論文の要旨

題目 A study on the environmental fate of organic pollutants adsorbed onto plastics

(プラスチックに吸着した有機汚染物質の環境運命に関する研究)

氏名 HASSAN MD NAZMUL

Plastic debris has become a serious issue because of its ubiquitous distribution in the environment. The plastic debris represents a potential hazard as a carrier of hydrophobic organic pollutants due to their adsorption ability of organic compounds. The fate of adsorbed organic pollutants on plastic surfaces would be affected by the plastic nature. In addition, contact of plastic debris with sediment after sedimentation results in the partitioning of the adsorbed organic pollutants into the sediment. The photodegradation process is a common environmental phenomenon both for plastics and organic pollutants. In this dissertation, photodegradation behaviors of hydrophobic organic pollutants affected by virgin and aged plastic natures were investigated. Furthermore, migration behaviors of hydrophobic organic pollutants adsorbed on plastics to sediments were studied.

This dissertation consists of six chapters of which the content is described briefly as follows:

Chapter 1 describes the background of this dissertation including the negative consequence of microplastics pollution and adsorption of hydrophobic organic pollutants. The papers related to the distribution of microplastics, adsorption of hydrophobic organic pollutants on floating microplastics, and the adverse effects on creatures were reviewed and the objectives and originalities of this dissertation were introduced.

Chapter 2 discusses the photodegradation behaviors of adsorbed 2,3,4,5-tetrachlorophenol (TeCP) and pentachlorophenol (PCP) on plastics and the effects of plastics. Polyethylene (PE) accelerated the photodegradation rate of PCP and TeCP, and the photodegradation rate constants on the PE surface were approximately 1.50 times higher than that on a glass surface. In contrast, the photodegradation of these organochlorine pollutants on polyethylene terephthalate (PET) and polyvinyl chloride (PVC) was slower than on the glass surface. Furthermore, photodegradation of PCP on the PVC surface was suspended after approximately 60 min of ultraviolet irradiation.

Chapter 3, describes the photodegradation behaviors of naphthacene as a model polycyclic aromatic hydrocarbon (PAH) on PE and glass surface to investigate whether PE with hydrogen donation potential could accelerate its photodegradation and or changes the photodegradation pathways. PE accelerated the photodegradation of naphthacene due to possible hydrogen donation. Although no change was observed for the photodegradation pathways of naphthacene, the apparent amount of the intermediates such as naphthacene quinone on PE was much higher than that on the glass. Because certain oxygenated polycyclic aromatic hydrocarbons demonstrate higher toxicity than their precursors, the result gives another indication that attention should be paid to the persistency of the toxic photodegradation intermediates should on plastics.

Chapter 4 discusses the effects of plastic aging on the photodegradation of 2,4,5-trichlorophenol (TriCP) on PE, PET, and PVC sheets. The photodegradation of TriCP on virgin PE sheet was accelerated whereas suppression occurred on the aged one. In addition, the aging of PET and PVC demonstrated stronger suppression on the photodegradation of TriCP than the virgin one. These results confirmed that plastic aging affects the photodegradation behaviors of TriCP adsorbed on plastic surfaces. The production of valleys and reduction of the plastic transparency by aging might be one of the causes for the suppressed photodegradation on the aged plastic sheets.

Chapter 5, describes the migration of adsorbed organochlorines such as TriCP and 1-chlorooctadecane from plastics to sediment. The results confirmed that the organochlorines adsorbed onto plastic were partitioned onto the sediment samples. In addition, migration was dependent on the combination of the organochlorines and plastics. From PE and PET, the migration rate of the aromatic organochlorine was higher than that of PVC. The result provided evidence that migration of organochlorines can be affected by environmental factors and dissolution via adsorption on sediment particles is a prominent pathway of migration.

Chapter 6, shows the general conclusions of all chapters and recommendations for future studies.