

Estimation of CTAB in water by ion chromatography

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Abstract

Surfactants are used in cooling water systems to keep the precipitating chemicals in dispersed condition and thus to deter the scale formation. The choice of using cationic or anionic surfactant as dispersants depends on the chemical nature of the raw water. At the same time, estimation of surfactants at trace level has always been a challenge. In the present study, Cetyl trimethyl ammonium bromide (CTAB), a cationic surfactant, is estimated at ppm level using high pressure ion chromatography in water medium. The CTAB is estimated here in raw water, domestic waste water and cooling water.

Keywords: Surfactants, dispersants, CTAB, high pressure ion chromatography.

Introduction

The service water/cooling water of fast breeder test reactor (FBTR) at Kalpakkam is treated with proprietary chemicals to minimize the corrosion and deposition in the system. Surfactants are used in cooling water to prevent the suspended solids and dissolved chemicals from settling/scale forming in the system. Surfactant based chemicals are also used as biocides to control the microbial population in the cooling water. CTAB, a cationic surfactant is used in the manufacture of soaps, detergents and cleaning agents. Recently a study has been initiated in our laboratory to find out the efficacy of cationic surfactants like CTAB and DDAB (dodecyl dimethyl ammonium bromide) as inorganic dispersants in cooling water. However, synthetic surfactants are very slow biodegrades in the environment and have been implicated in chronic health problems; especially these are toxic to the aquatic organisms (Abd-Allah Aly & Tarek, 1998; Garcia *et al.*, 1999). Considering the low biodegradability and ecotoxicity of surfactants, it is important to monitor its concentration in the water bodies. Cationic surfactants are determined by spectrophotometric, titrimetric and gravimetric methods (Ross, 1970). A molecule of CTAB ($C_{16}H_{33}(CH_3)_3NBr$) dissociates into CTA^+ and Br^- . Therefore an indirect method of cationic surfactant determination by using bromide ion selective electrodes has been tried earlier (Ross, 1983). In the present study, we assessed CTAB in water by estimating the bromide ion using an ion chromatograph.

Experimental

All reagents were prepared in deionized water (18M Ω cm water obtained from milli-Q system (Millipore, Academic)). Standard solutions were prepared for chloride, bromide and sulphate by using ion chromatography standard (AcculonTM reference standard). The standard solution of CTAB was prepared by dissolving required amount of CTAB (AR spectrochem) in distilled water. In some cases, the samples were prepared by diluting the raw/cooling/domestic water with distilled water and then

the required amount of analyte was added. The 10% raw water was prepared by diluting raw water 10 times with distilled water. The dilution was necessary to avoid excessive ionic loading of analytical column. 1.7 mM sodium hydrogen carbonate + 1.8 mM sodium carbonate was prepared by using ACS reagent (Fluka) and used as eluent with a flow rate of 1 ml/min.

The ion chromatographic system used was a Dionex 2000i model consisting of analytical pump, IonPac AG4A-SC guard column and IonPac AS4A-SC analytical column, self regenerating suppressor (ASRS) and conductivity detector (CDM-2).

Results and discussion

Fig.1 shows the chromatograms of chloride, bromide and sulphate standards (1 ppm each, A), 10% raw water (B), 1 ppm bromide in 10% raw water (C) and 2 ppm CTAB in 10% raw water (D). In case of B, C and D, the raw water was first 10 times diluted with distilled water and subsequently required amount of analyte was added to this diluted raw water. The dilution of raw water was necessary due to high concentration of chloride and sulphate in it. The chromatogram A shows the chloride (1), bromide (2) and sulphate (3) peaks recorded for the standard containing 1 ppm each of chloride, bromide and sulphate. The individual peak positions and their retention times were verified by recording the same for individual anions. No peaks were seen when a chromatogram (not shown) was recorded for the distilled water indicating absence of ionic species in it. In the chromatogram B, no signal for bromide was seen in case of 10% raw water. However chromatogram C exhibits clear signal for the presence of 1 ppm bromide (spiked) in 10% raw water. The chromatograms recorded for 2 ppm CTAB in 10% raw water and 20 ppm CTAB in raw water are shown in Fig.1D and 2A respectively. In case of Fig. 2A, 20 ppm of CTAB was prepared in raw water to begin with and subsequently, the entire solution was diluted 10 times. In both these cases, the signals for bromide are comparable but the CTAB concentration as well as the medium was different as mentioned above. Bromide peak could not be seen in case of less than 20 ppm CTAB in raw water

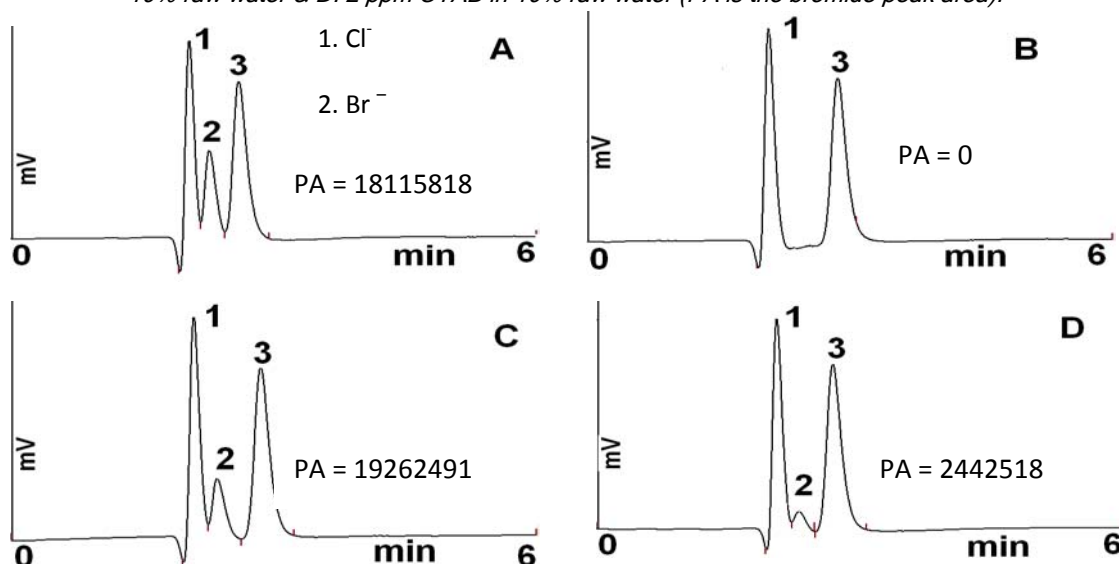
(chromatogram not shown) as probably it was merged under the chloride and sulphate peaks due to high concentrations of these two species in raw water. Therefore, the minimum detection limit for bromide, in turn CTAB in raw water is 20 ppm unless there is no other source for bromide in raw water which is the case usually. When a chromatogram for raw water without spiking CTAB in it was recorded, no bromide peak was seen indicating absence of bromide at this concentration.

The domestic waste water from the township was also analysed for CTAB as this surfactant is used in the manufacture of soaps, detergents, cosmetic and cleaning agents. Fig. 2B shows the chromatogram for 80 ppm CTAB in domestic water waste and below this concentration of CTAB, the bromide peak was not visible in this matrix due to higher concentration of chloride and sulphate in domestic waste water compared to raw water. In case of domestic water, the 80 ppm of CTAB was prepared in domestic water and then the entire solution was diluted 40 times. Similarly, the minimum detection limit for CTAB in cooling water of FBTR is 200 ppm (Fig. 2C) due to very high concentration of chloride and sulphate in cooling water system. In case of cooling water, the 200 ppm of CTAB was prepared in cooling water followed by 100 times dilution. The addition of biocides (with a high chloride content) and chlorination of the cooling water increases the chloride concentration. Similarly, the addition of sulfuric acid in the cooling water increases the sulphate concentration in cooling water resulting in the higher minimum detection limit of bromide/CTAB.

Conclusion

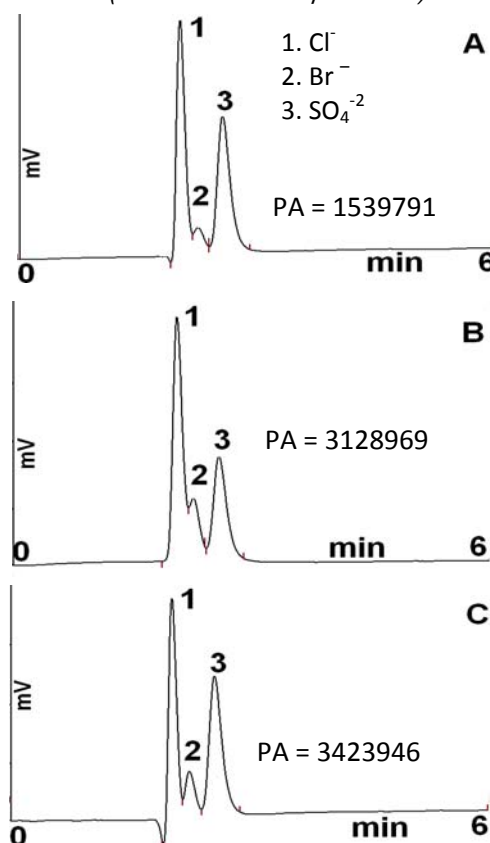
Cationic surfactants like CTAB (with bromide as counter ion) in

Fig. 1. A. 1 ppm standard solution of Cl^- , Br^- & SO_4^{2-} , B. 10% raw water, C. 1 ppm of Br^- in 10% raw water & D. 2 ppm CTAB in 10% raw water (PA is the bromide peak area).



water can be estimated by monitoring the concentration of bromide ion using ion chromatography. In the present study, the minimum detection limit for CTAB was 2 ppm in deionized water. However, the minimum detection limit

Fig. 2. A. 20 ppm CTAB in raw water, B. 80 ppm CTAB in domestic waste water & C. 200 ppm CTAB in cooling water of FBTR (PA is the bromide peak area).



for CTAB in raw water, domestic waste water and cooling water were observed to be 20, 80 and 200 ppm respectively. The higher minimum detection limit was due to the presence of higher chloride and sulphate content. The domestic waste and cooling water were found to be free from CTAB with respect to their minimum detection limits.

References

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