The effects of Sodium Thiosulfate on Metal Toxicity in Wastewater

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Background

Chlorine used for disinfection in a water treatment plant is very toxic to aquatic organisms (Karr, 1985; Stewart, 1996) Therefore, U S Environmental Protection Agency (US EPA) recommends that residual chlorine (RC) in the test water (i.e , effluent or receiving water) be measured and dechlorinated using 6 7 mg/L anhydrous sodium thiosulfate (ST) to reduce 1 mg/L chlorine. However, addition of the dechlorinating agent may eliminate the acute toxicity of effluent samples since stable complexes with several cationic metals could be formed (Hockett and Mount, 1996) Potential modification of toxicity in wastewater samples when dechlorinated with ST was seldom investigated

This study was performed to evaluate the effect of ST in wastewater sample on metal toxicity when applied to reduce RC

Method

Test organisms were <24 h old *Daphnia magna (D magna)* neonates obtained from clone, cultured and maintained in our laboratory since 2003 All aspects of the culture, maintenance, and quality assurance and control of the test organisms were performed according to US EPA guidelines (2002) Four metals were used for tests; Cd^{2+} ($CdCl_2 \cdot 5H_2O$), Cu^{2+} ($CuSO_4 \cdot H_2O$), Ni^{2+} ($NiCl_2 \cdot 6H_2O$) and Zn^{2+} ($ZnCl_2$) The modified ST addition test was conducted by the general method described by US EPA (Mount and Carnahan, 1998) The water samples (40 mL) containing 1 mg/L RC and median effective concentration (EC_{50}) of each metal were prepared, and treated with ST stock solution to establish five concentration of ST (3.7, 4.7, 5 7, 6 7 and 7.7 mg/L) *D. magna* was exposed to the test solution and measured for mortality after 24 and 48 h of exposure. For baseline toxicity test, we conducted RC only toxicity test and metal plus ST toxicity test

Result

The acute toxicity tests were performed for determining the 24 and 48 h EC_{50} for *D magna* against

metals and RC EC_{50} values of each chemical are shown in Table 1 In addition, EC_{50} value of RC was 0 13 mg/L (data not shown)

Table 1 Acute *D magna* toxicity (48 hr EC_{50}) of copper, nickel, cadmium and zinc

Metal	*D magna* EC_{50} of 48 h exposure (mg/L)
Cd	0 18
Cu	0 02
Ni	10
Zn	1

Table 2. Survival of *D. magna* after the 48 h exposure to the mixture of 1 mg/L RC, EC_{50} and varying ST levels

Test Number	Treatments	ST (mg/L)	Survival of *D magna* (%)				
			3 7	4 7	5 7	6 7	7 7
1	ST+RC		80 (52-108)	95 (85-105)	100	100	100
2	Cd+ST		70 (50-90)	80 (64-96)	85 (73-97)	75 (65-85)	50 (38-62)
3	Cd+ST+RC		65 (46-84)	80 (96-64)	80 (57-103)	75 (65-85)	90 (78-102)
4	Cu+ST		95 (85-105)	100	75 (50-100)	100	100
5	Cu+ST+RC		55 (36-74)	70 (44-96)	85 (75-95)	95 (85-105)	100
6	Ni+ST		95 (85-105)	95 (85-105)	80 (64-96)	80 (64-96)	75 (56-94)
7	Ni+ST+RC		45 (25-65)	70 (50-90)	75 (51-89)	60 (48-72)	85 (65-105)
8	Zn+ST		85 (66-104)	60	50 (38-62)	45 (35-55)	60 (44-76)
9	Zn+ST+RC		15 (5-25)	30 (10-50)	15 (5-25)	20 (4-36)	30 (18-42)

95% confidence intervals are shown in brackets

Table 2 summarized the results from ST addition to RC that the toxicity of 1 mg/L RC appeared to be completely removed with 5 7 mg/L ST (Table 2, Test Number 1) When ST was added to metal only samples, generally grater than 50 % survival was observed in all cases (Table 2, Test Number 2, 4, 6, 8) As well, Table 2 shows the percent survivals of ST and RC addition to EC_{50} concentration of each metal (Table 2, Test Number 3, 5, 7, 9) It shows that ST can reduce the toxicity of metal when ST and RC addition to EC_{50} of Cd, Cu, and Ni with the exception of Zn, Survival was 75% for Cd in the presence of 6 7 mg/L of ST and 1 mg/L of RC, 95% for Cu, 60% for Ni, and 20% of Zn (Table 2, Test Number 3, 5, 7, 9), which is no significant effect on survival was noted in any of the other tested ST concentrations

Discussion

The results obtained in this study of ST plus metal treatment show that the toxicity was decreased except only Zn. Although dose dependent pattern of metal toxicity reduction was not evident, this observation suggests that ST may bind with metals to reduce metal toxicity This finding is in good agreement with previous reports that formation of stable complexes with Cd, Cu, and Ni (Hockett and Mount, 1996). In the same study, ST did not reduce the toxicity of Zn (Table 2, Test Number 8) This observation may be in part explained by the previous report that Zn did not bind with ST (Hockett and Mount, 1996) The results of this study demonstrate that the toxicity of metal containing wastewater is affected when ST is applied to treat RC in the sample. We found that the *D magna* survival was more than 70 % when 4.7 mg/L ST was applied. It should be noted that this amount is 70 % of the recommended amount of the RC quencher.

Therefore we may suggest that the recommend value (6 7 mg/l) of ST to reduce 1 mg/L chlorine by US EPA may not be appropriate value because the use of ST in effluent sample may affect to the toxicity of some metals. In addition, more research would be required to determine the effects of ST on other metals and other freshwater species. Alternative dechlorinating procedure should also be looked into

Reference

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