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Effect of Nonionic-Surfactant on the Extraction of Inorganic and Organic Contaminants from Soil

Ilwon Ko[1*] · Cheol-Hyo Lee[1] · Ho-Jin Choi[2] · Yeol Ahn[2] · Jeong-Gyu Kim[3] · Kyoung-Woong Kim[4]

[1]*Environmental Research Center, OIKOS Co. Ltd., Room 1007, Daeryung Techno Town Building 8-Cha, 481-11, Gasan-dong, Geumcheon-gu, Seoul, 153-775, Korea*
[2]*Lab. of Soil Environment, Rural Research Institute, 1031-7, Sa-dong, Sangnok-gu, Ansan-si, Gyeonggi-do, 426-170, Korea*
[3] *Division of Environmental Sciences and Ecological Engineering, College of Life and Environmental Sciences, Korea University, 1, 5 Ga, Anam-dong, Sungbuk-gu, Seoul, 136-701, Korea*
[4]*Arsenic Geoenvironment Lab.(NRL), Department of Environmental Science and Engineering, Gwangju Institute of Science and Technology, 1, Oryong-dong, Puk-gu, Gwangju, 500-712, Korea*
e-mail: iwkoh@hotmail.com

ABSTRACT

Multiple contaminants have frequently evoked in the subsurface environment. The inorganic and organic contaminants have the difference of physical and chemical properties. In soil washing process, it is not easy to choose extractant for the simultaneous extraction of multiple contaminants. The time required for the extraction is related with the sorption of the contaminants with soil. The objective of this study was to determine the effect of nonionic surfactant on adsorption and desorption of inorganic and organic contaminants on soil. The specific aims were to investigate the desorption kinetics of contaminants and to determine their readsorption on soil and complexation with surfactant. Through the adsorption and desorption phenomenon, the extraction mechanism of the surfactant washing was suggested. The three types of contaminated soil was prepared with contaminants of (1) Pb, Ni, Zn and F, (2) hydrocarbon (HC), and (3) HC, Pb, Ni, Zn and F. Nonionic surfactant (Tween 80) as an extractant was chosen comparing with the acid washing (HCl).

The extraction of contaminants in three kinds of soils was extremely sluggish and the equilibrium of extraction of Pb, Ni, Zn and F might take over 1 hr and that of HC

reached within 30 min. The relationship between desorption rate (V = S / t) and desorption time can be described using the two-constant rate equation (ln V = A + B ln t), where S is desorption amount and A and B are constant. In this equation, B indicates that the smaller B is, the faster desorption rates drop. In all types of contaminated soil, B values of HC and F were smaller than those of Pb, Ni and Zn. It was found that the extraction rate of HC and F dropped faster than those of Pb, Ni and Zn. A relatively high r^2 value indicates that the model successfully describes the kinetics of chemical extraction. The kinetic models indicated that in surfactant washing, the two-constant rate equation was the best equation for all contaminants and Elovich equation and Parabolic diffusion equation was partially the best model for Pb. The three rate mechanisms provided a very high degree of correlation of the experimental sorption rate data suggesting either model could be used in design applications and the extraction of contaminants controlled by the diffusion processes. The sorption of inorganic contaminant occurs both in the form of free inorganic and in the form of surfactant complexed inorganics. In the presence of nonionic surfactant, the sorption of free inorganics was dominant. Decreasing solution pH from pH 6~7 to pH 2~3 increases the rate of the sorption of surfactant. Due to the presence of surfactant the rate of inorganic sorption also increases, while without surfactant it decreases with a decrease of solution pH. In the feasibility test of soil washing, the sequential washing (surfactant washing after acid washing or acid washing after surfactant washing) is more effective than the simultaneous washing (surfactant washing at pH 2). Therefore, the sequential washing using nonionic surfactant and acid is suitable for the enhanced removal of both inorganic and organic contaminants.

Key words: Soil washing, Surfactant, Hydrocarbon, Heavy metal, Anion, Sorption