

The interaction of ozone with natural organic matter (NOM) in Australian drinking water Treatment and its effect on the formation of bromate and assimilable organic carbon (AOC)

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SUMMARY

The aim of this study was to analyse the interaction of natural organic matter (NOM) with the disinfectant ozone and the influence these interactions have on bromate formation and the production of assimilable organic carbon (AOC) in Australian drinking waters.

In order to achieve this, four local source waters (Hope Valley Reservoir, Myponga Reservoir and Warren Reservoir and Lake Wallace) were selected based on the variability of their raw water characteristics. Ozonation experiments on all four waters revealed that, even at low ozone / DOC ratios, bromate formed in levels above current regulatory guideline values. Previously developed bromate formation prediction models based on (overseas) raw water quality characteristics were assessed and found generally not to be applicable to the prediction of bromate in Australian drinking waters.

The NOM from two of these raw waters (Myponga and Lake Wallace) was first concentrated via reverse osmosis and then fractionated according to molecular weight (using ultrafiltration) and character (using ion exchange resins). This resulted in the production of eight distinct isolates derived from each source water. Analysis of the structural makeup of each fraction by techniques such as ¹³C-NMR, UV spectroscopy and HPSEC revealed significant differences in character and structure of each NOM isolate.

Ozonation of these fractions under identical conditions showed that the amount of bromate formed was dependent on the individual fraction and, more importantly, on the structural characteristics of that particular isolate. Kinetic studies revealed an apparent relationship between ozone decomposition and the formation of bromate. Analysis of these data using the previously developed "bromate yield" concept revealed the existence of a bromate formation threshold value for each NOM isolate, ozone being consumed readily upon addition to the sample before bromate begins to form. Once the ozone threshold has been met, bromate (per unit of consumed ozone) forms at a rate dependent on the characteristics of each fraction. Analysis using the "ozone exposure" concept confirmed this trend.

Research into the dominant mechanism of bromate formation revealed that the response of each fraction was dependent on whether the formation mechanism was dominated by direct oxidation (via the molecular ozone mechanism) or indirect oxidation (via the hydroxyl radical mechanism).

A study of 30 randomly selected bottled waters for disinfection by-products (DBPs) found that bromate was present in 12, with all being above guideline levels, some significantly so, posing a possible health concern. THMs were detected in 18 samples but in all cases were present at low concentrations.

An investigation into the influence each NOM isolate has on the formation of assimilable organic carbon (AOC) through the analysis of bacterial regrowth potential (BRP) values revealed that certain fractions may be contributing more to the BRP of the raw water and that the effects are dependent on the character of the NOM in the water. If the more biodegradable fractions can be preferentially removed after ozonation, problems caused by the formation of ozonation by-products will be reduced.'