Study on the mechanism of soil and groundwater contamination by 1,4-Dioxane

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It is planned to implemented the Environmental Quality Standard (EQS) for soil pollution of 1,4-Dioxane (DXA) in Japan soon. DXA ($C_2H_8O_2$) has a density similar to that of water at room temperature and is a colorless and transparent liquid. It has a relatively low boiling point at 101℃, dissolves well in both water and oil, and belongs to the group of volatile organic compounds (VOC). Due to these characteristics DXA is a widely used solvent and was used in large amounts as stabilizer for 1,1,1-Trichloroethane (MC). It is assumed that DXA has a low affinity to adsorb on organic substances within the soil matrix, has a lower volatilization rate and is hence highly mobile. Therefore, it is likely that its soil and groundwater contamination mechanism is different compared to other VOC.

In this study, in order to understand the behavior characteristics of DXA in soil and groundwater, as well as soil and groundwater contamination mechanism, distribution experiments regarding DXA between solid-liquid phase and liquid-gas phase as well as three kinds of soil column experiments were conducted. Toyoura sand and organic soil were used for all experiments respectively. The results of these experiments about the behavior of DXA were compared to that of MC which often occurs together with DXA.

DXA was almost only present in pore water in the distribution experiments, and only a small amount adsorbed on soil particles or vaporizes into the gas phase. In case that MC was present as NAPL in water, the presence of MC phase did not affect the distribution of DXA.

Soil column experiments in order to understand the volatilization in unsaturated soil showed that DXA which vaporized from contaminated soil dissolves in soil water while spreading upwards through the soil gas, in case that DXA is present in the unsaturated soil. Therefore, the probability of DXA to spread until close to the soil surface through soil gas is low, and it was further shown the possibility that soil leachate values exceed the EQS for soil pollution in intermediate depths.

Further soil column experiments, in order to understand the infiltration properties during precipitation into the unsaturated soil, showed that DXA in the unsaturated zone will dissolve in infiltrating rain water and percolate with it; however, in case that rain water does not infiltrate into the unsaturated soil, the concentration of DXA remains high within the soil matrix. Hence it is likely that at places where rain water infiltration does not occur, such as under buildings, the concentration of DXA in the unsaturated soil remains high within the soil matrix and that DXA can be mobilized after demolition of buildings through infiltrating rain water until it reaches the aquifer where it may cause groundwater contamination.

In this research, DXA specific soil and groundwater contamination characteristics were examined by understanding the behavior characteristics of DXA in the unsaturated zone.

The content of this presentation was partly funded by the Environmental Research and Technology Development Fund (5-1503) of the Ministry of the Environment, Japan.

Keywords: 1,4-Dioxane, soil and groundwater contamination, contamination mechanism, unsaturated soil, soil column experiment

