Monitoring natural organic matter and disinfection by-products at different stages in two South African water treatment plants

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Abstract

Natural organic matter (NOM) is a complex organic material present in natural surface water. NOM can cause problems during water treatment – most notably the formation of toxic disinfection by-products. This study was undertaken in order to assess the effectiveness of some of the water treatment techniques employed by selected water supply companies in South Africa in dealing with NOM. Total organic carbon (TOC) and ultra violet (UV) absorbance at wavelength of 254 nm were measured and used to calculate specific ultra violet absorbance (SUVA), which was used to determine the changes in NOM concentration throughout the water treatment train. Other parameters measured include pH, turbidity, chemical oxygen demand (COD) and conductivity. Water samples were collected from two water treatment plants in South Africa, namely Sedibeng (Balkfontein) and Midvaal. The overall TOC reduction after the water treatment processes was 33% and 30% at Midvaal and Sedibeng, respectively. SUVA values were generally low (<2 $\ell \cdot mg^{-1} \cdot m^{-1}$) indicating the presence of aliphatic compounds and less 'aromaticity' in NOM of the water samples. Water insoluble β-cyclodextrin (β-CD) polyurethanes were then applied to the water to compare TOC reduction in addition to 'normal' water treatment processes, and were found to provide up to 19% additional TOC decrease, and UV absorbance reduction was up to 78%. Results obtained using gas chromatography-mass spectrometry (GC-MS) analysis after chlorination, revealed that the water had the potential to form halomethane compounds with chloroform being the most dominant. Again, water-insoluble β-CD polyurethanes were applied to the water as a treatment to remove trihalomethanes (THMs) and were found to efficiently remove up to 95% of THMs formed during the disinfection step. The treatment processes studied have limited ability in dealing with NOM and are not individually effective in NOM removal. Results obtained indicate that the application of β-CD polyurethanes in addition to the water treatment processes may enhance NOM removal in water and significantly reduce the THMs formed.

Keywords: β-cyclodextrin polyurethanes, natural organic matter, total organic carbon