this point of view for the environmental health issue has been increasingly emphasized in the world. For the benefit in our daily lives, organic compounds have been extremely synthesized and produced in the past for only about a century. Some heavy metals and organic pollutant compounds synthesized are transported for long distances from the emission sources through the atmosphere and water and residue to long terms in the nature environment. These chemicals proved to have adverse effects on ecosystems and human health. Nowadays, concern about the human health related to the environmental problems caused by the organic chemical substances in environmental samples such as water bodies, sediments and atmosphere has been continuously increasing in the world.

In here, as the emergent chemicals, endocrine disrupting chemicals, persistent organic pollutants (POPs) such as dioxins, dioxin like PCBs and organochlorine pesticides is widely produced and used around our society, since these compounds were synthesized within the past 100 years. POPs are frequently found in the Arctic despite never having been used there. It means that they are significantly persistent in the environment and widespread global distribution. Most these compounds have a hydrophobic characterization. Then, they are more easily transported with suspended substances in the water phase. The suspended substances with the absorbed organic compounds in water flow to rivers and accumulate to the sediment phase. Then, sediment cores have been used to determine modern and historical inputs of contaminants to aquatic environment.

Many industrial products are distributed in the form of unpurified compounds to our life environment and finally settled to the natural environment. In several national projects, some known estrogens such as phthalate esters (PAEs), nonylphenol (NP) and bisphenol A have been reported and investigated about their release and fate in aquatic environment. Regarding estrogenic activity as endocrine disruption, isomer-specific analysis as a new technique should be attempted because the different activity occurred depending on each isomer and distribution of their isomers in each environmental phase is different.

In the year 2001, the treaty of POPs was estimated to regulate and restrict using and producing them in the global scale at the Stockholm convention. POPs are endocrine disrupters and persistent in the environment, having long half-lives in water, air, soil, sediments or biota. Because of their lipophilic nature, they tend to accumulate in higher trophic animals through food chains.

In terms of assessing the levels of contamination, the recovery on chemical analysis of POPs in environmental samples is very important because they residue especially low level as part per billion or trillion in aquatic environment. In order to increase precision and sensitivity for chemical analysis of POPs, high-resolution gas chromatography coupled with a high-resolution mass spectrometric detector (HRGC-HRMS) is highly required and used throughout the world. To understand the emission sources of these compounds, the concentrations and the specific compositional characteristics of POPs in the environmental samples can be employed.

Moreover, nitrogen and carbon stable isotope ratios ($\delta^{15}N$ and $\delta^{13}C$) have been widely used to assess the dynamics of organic matter in biogeochemistry and ecological study. From the isotopic viewpoint, $\delta^{13}C$ and $\delta^{15}N$ might be varied depending on environmental and their own conditions. Therefore, the variation of stable isotope ratios in the environmental samples might provide basic information to understand and predict their changing.

Here, organic substances that are emerging issue are mainly described, and also organic substances in the sediments, which causes surface, water the contribution or effect is described.

2. Causative materials for contamination of surface water

Waste water from industries such as iron and steel, electroplating, chemical, paper and pulp, textiles, food, pharmaceuticals and rubber, often drains into surface waters only after removal of materials of commercial value, e.g. metals and certain organic chemicals. Domes-tic sewage is discharged to rivers after removal of organic matter and some chemicals at sew-age treatment works. Levels of nitrates and phosphates in the effluents can still be very high, however, and these can have significant adverse effects on downstream aquatic ecosystems. Some components of domestic sewage are largely untreated, e.g. domestic synthetic detergents. These cause contamination and eutrophication of the receiving waters.

For example, when water is stored in lakes, marshes or reservoirs, it is likely to support increase of algae, some of which may produce undesirable by-products, giving unpleasant odor such as geosmin and 2-methylisobornenol or producing harmful effects on human health such as microcystins. Agricultural chemicals are directly and widely distributed into the environment. If they are physico-chemically stable, they become causative materials for ecological changes in rivers, lakes and marshes.

Recently, the following are noticed as emergent chemicals: Phthalate, endocrine disrupting chemicals (EDCs), persistent organic pollutants (POPs) and pharmaceuticals for humans and animal use.

3. Heavy metals

The pollution of the surface water by the heavy metals may become that industrial wastes such as metal plating, manufactures of pigments and paints, fungicides, the ceramic and glass industry and others are caused. From the metals in the surface water, there are Cd and Hg as a causing the health hazard to human. In Japan, chronic toxicity of cadmium named Itai-itai (Ouch-Ouch) disease, an osteomalacia with various grades of osteoporosis accompanied by severe renal tubular disease, and low-molecular-weight proteinuria have been reported among people living in contaminated areas around the Zintsu river basin. Humans can be exposed to cadmium via drinking water and foods from contaminated rivers polluted with the discharge of ore waste. A field survey found that the discharge of wastewater in a mine contained 4 mg L^{-1}, and river water 10 $\mu g\ L^{-1}$ of cadmium. In river sediment, 0.16-0.18 ppm of cadmium was detected upstream of the mine, and 4.1-23.8 ppm downstream. The daily intake of cadmium in the most heavily contaminated areas amounted to 600-2000 μg day^{-1}; in other less heavily contaminated areas, daily intakes of 100-390 μg day^{-1} have been found.

Mercury in wastewater produced by chemical plants was metabolized to the organic form (methyl mercury) which is by-products of acetaldehyde synthesis. Methyl mercury caused contamination of an enclosed marine basin where they were biologically accumulated in fish and shellfish. Consumption of these contaminated food resources caused serious Hunter-Lassel syndrome, particularly in the local fishing community. This disease became known as "Minamata Disease" after the name of the bay. Recently, mercury pollution in water has been reported around gold mining area such as the Amazon River basin in Brazil, Lake Victoria in Tanzania, Mindanao Island in the Philippines, Kalimantan Island in Indonesia, and Vietnam. The presence of mercury in water around gold mines is due to the use of mercury for producing Au-Hg amalgam. Gold particles such as gold dust collected from surface soil and river sediment in tropi-cal rain forests produce an amalgam when metal mercury 2-7 kg for every 1 kg of gold is added. Recovery the mercury in the amalgam by vaporization using a burner gives pure gold. The Vaporized mercury, however, pollutes the air and water. The results of a field survey found high concentrations of mercury in mud and sediments from polluted regions, and in fish living in polluted water.

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Biographical Sketch

Yun. S. Kim is a senior researcher in the water analysis and research center of K-water, Daejeon, Korea. He obtained his Bachelor`s Degree, Master`s Degree and Ph.D (Bioresource Sciences; Environmental Analysis Chemistry) from Nihon University, Japan. He has worked with persistent organic pollutants (POPs) such as, dioxins, PCBs and organochlorine pesticides in riverine and estuarine samples and their risk assessment in East Asia at the National Institute for Agro-Environmental Sciences and the Yokohama National University, Japan, respectively. He is interested in researching structure elucidation and the development of analysis methods for emerging organic compounds in environmental samples and their risk assessments.