# 摘　要

本研究利用人工製備磁性過氟辛酸鋁(magnetic perfluorooctylalumina, MPFOA)結合臭氧反應處理德基水庫原水，以探討磁性催化劑製備情形與處理原水反應機制和處理後水中有機物質之官能基分佈情形。

本研究採集中台灣地區德基水庫之飲用水水源為探討之水體，藉由 XAD-8 樹脂分離出五種天然有機物質，水中有機物分離成腐植酸(29.5 %)、黃酸(19.5 %)、疏水性中性物(37.9 %)、疏水性鹼性物(2.9 %)以及親水性物質(10.2 %)等五種有機物。

製備磁性催化劑(MPFOA)之特性可利用掃描式電子顯微鏡/能量分散光譜儀(SEM/EDS)、超導量子干涉磁量儀(SQUID)、X光單晶繞射儀(XRD)以及傅利葉轉換紅外線光譜(FTIR)來鑑定。 MPFOA具有吸附臭氧及有機物的能力，亦可增加臭氧在水中的溶解度及穩定度，故在臭氧化過程中添加MPFOA可提高臭氧對有機物質破壞之效率。在整個臭氧反應中皆利用即時監測偵測氧化還原電位(ORP)、水中溶臭氧($DO_3$)及pH即時數據資料，以供來討論臭氧反應機制並建立臭氧與添加催化劑反應之模擬Nernst方程式。

根據傅立葉轉換紅外線分光光譜儀和碳-13 核磁共振光譜儀來探討原水經由臭氧反應與添加 MPFOA 後之官能基變化情形。本研究分

析結果發現水中部份官能基因臭氧添加 MPFOA 反應後而被破壞，有

提昇臭氧反應性之趨勢。

關鍵字：磁性過氟辛酸鋁、催化劑、天然有機物質、臭氧、傅立葉轉換紅外線分光光譜儀、碳-13 核磁共振光譜儀

# Abstract

This study the magnetic perfluorooctylalumina (MPFOA) is used to enhance the efficiency of ozonation on the treatment of the eutrophic raw water of Te-Chi Reservoir. The investigation includes the preparation of the magnetic catalyst, miasmic study on the ozonation of the raw water and the variation of functional groups upon the ozonation.

The water samples were collected from Te-Chi Reservoir which provides major domestic water supply in metropolitan central of the Taiwan area. The organic contents of water samples were extracted and classified into humic acids (HAs, 29.5 %), fulvic acids (FAs, 19.5 %), hydrophobic neutrals (37.9 %), hydrophobic bases (2.9 %) and hydrophilic fractions (10.2 %) by using of XAD-8 resins.

The characteristics of MPFOA can be identified by the scanning electron microscopy with energy dispersive spectroscopy (SEM/EDS), Superconducting quantum interference device (SQUID), X-ray powder diffraction (XRD) and Fourier-transform infrared spectrophotometer (FTIR). MPFOA has the more ability to adsorb ozone and organic matters, and furthermore to increase the ozone dissolving rate and stability. Therefore, the ozonation with MPFOA can raise the decomposition efficiency of toward to organic matters. During ozonation process, the ORP, $DO_3$, and pH values were monitored and

connected to an on-line oscilloscope to investigate the ozonation mechanisms. The data also used to establish the Nernst equation and simulate the possible ozonation mechanisms the presence of catalyst.

The profile of functional groups during the ozonation was examined by both FTIR and $^{13}C$ NMR spectra. The variation of functional groups can represent the destruction by ozonation and ozonation with MPFOA in this study.

*Keywords:* magnetic perfluorooctylalumina (MPFOA), catalyst, NOMs, ozonation, FTIR, $^{13}C$ NMR

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# Nomenclatures

| | | |
|---|---|---|
| $^{13}C$-NMR | $^{13}C$ nuclear magnetic resonance | 碳-13 核磁共振光譜儀 |
| $A_{254}$ | Absorbance at 254 nm | 254 nm 波長之吸光度 |
| AOP | Advanced oxidation process | 高級氧化法 |
| COD | Chemical oxygen demand | 化學需氧量 |
| DO | Dissolved oxygen | 溶氧 |
| $DO_3$ | Dissolved ozone | 溶臭氧 |
| DOC | Dissolved organic carbon | 溶解有機碳 |
| FAs | Fulvic acids | 黃酸 |
| FTIR | Fourier transform infrared spectrophotometer | 傅利葉轉換紅外線光譜儀 |
| HAs | Humic acids | 腐植酸 |
| HPLC | High performance liquid chromatography | 高效率液相層析儀 |
| MPFOA | Magnetic perfluorooctylalumina | 磁性過氟辛酸鋁 |
| NOMs | Natural organic matters | 天然有機物質 |
| OH radical | Hydroxyl radical | 氫氧自由基 |
| ORP | Oxidation reduction potential | 氧化還原電位 |
| SUVA | Specific ultra-violet absorbance | 比紫外光吸光度 |
| SEM/EDS | Scanning electron microscopy with energy dispersive spectroscopy | 掃描式電子顯微鏡/能量分散光譜儀 |
| SQUID | Superconducting quantum interference device | 超導量子干涉磁量儀 |
| TDS | Total dissolved solids | 總溶解固體 |
| XRD | X-ray powder diffractometer | X 光粉末繞射儀 |