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Effects of Anions and Anion Mixtures on the Reproduction of Ceriodaphnia dubia

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Municipal and industrial effluents often fail chronic toxicity tests due to elevated levels of osmotic or ionic strength. However, there is significant variability in the toxicity of effluents ranging from 0.1 to 1 part per thousand total dissolved solids (TDS) attributable to the effects of the individual anions (chloride, sulfate and bicarbonate) and their interactions. Manipulation of the anion concentrations in effluents has the potential to reduce toxicity. Three-brood, 7-d toxicity tests with C. dubia were conducted on serial dilutions of chloride (Cl-), sulfate (SO4-2) and bicarbonate (HCO3-) and solutions containing mixtures of Cl- (3, 193, 243, 340 mg/L), SO4-2 (38, 308, 367, 496 mg/L) and HCO3- (115, 238, 336, 486 mg/L) prepared in deionized water reconstituted to 40 mg/L hardness and 100 mg/L alkalinity. Tests were conducted using Whole Effluent Toxicity testing procedures, repeated three times and accompanied by KCl reference toxicant tests. IC50 values for Cl-, SO4-2 and HCO3- averaged 637 mg/L, 780 mg/L, and 767 mg/L (alkalinity of 629 mg/L as CaCO3), respectively. These toxic concentrations are often exceeded in effluents. In the tested mixtures, the IC50 value for TDS was determined to be 1184 mg/L (29.7 mM/L), with an IC25 value of 787 mg/L (19.7 mM/L). Differences in TDS accounted for about 80% of the variability in average reproduction among the tested solutions. Across the range of TDS represented by the 64 mixture solutions and within the range of tolerable TDS (< IC50 value), reproduction increased as the ratio of SO4-2 to Cl- increased. However, reproduction decreased as the ratio of HCO3- to Cl- increased. Information from these tests was used to develop multivariate models using the solution-strength variables (TDS and ionic strength) with the SO4-2:Cl- ratio and the HCO3-:Cl- ratio to predict C. dubia reproduction in slightly-saline solutions. The models produced can be used to evaluate the potential toxicity of effluents and to suggest substitutions that may reduce their toxicity.