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Bio-toxicity Assessment of PFOA and PFOS to Vibrio fischeri by Photomultiplier Tube

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Abstract. Bio-toxicity using luminescence of PFOA and PFOS was assessed by photomultiplier tube. The assessment was evaluated based on EC50 and transient profile in time with varying concentration of 0.0~250 mg/L in 6 steps. As a result, the toxicity was found out to be 150.3 and 237.7 in EC50 for PFOA and PFOS, respectively. Besides, the profiles depicted that PFOA is more toxic than PFOS.

Keywords: Bio-toxicity, Toxicity assessment, Vibrio fischeri, PFOA, PFOS

1 Introduction

Perfluorinated chemicals (PFCs) are widely used as surfactants since they reduce surface tension caused by the lipophobicity of fluorocarbons1. Among the common PFCs, the amounts of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) have been particularly increased for decades. PFOA is utilized as a surfactant to make fluoropolymers such as Teflon; whereas, PFOS is famous as a key ingredient of a fabric protector in Soctchgard, which is brand name of 3M Company. Being stable chemical or biodegradable attacker, PFOA and PFOS are issued as persistent organic pollutants (POPs), which could be hazardous to organisms, especially in water-base. The collective chemical and toxic characteristics of PFOA and PFOS are presented in Table 12. In domestic natural river system and the effluent from STP, PFOA and PFOS were detected in the range of 1.0~153 ng/L and 0.4~396 ng/L, respectively3, 4. Not only PFCs but also other pollutants, such as heavy metals and non-degradable chemicals were identified in the natural water system. These pollutants could act compositely on organisms as toxic synergism. Therefore, it is essential to conduct the basic study and quantitative assessment about the toxicity of PFOA and PFOS.

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Table 1. Chemical and Biological Characteristics of PFOA and PFOS

Characteristics		PFOA	PFOS
Cas No.		335-67-1	1763-23-1
M. W.		414.07	500.13
Bioaccumulation	BCF	56	56
	logKow	4.81	4.49
Toxicity	Fish ChV	1.3	3
	EC50	524	>500

In this study, assessment of the toxicity of PFOA and PFOS was performed using photomultiplier tube, PMT, by varying the concentrations. The PMT was set in module assay with sample cuvette cases(Fig. 1). Then, the toxicity was quantified by relative luminescence of Vibrio fischeri.

Fig. 1. Experimental device including PMT

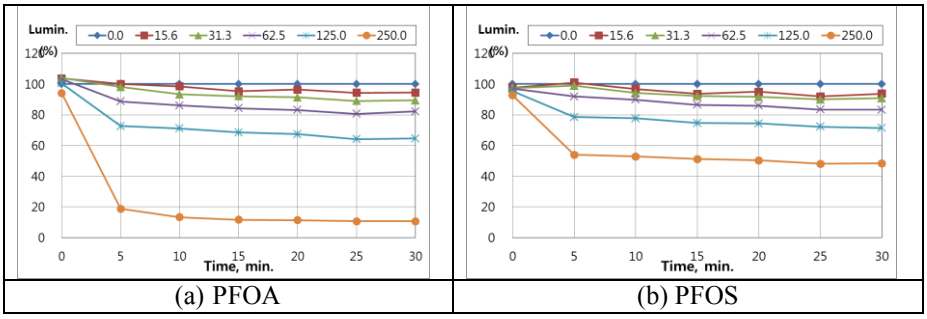
2 Methodology

After setting the temperature to 15˚C, the emulsion of luminescence bacteria was activated for 30 minutes. The specimen was V. fischeri as lyophilization. The standard concentrations of PFOA and PFOA test solution were determined in 6 steps of 0.0, 15.6, 31.3, 62.5, 125.0 and 250 mg/L for PFOA and PFOS. The PFCs were purchased from Sigma Aldrich and stoked as the concentrations. The mixed samples were set in the photomultiplier tube with sampling cuvette. The experiment assay was composed of temperature control block, cuvette case and optical sensing light as well as the above modules in a closed box. The assay was designed to operate 8 samples simultaneously in first set-up value. The analysis sensitivity was $3.0 \times 10\text{-}21$ in

Luciferase. The operation time was 30 minutes, in which the luminescence was detected in relative value (%) to blank one.

3 Results and Discussions

The values of relative luminescence based on concentration are depicted in Fig. 2. The slopes were found to be steep from 0~10 minutes, especially in the first 5 minutes. Varying the concentration, a sudden increase of the transient profiles appeared for 125.0 and 250.0 mg/L in both cases, more significantly in PFOA. The tested values of EC50 in this experiment were 150.3 and 237.7 for PFOA and PFOS, respectively. These are small compared to the literature values stated in Table 1.



(a) PFOA (b) PFOS

Fig. 2. Transient profiles for (a) PFOA and (b) PFOS.

The toxicity assessment for micro-pollutants should be quantified not just for one-factor, but for multi-effects with other compounds. And after proper treatments of the pollutants, the comparison of toxic effects should be established using evaluation tools.

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