

## Abstract

Natural eutrophic water samples collected from Te-Chi Reservoir in central Taiwan are treated with ozonated. The contents of organic matters collected from the samples were classified into humic acids (24.3%), fulvic acids (7.9%), hydrophobic neutrals (2.2%), hydrophobic bases (25.2%) and hydrophilic fractions (40.4%) by using XAD-8 resins. Their disinfection by-product formation potentials were investigated. Some species of natural organic matters (NOMs), e.g. humic acids and their related substances are easy to form carcinogenic or mutagenic by-products when the water is treated with chlorine-contained chemicals. The concentrations of NOMs species in water are difficult to quantify, and are often measured via their formation of cancer-causing potentials such as Trihalomethane Formation Potential (THMFP) and Haloacetic Acid Formation Potential (HAAFP) after the water being treated with chlorine or ozonation.

The raw water of Te-Chi Reservoir and the humic acids extracted were ozonated for study. The on-line data of oxidation reduction potential (ORP), dissolved ozone ( $\text{DO}_3$ ) and pH were collected by using an oscilloscope and the on-line absorbance at 254 nm ( $A_{254}$ ) value was obtained from a UV spectrophotometer (Carry50). The content of OH radical was measured successfully by using HPLC (high performance liquid

chromatography) in the presence of coumarin. Those data are used to interpret the ozone decomposition mechanisms. Moreover, these data [ORP (Oxidation reduction potential), DO<sub>3</sub> (dissolved ozone), pH, OH radical and A<sub>254</sub> (Absorbance at 254 nm)] could be used to develop an additional Nernst model in ozonation.

According to <sup>13</sup>C NMR (<sup>13</sup>C nuclear magnetic resonance) and FTIR (Fourier-Transform infrared spectrophotometer) spectra, the changes of functional groups during ozonation and ozonation with scavenger were examined. Most of the peaks in every different carbon functional group, were decreased after ozonation.

Keywords: Humic acids, NOMs, THMFP, HAAFP, Ozonation, ORP, DO<sub>3</sub>,

A<sub>254</sub>, HPLC, FTIR, <sup>13</sup>C NMR

## 摘要

本研究主要是探討自中台灣德基水庫所採集的優養化水體，通入臭氧後所進行的反應分析。藉由採集來的水庫原水可經由 XAD-8 樹脂分類成(在優養化水體所佔的比例)：腐質酸(24.3%)、黃酸(7.9%)、疏水性中性物質(2.2%)、疏水性鹼性物質(25.2%)以及親水性物質(40.4%)。另外，再各別分析其消毒副產物生成潛能。某些天然有機物質(例如：腐質酸及其衍生物質)經由氯氣的消毒之後，容易產生致癌性物質或具突變因子的副產物，因其具有較多之芳香族結構和不飽和碳之化學鍵結，結構較不穩定，有利於氯的反應生成鹵化有機物質；此外，由於天然有機物質的濃度在水中很難去定量之，因此常經由致癌性生成潛能的形成來測量，例如：三鹵甲烷和鹵化乙酸生成潛能(經過氯氣或臭氧消毒程序所生成的物質)。

德基水庫的原水和其被分離出來的腐質酸，是本研究臭氧反應主要的研究對象。利用示波儀來收集氧化還原電位、溶在水中臭氧濃度以及酸鹼度的即時資料，並藉由可迅速擷取大量資料的紫外光分光光度儀(Carry50)來分析在 254 毫微米波長下的光吸收度。此外，臭氧反應中的氫氧自由基量的分析，可經由液相層析儀配合香豆素(coumarin)獲

知。上述資料皆可用來說明臭氧反應的機制。同時，利用這些資料（氧化還原電位、溶在水中臭氧濃度、酸鹼度以及 254 毫微米波長的光吸收度）來建立在臭氧反應中的模擬 Nernst 方程式。

根據碳 13 核磁共振光譜儀以及傅立葉轉換紅外線分光光譜儀的圖譜分析，可幫助了解水庫水體官能基分布特性經過臭氧直接間接反應和臭氧直接反應後的變化。分析結果可明顯地發現在各個官能基中，大部分皆會因臭氧反應而有減少的趨勢。

關鍵字：腐植酸、香豆素(coumarin)、模擬 Nernst 方程式、碳 13 核磁共振光譜儀、傅立葉轉換紅外線分光光譜儀