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사염화규소 누출사고지점 주변 식물에 대한 노출지표 평가

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Evaluation of Exposure Indicators for Plants by Silicon Tetrachloride Release

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Received: 15 November 2017/ Revised: 21 November 2017/ Accepted: 23 November 2017

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Abstract

BACKGROUND: Silicon tetrachloride reacts with moisture in the atmosphere to generate hydrogen chloride, which affects the environment. Since silicon tetrachloride and its by-products are dispersed in the atmosphere in a short time after the silicon tetrachloride release into the atmosphere, it is difficult to directly assess the extent of environmental impact. In the present study, the exposure test of silicon tetrachloride or hydrogen chloride was examined in order to establish the criterion of the range affected by the silicon tetrachloride release, and the actual crops in the area exposed to silicon tetrachloride leakage were analyzed.

METHODS AND RESULTS: For the experiment of exposure to silicon tetrachloride or hydrogen chloride, the leaves of red-pepper and corn were used in glass sealed containers. In the actual accident area, 59 samples from 10 different kinds of crops were collected. The pretreatment of the sample was performed by freezing and grinding, and then extracted using distilled water. The pH and concentration of chloride (Cl⁻) ion of the extracted solution were measured using pH

meter and ion chromatograph, respectively.

CONCLUSION: Exposure to silicon tetrachloride caused visible damage, increasing the concentration of chloride ion, and decreasing the pH as well as hydrochloric acid. In the actual crops of the affected area, the tendency was the same as the result of the laboratory test, and the range of influence could be estimated through the concentration of Cl⁻ ion over 2,000 mg/kg, and the correlation evaluation between the concentration of Cl⁻ and pH. Therefore, the concentration of Cl⁻ ion and the correlation between Cl⁻ and pH would be considered as the factors to estimate the influence range of silicon tetrachloride release.

Key words: Chemical release, Environmental impact, Environmental pollutant, Hydrogen chloride, Silicon tetrachloride

서론

2015

(SiCl_4) 108 kg
(27,000 m²)

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가 2.865 mL, 8.2 mL
 69.4°C, 57.3°C, pH
 (Lewis, R. J., 1996; Simmler, 2000; Jianwen *et al.*, 2015).
 (ferrosilicon) 가
 가 (Simmler, 2000; Park *et al.*, 2013).
 (solar cell) 가
 가 (Kapias *et al.*, 2001).

$$SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$$

 (National Research Council, 1998, 2009).
 가 (Jianwen *et al.*, 2015).

사고지역 시료 채취

2.6 km
 5 가 가
 10 59 (24, 7, 7,
 6, 3, 3, 2, 5, 1, 1)
 PE(Poly ethylene)
 4°C

시료 전처리 및 분석 방법

가
 pH
 0.5 g 20 mL 10
 , 0.2 μm cellulose acetate
 pH 5 mL
 pH (, S220)
 (, ICS 3000)

결과 및 고찰

사염화규소/염산 노출에 의한 식물의 가시적 피해증상

(Fig. 1, 2).

가 가
 가 Mg²⁺ H⁺
 가 가

재료 및 방법

노출 실험

가
 (37% hydrochloric acid)
 (18.5 L) , 90
 가 (Cl)

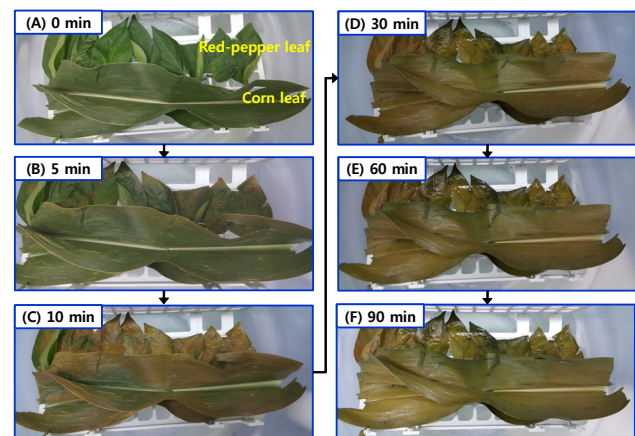


Fig. 1. The change of visible damage of crop over time after SiCl₄ exposure. Reaction time: (A) 0 min, (B) 5 min, (C) 10 min, (D) 30 min, (E) 60 min, (F) 90 min.

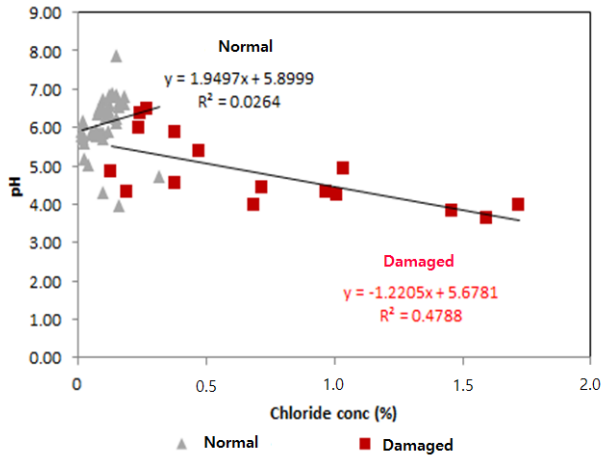


Fig. 5. The correlation between the concentration of chloride ion and pH in the accidental area.

피해지역 농작물의 염소이온 농도 및 pH

10 59
 , 가
 7,207 mg/kg(2,405~17,212 mg/kg) , 가
 1,025 mg/kg(143~3,182 mg/kg)
 가 가
 7 (Fig. 4(A)).
 Cl⁻ 가 3,000~3,500 mg/kg

(Ayers and Westcot, 1985; Marschner, 1995).

pH 4.80(3.62~6.44) , pH
 6.10(3.94~7.88) pH가
 (Fig. 4(B)). Hindawi(1968) 가
 가

가 , 3
 (2 , 1)
 가

pH , 가
 Cl⁻ pH (y=-1.2205x
 +5.6781, R²=0.4788) (16)
 가 pH가
 (Fig. 5).
 가 (R²=0.0264), 가
 가

가 2,000
 mg/kg , pH
 59 16 ,
 800 m .

1) Cl⁻ 가 2,000 mg/kg , 2)Cl⁻ / pH

결론

가
 가 , pH가

가

가 pH
 가

2,000 mg/kg , Cl⁻ pH 가
 가 pH가

Notes

The author declare no conflict of interest.

Acknowledgement

This work was supported by the National Institute of Environmental Research R&D (1900-1946-303-210-13) of Korea government (NIER).

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