No. 0621

Development of Novel Monitoring System for Trace Boric Acid in RO Desalting Water

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Summary

Desalination is an important and rapidly growing source of drinking water in the world originating from sea water. One of the principal desalination technologies in use is reverse osmosis (RO). The mechanisms of salts removal by RO membranes are not fully understood and some elements are not removed with high efficiency. Boron is one of them. The boric acid concentration in sea water is 4.6 mg B dm^{-3} and the tolerable upper concentration in drinking water is limited up to 1.0 mg B dm^{-3}. Therefore a sensitive, practical boron analysis method using low-cost instrumentation has been desired on a site-by-site basis. To develop novel analytical methods for monitoring the concentration of boric acid in water produced by RO treatment of sea water, two kinds of methods using HPLC and voltammetry have been examined.

A novel method of on-line absorptiometric determination for trace amounts of boron was developed based on the complexation with chromotropic acid presorbed on an anion-exchange column (TSK gel IC-Anion-PW). On-line reaction and separation were achieved by controlling pH conditions in solutions to accelerate the 1 : 2 complex formation. The stepwise backflush method for elution of the free ligand and the complex with $NaClO_4$ solutions was effective to make the operation time shorter (for about 15 min a sample). The reproducibility of measurements using 2 cm^3 sample solution containing 0.10 mg B dm^{-3} was within 0.3 % RSD (n = 3).

Although boric acid is electrochemically inert, a boric acid-Tiron complex was found to be electrochemically active. The oxidation potential was observed at 500 mV for free ligand and at 900 mV for the complex. On the basis of the equilibrium and kinetic consideration, the active chemical species at pH 7 was ascribed to the 1 : 1 complex. By using differetial pulse voltammetry in the range of 800 to 1,200 mV, the peak current for the 1 : 1 complex oxidation was proportional to the boric acid concentration and the detection limit was 0.3 mg B dm^{-3}.

Thus, the newly developed two methods can be applicable to the monitoring ststem of boron at idividual RO desalination plants.