# 行政院國家科學委員會專題研究計畫 成果報告

## 飲用水加氯消毒對消毒副產物生成及微生物再生之效應研究
## 研究成果報告(精簡版)

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出席國際會議研究心得報告及發表論文

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中 華 民 國 96 年 10 月 31 日

# 行政院國家科學委員會專題研究計畫成果報告

## 飲用水加氯消毒對消毒副產物生成及微生物再生之效應研究

## Effects of Chlorine Disinfection on DBPs Formation and Microbial Regrowth

計畫編號：95-2221-E-002-149

執行期限：95年8月1日至96年7月31日

主 持 人：王根樹　國立台灣大學公共衛生學系

**摘要**

本年度計劃延續本研究室過去數年之研究基礎，針對飲用水中消毒副產物之生成特性加以探討。本年度主要研究內容分成三部份: 1. 前加氯對優養化水體中藻類降解及消毒副產物生成之影響；2. 加氯對特定有機前質生成消毒副產物特性之研究(以芳香族及直鏈前質為對象)；3. 消毒副產物生成後於配水系統之濃度變化。第三部份之成果尚未完成彙整，本報告針對第一及第二部份加以說明。報告第一部分已發表於2007年三月美國芝加哥舉行之ACS年會，並投稿ACS Symposium Series (SCI期刊)；第二部份則以投稿2008 IWA WWC，期刊論文正撰寫中。第三部份待完成整理後再修正此報告。

前加氯對 *Microcystis aeruginosa* 之降解試驗結果顯示，以4 mg/L之劑量進行前加氯會增加水體之THM及HAA生成潛能。針對批次反應槽及連續流反應槽(藻類濃度連續稀釋)進行之試驗，氯仿生成潛能分別增加62~113 μg/L 及 12~23 μg/L。經過混凝、沉澱及過濾處理後，前加氯處理亦降低傳統處理對DBP前質之處理效能。前加氯所導致之有機物釋出有利於含溴物種之生成，顯示其主要為直鏈狀物質。試驗結果亦顯示提升水體溫度會增加藻體是出有機前質之機會。針對不同結構前質所進行之試驗結果則顯示，雖然芳香族結構有利於含氯DBP物種之生成，但前加氯亦可能破壞芳香族前質之結構，使含溴DBP物種之比例大幅上升。

**關鍵詞：**消毒副產物、前加氯、優養化、有機前質。

***Abstract***

This study elucidated the characteristics of DBP formation in drinking water. The study was separated into three parts: 1) effects of prechlorination on algae cells and its impacts on DBP formation; 2) chlorination of selected model compounds and DBP formation; 3) degradation of DBPs in distribution system. The third part of this study is still in progress, and this report covers the first and the second parts. The first part (chlorination of algal cells and impacts on DBP formation) has been presented in 2007 ACS National Meeting, and the second part has been submtted to 2008 World Water Congress for possible presentaion.

The effect of pre-chlorination on the trihalomethanes (THMs) and haloacetic acids (HAAs) formation from *Microcystis aeruginosa* was investigated. *M. aeruginosa* was cultivated under both batch and chemostat modes and harvested at different growth phases, and the formation of disinfection byproducts (DBPs) from the algal suspensions and extracellular organic matter (EOM) in the water treatment processes with and without pre-chlorination were measured. The results showed that pretreatment with 4 mg/L of chlorine increased chloroform formation potential by 62~113 μg/L and 12~23 μg/L from *M. aeruginosa* cultivated in batch culture and in chemostat, respectively. After conventional treatment processes, the pre-chlorination results in 10~50% decrease in overall DBPs precursor removal. When 0.5 mg/L of bromide was spiked into the algal suspension, the DBPs formation shifted from chlorinated to brominated species. Furthermore, the results of THM formation potential (THMFP) tests showed that the algae cultivated at the lower temperature water released less intracellular organic matter and less amounts of THMs precursors after pre-chlorination than that cultivated at the higher temperature water. Chlorine reactivities with model compounds are also studied. The results demonstrated that aromatic precursors favor the chlorine-DBPs formation; however, a major portion of bromine-DBPs was observed when the aromatic precursors were oxidized by chlorine.

**Keywords:** Disinfection byproducts, prechlorination, eutrophication, organic precursors.

## INTRODUCTION

Chlorine is widely used as the primary disinfectant in water treatment process for protection of public health. In addition, chlorine may also be used as a pre-oxidant for the oxidation of many reduced inorganic species and organic pollutants in raw water. When eutrophicated water is used as the raw water, algae cells and their excreted metabolic products may be present in the water

and contribute to the formation of DBPs. In general, factors affecting DBP formation include algae species, algal growth phase, and reaction condition such as pH, chlorine dose, and contact time. It has been reported that algae cells and biomass play the major role in THM production while the extracellular products (ECP) produces only a small fraction of DBPs. The ECP of algae may not be effectively removed by the traditional water treatment processes while algae cells can be removed in the coagulation and filtration units.

In this study, the effects of prechlorination on DBPs formation from *M. aeruginosa* were assessed. The specific objectives were (i) to determine the effects of incubation modes on algal growth; (ii) to determine DBPs formation from algal suspensions and EOM; (iii) to determine the effects of prechlorination on DBPs formation from algal suspensions after water treatment processes. In addition, the structure of the organic precursors also affects the THMs species distribution. In general, aromatic precursors favor chlorine reactions and aliphatic precursors favor bromine reactions. The chlorine reactivity with different model compounds were also evaluated.

## EXPERIMENTAL

### Algal Culturing

Axenic culture of *M. aeruginosa* (cyanobecterium, strain 4044 ) obtained from Academic Sinica in Taiwan was cultured and investigated in batch mode and chemostat. In batch culture, *M. aeruginosa* was grown in a 22-L custom-made cultivation tank containing 15 L of the synthetic sterilized algal growth media that was modified from M-11. Cultures received 1500~2000 Lux of light on a 14-h light/10-h dark cycle and the water temperatures were maintained at 24±1$^{o}$C. For chemostat mode, *M. aeruginosa* was cultured in a continuously mixed, 15-L custom-made cultivation tank. The chemostat reactor was supplied with a constant inflow of synthetic sterilized algal growth media, and was cultivated at a dilution rate of 0.3/day at 24±1 $^{o}$C, supplied with filtered air, and provided with 1500~2000 Lux of illumination on a 14-h light/10-h dark cycle.

### Simulation of Water Treatment Processes

For pre-chlorination treatment, 4 mg/L chlorine (prepared with NaOCl) was added into 1500 mL of the incubated algal suspensions (denoted as the raw water), stirred evenly and kept still for thirty minutes. For coagulation, reagent grade aluminum sulfate (Nacalai Tesque, Kyoto, Japan) was used as coagulant in jar-test experiments. Prior to addition of the coagulants, the pH of the samples was adjusted to 5 with $H_2SO_4$ and/or NaOH. Following the addition of the 20 mg/L of alum, the jars were rapidly mixed at 100 rpm for 1 minute, flocculation occurred while stirring at 20 rpm for 30 minutes and quiescent settling for thirty minutes. The supernatant was withdrawn and filtered with 1 μm membrane filter (denoted as the filtered water) for further analysis. In order to differentiate the EOM contribution to DBP precursors, the algal suspensions were filtered with 0.45 μm filters to remove the algal cells.

### Chlorine Reactivity with Model Compounds

Four model organic precursors are used in this study to represent the THMs precursors with different structures: resorcinol, phloroglucinol, hydroquinone and 1,7-heptanediol. Although with similar structure, the preliminary tests showed that the three aromatic precursors have different THMs formation potentials. The THMFP measurement follows the procedures described in section 5710B of the Standard Methods. Four THMs were quantified by a GC/MS (Agilent 6890GC/5973MSD) using a fused silica capillary column. Bromide was spiked at 0 and 0.5 mg/L in THMFP tests for comparisons.

## RESULTS

### Effect of Pre-chlorination on Algal Suspensions and EOM

Table 1 shows the effect of pre-chlorination on the NPDOC concentration of the bulk algal suspensions. For *M. aeruginosa* growing in batch culture and collected at the 10$^{th}$, 20$^{th}$, and 45$^{th}$ day, the treatment processes resulted in a NPDOC removal from 1.96, 2.31, and 4.10 mg/L to 0.83, 1.57, and 3.44 mg/L, respectively, when pre-chlorination was not applied. On the other hand, the pre-chlorination increased the NPDOC of raw water to 3.53, 4.82 and 7.64 mg/L, respectively, at different growth phase; and the NPDOC was 2.95, 3.51, and 5.48 mg/L, respectively, after treatments. After pre-chlorination, the NPDOC of raw water almost doubled for *M. aeruginosa* growing in batch mode, and similar results were observed for chemostat mode. From the data in Table 2, it appeared that the increase of NPDOC in raw water resulted from the liberation of the intracellar organic matter from algal cells. The lysing of algal cells due to chlorine oxidation will contribute to the NPDOC and hence the DBP precursors in the chlorinated raw water, in particular for algae in batch culture.

### THMs Formation from Algal Suspensions

THMFP from *M. aeruginosa* suspension in batch culture with and without pre-chlorination is shown in Figure 1. Without pre-chlorination, it is observed that 498, 1397 and 2623 μg/L of chloroform formation were obtained from water samples taken on the 10$^{th}$, 20$^{th}$ and 45$^{th}$ day of cultravation in batch mode. A significant increase of THM precursors accompanying the algal growth was observed. After the coagulation and sedimentation processes, a 70~90% reduction of chloroform precursors was obtained. However, the

filtration process only exhibited a limited ability to remove more THM precursors. When 4 mg/L of pre-chlorine was applied in the raw water, the chloroform formation was about the same as obtained without pre-chlorination. However, a slight increase of chloroform yield was noticed, especially in the filtered water (discussed later).

Figure 2 shows the chloroform formation from the algal suspensions in chemostat mode that was collected on the $10^{th}$, $20^{th}$ and $30^{th}$ day of cultivation. Without pre-chlorination, the three raw water samples produced 80, 123, and 115 μg/L of chloroform, respectively. Unlike that in the batch culture, the algae cultivated in chemostat did not produce more chloroform precursors with the increasing growth time. The coagulation and sedimentation treatments reduces 53~77% of the chloroform precursors for samples taken from the chemostate. For filtered water, however, additional 10% of THM precursors removal was obtained. On the other hand, when the samples were pretreated with 4 mg/L of chlorine, the chloroform formation was about the same as obtained without pre-chlorination in the raw and settled water. But no additional THM precursor removal was obtained after filtration when pre-chlorination was applied.

**THMs Formation from EOM**

Figure 3 shows the chloroform formation from EOM (ECP plus released intracellular products after pre-chlorination) in batch culture treated with the same processes as described in the previous section for algal suspensions. The chloroform formation in raw water were lower than that obtained from algal suspensions; however, the chloroform formation in filtered water were about the same as those obtained from algal suspensions (see Figure 1). For comparison, Figure 4 shows the chloroform formation from EOM in chemostat mode. The effects of pre-chlorination on chloroform formation are much more apparent in Figure 4. Without pre-chlorination, the EOM (ECP only) in chemostat mode produced a nearly constant quantity of chloroform throughout the treatment train. With 4 mg/L of pre-chlorine addition in the raw water, however, the chloroform formation was tripled for the raw water samples. The sedimentation unit removed about 50% of the chloroform formation potential, but no further removal was found in filtration unit.

Results in Figures 1 to 4 indicate that the primary source of chloroform precursors in the filtered water of the algal suspensions comes from the EOM (ECP only) of the algal cells, and the ECP can not be effectively removed by the conventional water treatment process. When raw water is treated with pre-chlorination, the algal cells was oxidized and released the intracellular organic matter into the water because of cell lysing. The cell lysing contributes to the DBP precursors and increase the THM formation potential in the treated water.

Table 2 summarizes the percentage removal of THM precursors for algal suspension and EOM samples after treatment processes (filtered water THMFP vs. raw water THMFP). For EOM in chemostat mode, the treatment processes remove 23% of the THM precursors when pre-chlorination was not applied; and the THM precursors percentage removal increased to 45~48% when samples were pre-chlorinated. It has been shown that the intracellular matters comprised high molecular weight organic compounds like humic acid while ECP were composed of low molecular weight organic matter (*11*). The high molecular weight intracellular organic matters that produced from cell lysing after pre-chlorination could be partially removed by coagulation and settling units when it is transferred into water. After pre-chlorination, however, it should be noted that the DBPFP is still higher than those without pre-chlorination. For batch mode, the EOM didn't show this phenomenon since the 4 mg/L pre-chlorine dosage is not high enough to oxidize the algal cells in raw water. When the bulk algal suspensions were used for treatments, essentially all of the samples without pre-chlorination gave better percentage removal of THM precursors than that of the samples with pre-chlorination.

**Chlorine Reactivity with Model Compounds**

As examples of THMFP tests, Figures 5 and 6 give the THMFP of resorcinol and 1,7-heptanediol. The aromatic resorcinol gives a very high THMFP – as high as 18,000 μg/L of THMFP when the concentration of resorcinol is 8 mg/L as dissolved organic carbon (DOC). For comparison, the THMFP of 1,7-heptanediol is quite low – only 50 μg/L of chloroform when bromide is not spiked. When bromide is spiked at 0.5 mg/L, a higher THMFP was obtained for 1,7-heptanediol (no apparent increase on total THMFP for resorcinol was observed when bromide was spiked). For phloroglucinol and hydroquinone, the THMFP tests give similar trends as shown in Figure 1; however, a lower total THMFP were obtained. The chlorine dosages in THMFP tests are very high (100 mg/L) so that suitable chlorine residuals after THMFP tests can be obtained. When chlorine dosages are not enough, the THMFP tests may give different results. As shown in Figure 3, the total THMFP decreases with increasing resorcinol concentrations; and no bromine-THMs are formed when bromide was spiked in the solution. The result in Figure 7 is consistent with general concept for DBP characteristic of aromatic precursors – the aromatic precursors favor chlorine reactions to form chloroform. However, the addition of higher chlorine dosages will change the resorcinol structure. Figure 8 showed that resorcinol was degraded to some products when chlorine was added, and higher chlorine dosage formed more degradation products. The chlorine may break the aromatic ring so that the degradation products can react

with chlorine/bromine to form bromine-THMs when bromide is spiked, as shown in Figures 5 and 7.

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**TABLE 1. NPDOC of algal suspensions with and without pre-chlorination**

| Cultivation time | Without pre-chlorination | | With pre-chlorination | |
|---|---|---|---|---|
| | Raw | Filtered | Raw | Filtered |
| Batch culture | | | | |
| 10th day | 1.96 | 0.83 | 3.53 | 2.95 |
| 20 th day | 2.31 | 1.57 | 4.82 | 3.51 |
| 45 th day | 4.10 | 3.44 | 7.64 | 5.48 |
| Chemostat (24±1 °C) | | | | |
| 10 th day | 1.13 | 0.92 | 1.82 | 1.45 |
| 20 th day | 1.38 | 1.25 | 2.18 | 1.63 |
| 30 th day | 1.57 | 1.36 | 2.27 | 1.75 |

NOTE: The unit of NPDOC is mg/L.

The filtered water has gone through coagulation/flocculation and sedimentation units.

**TABLE 2. THMFP percentage removal for algal suspensions after water treatment processes with and without pre-chlorination**

| Cultivation time | EOM | | Algal suspensions | |
|---|---|---|---|---|
| | No pre-$Cl_2$ | With pre-$Cl_2$ | No pre-$Cl_2$ | With pre-$Cl_2$ |
| Batch culture | | | | |
| 10th day | 94.3 | 43.7 | 97.6 | 49.3 |
| 20 th day | 68.6 | 69.3 | 92.4 | 88.5 |
| 45 th day | 71.2 | 70.3 | 80.7 | 79.5 |
| Chemostat (24±1 °C) | | | | |
| 10 th day | 0.0* | 45.0 | 82.3 | 67.2 |
| 20 th day | 19.5 | 45.3 | 85.2 | 72.8 |
| 30 th day | 22.7 | 47.7 | 87.4 | 71.1 |

* No apparent THMFP removal was observed.

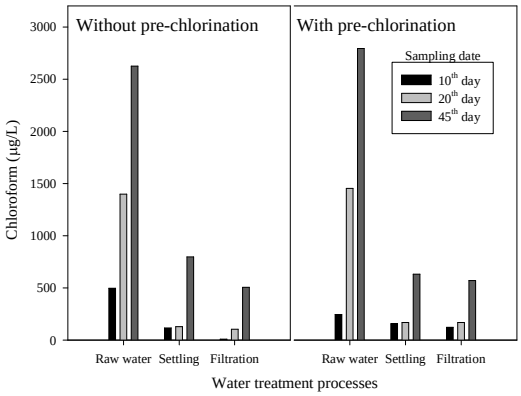



Figure 1 Effect of prechlorination on chloroform formation for algal suspensions (in batch culture).

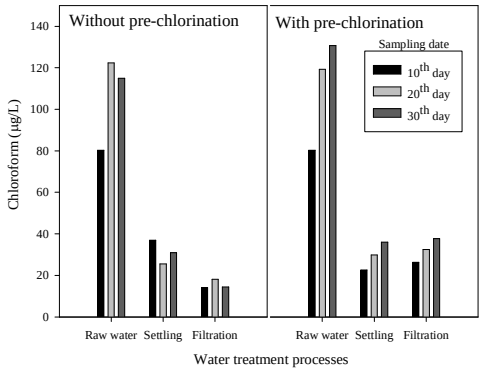



Figure 2 Effect of pre-chlorination on chloroform formation for algal suspensions (in chemostat).

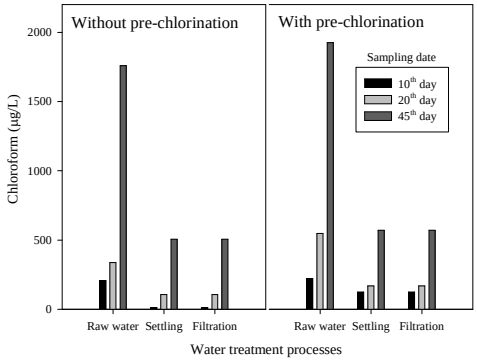



Figure 3 Effect of pre-chlorination on chloroform formation for EOM (in batch culture).

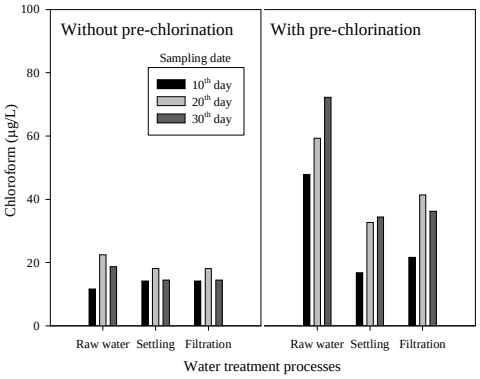



Figure 4 Effect of pre-chlorination on chloroform formation for EOM (in chemostat).

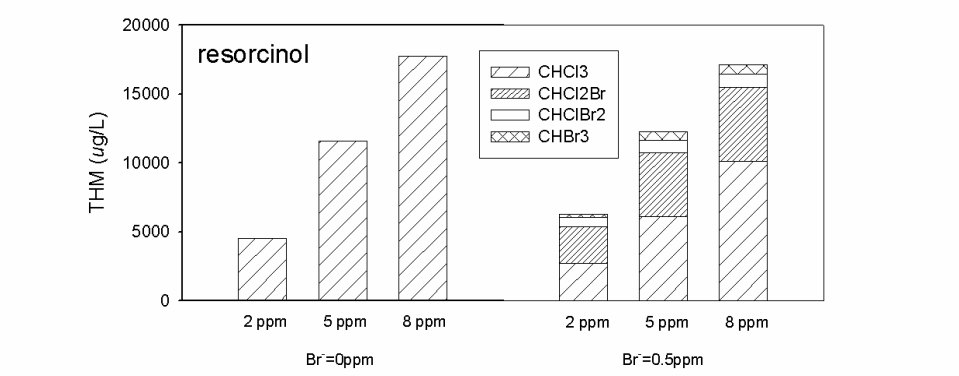



Figure 5 THMFP of resorcinol ([resorcinol] = 2, 5 and 8 mg/L as DOC, $[Cl_2]_0$ = 100 mg/l.)

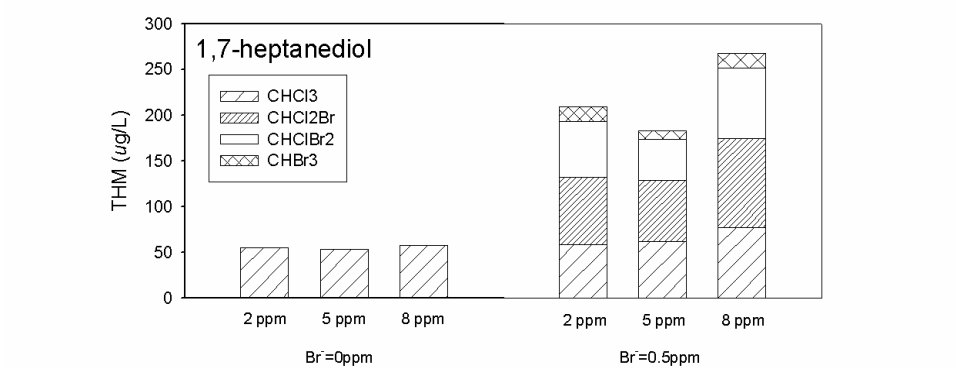



Figure 6 THMFP of heptanediol ([heptanediol] = 2, 5 and 8 mg/L as DOC, $[Cl_2]_0$ = 100 mg/l.)

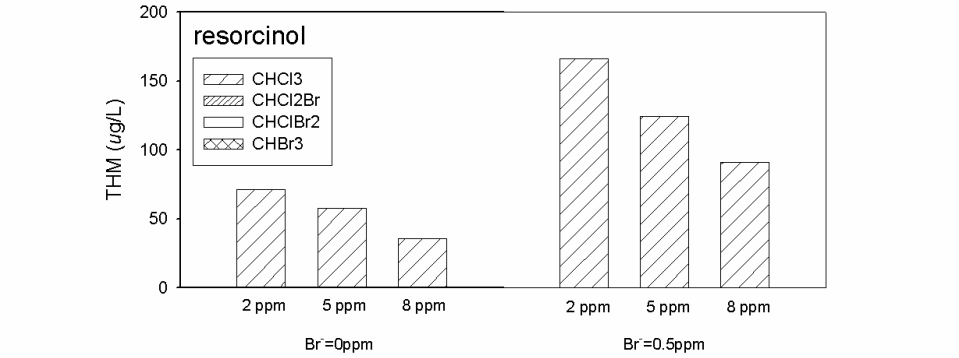
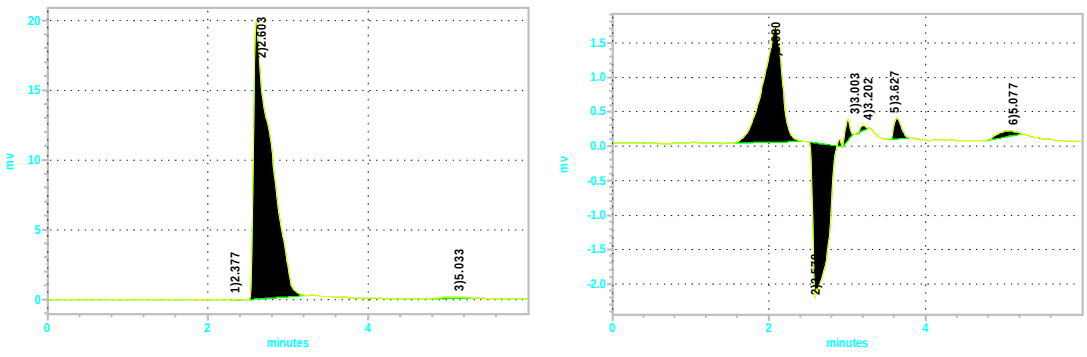



Figure 7 THMFP of resorcinol ([resorcinol] = 2, 5 and 8 mg/L as DOC, $[Cl_2]_0$ = 10 mg/l.)




$[Cl_2]$ = 0 mg/L $[Cl_2]$ = 20 mg/L

Figure 8 HPLC chromatogram of resorcinol with and without addition of chlorine.

# 參加美國化學會年會報告
# American Chemical Society 233rd National Meeting

會議時間：2007 march 25 – 29.
會議地點：美國伊利諾州芝加哥市
報告人：王根樹（國立台灣大學公共衛生學系）

## 1. 前言

美國化學會（American Chemical Society）所舉辦之年會及儀器展爲化學界最盛大的國際研討會之一。ACS 年會每年春、秋兩季輪流於美國主要城市舉辦，本年度春季年會於 2007.3.25.至 2007.3.29.於芝加哥市舉行（2007 八月之秋季年會於波士頓舉行）。ACS 年會已舉辦超過 100 年，規模龐大，爲世界化學界之盛事；雖爲美國之化學專業研討會，但吸引各國化學領域人員參加。由於 ACS 有數十個不同之 Division，每個 Division 有區隔成數個至十餘個 Sub division，因此全國會議舉行時均由各個 Division 分別進行論文蒐集、審查及發表工作。由於同時有數十個會場進行論文發表，一般會議中心無法提供如此多之會場，本次年會分別在芝加哥市最大之 McCormick Place（分成三個彼此相連卻又獨立運作之會議中心）以及市中心幾個大旅館之會議中心舉行會議。以筆者參與之 Environmental Chemistry Division 而言，筆者主要參與之消毒副產物論壇（DBPs Symposium）口頭發表會場位於芝加哥南區之 McCormick Place North 會場（亦爲 Environmental Chemistry Division 各專業論壇之會場集中地）但壁報論文會場則位於芝加哥市中心之 Hyatt 旅館，兩地距離超過 30 分鐘車程。

本次 ACS 年會總參加人數達一萬二千人以上，發表論文近千篇，參與國際人士亦無法計數（僅國際委員會之歡迎茶會即有 400 人參加）。如同筆者往年常參與之 AWWA 年會，ACS 年會亦兼具學術與實務功能，除了專業學術論文發表外，亦針對化學領域實務操作及管理議題加以探討，此點與我國舉辦之學術會議參加人員幾全爲學術界人事之現象有很大之差異。

## 2. 本次大會內容

本次 ACS 年會共分成 33 個 Division Meeting，涵蓋範圍自基礎之有機、無機、物化等基礎化學至應用領域之農業、毒理、環境、法規等應用化學。各不同 Division 再依其涵蓋範圍規劃不同之論文主題。以筆者所參與之環境化學 Division 爲例，即包含十個環境化學相關之主題（包括污染物質傳輸、空氣化學、水化學、能源、復育等），各個不同主題再細分其論文類別。筆者所參與之論文發表即屬於環境化學 Division 所涵蓋之「消毒副產物之生成、控制及健康效應論壇」（Occurrence, Formation, Health Effects

and Control of Disinfection By-Products in Drinking Water）。此論壇涵蓋所有飲用水消毒副產物之研究主題，共安排 6 個論文發表的 session，每個 session 各發表 8 篇口頭論文，另有 poster session，由各大學及顧問公司研究人員發表最新的研究成果，這些會場常坐滿來自各研究單位的研究人員，也最能看到美國各地的資深研究人員。

此次消毒副產物論壇由 ACS 環境化學 Division 四位中生代學者負責（年齡均在 45-50 之間），延續前兩次消毒副產物論壇（前一次於 1990 年代舉行），此次消毒副產物論壇亦經 ACS 審查通過，在會後蒐集會議所發表之論文彙編成集，在經過 peer review 後編成 ACS Symposium Series（列名 SCI 期刊），預定於 2007 年底出版。筆者此次會參與 ACS 年會之消毒副產物論壇，主要原因即因筆者歷年常參與 AWWA 年會並發表 DBP 研究相關論文，得以認識此次籌備 ACS 年會之消毒副產物論壇之幾位教授，因而收到其邀請參與論文投稿，並因此加入 ACS 成爲會員。筆者此次所發表之論文亦已經初審通過，已完成全文撰寫並投稿 ACS Symposium Series 之消毒副產物專輯。此次參與之消毒副產物論壇參與人員包括產、官、學各界人士，亦有各大學研究生（不分碩博士）發表其論文。在這個會場除可知道美國最新的學術研究方向外，常可看到美國各知名大學的教授在現場指導及協助其研究生進行論文發表，也是研究生間彼此認識的好機會。

由本次 DBP 論壇之報告主題安排亦可看出現今國際上飲用水領域對於 DBP 之認知無論在 DBP 之生成化學特性、毒性效應、控制技術之概念均與以往有所不同。除傳統的 NOM 外，現今對於受到污水影響之背景有機物、來自生物活動的含氮有機物質等均非常重視，此點值得重視。

此次研討會也讓筆者知道目前所進行之 THM、HAA 等研究已逐漸過時，目前之 DBP 研究已漸漸朝新興消毒副產物（以含氮之 DBP 爲主，如 NDMA）。未來必須開發新的研究題目方能與其他研究人員競爭。

3. 筆者的論文

筆者本次發表之壁報論文爲：Pre-chlorination Induced DOC and DBPs Formation from *Microcystis aeruginosa* in Treatment Processes。自來水廠在處理原水的程序中，爲因應原水中較高的有機物濃度，會採用前加氯的方法來氧化部份汙染物及其它有機物質，以減輕後續混凝、沉澱、過濾單元的處理負擔，並減少操作成本，目前台灣地區許多自來水廠皆採用此一方法。前加氯的氧化作用固然可解決一部份水質問題，但當原水中含有藻類細胞，甚至是來自高優養化的水源時，可能反而會造成飲用水中消毒副產物前趨物質的增加，提高民眾健康危害的風險。本研究以各種實驗室培養的含藻原水進行淨水程序的模擬，並討論有\無前加氯的差異、藻類細胞及胞外物質的貢獻量、培養溫度的影響、溴離子與氯離子的競爭，以及 THMs 及 HAAs 的生成。結果表示，前加氯的氧化作用會增加過濾水中消毒副產

物前趨物質的含量，且這部份前趨物質是由於藻類細胞破裂，釋出胞內物質而產生的；藻類細胞所產生的有機物大多爲脂肪族的前趨物質，因此在形成消毒副產物時溴離子會增加其生成量 1~2 倍；而前加氯的氧化力對於低溫(17~20℃)環境培養下的藻類細胞作用較小。以往之研究多以水中溶解性有機物爲對象，本研究則以藻體爲目標物進行探討。有趣的是在會場聆聽中發現大陸哈爾濱工業大學亦正進行類似研究。

4. 心得與建議

本次參與 ACS 年會，注意到自來水研究已逐漸走向跨校合作及國際化，所執行之研究計畫常由跨國團隊共同進行，其品質遠非筆者這種「單打獨鬥」行的研究所能比擬。未來若不能加強科技整合並參與其他研究團隊共同研究，並進一步與國際研究人員合作，未來恐無法在學術研究領域立足。

此次研討會也讓筆者知道目前所進行之 THM、HAA 等研究已逐漸過時，目前之 DBP 研究已漸漸朝新興消毒副產物（以含氮之 DBP 爲主，如 NDMA）。未來必須開發新的研究題目方能與其他研究人員競爭。會後與美國亞歷山那州立大學（Arizona State University）之 Paul Westerhoff 教授聯絡，請教其所進行含氮 DBP 物種研究概況。Paul Westerhoff 教授爲此次會議主辦人之一，筆者於 2006 年參與 AWWA 會議時與其認識。蒙 Paul Westerhoff 教授協助，提供其近年所進行研究相關資料，並應允未來將協助筆者進行 N-DBP 之研究，筆者已與研究室人員研商，預定暑假開始進行 N-DBP 之前置試驗，配合現有 C-DBP 之研究設備及成果，在現有研究架構及成果爲基礎下轉移研究主題，以與世界研究主流接軌。

本次參與 ACS 年會有機會參與國際研究人員之聚會。由於過去參與國際研討會，能有機會認識到國外貴賓，此次前往 ACS 年會即互相聯絡，並能透過此機會參與一些聚會，對提升國際視野有很大的幫助，未來應多參與此類活動，以增加與國際研究人員接觸的機會。

# 參加美國化學會年會報告
# American Chemical Society 233rd National Meeting

會議時間：2007 march 25 – 29.
會議地點：美國伊利諾州芝加哥市
報告人：王根樹（國立台灣大學公共衛生學系）

## 1. 前言

美國化學會（American Chemical Society）所舉辦之年會及儀器展爲化學界最盛大的國際研討會之一。ACS 年會每年春、秋兩季輪流於美國主要城市舉辦，本年度春季年會於 2007.3.25.至 2007.3.29.於芝加哥市舉行（2007 八月之秋季年會於波士頓舉行）。ACS 年會已舉辦超過 100 年，規模龐大，爲世界化學界之盛事；雖爲美國之化學專業研討會，但吸引各國化學領域人員參加。由於 ACS 有數十個不同之 Division，每個 Division 有區隔成數個至十餘個 Sub division，因此全國會議舉行時均由各個 Division 分別進行論文蒐集、審查及發表工作。由於同時有數十個會場進行論文發表，一般會議中心無法提供如此多之會場，本次年會分別在芝加哥市最大之 McCormick Place（分成三個彼此相連卻又獨立運作之會議中心）以及市中心幾個大旅館之會議中心舉行會議。以筆者參與之 Environmental Chemistry Division 而言，筆者主要參與之消毒副產物論壇（DBPs Symposium）口頭發表會場位於芝加哥南區之 McCormick Place North 會場（亦爲 Environmental Chemistry Division 各專業論壇之會場集中地）但壁報論文會場則位於芝加哥市中心之 Hyatt 旅館，兩地距離超過 30 分鐘車程。

本次 ACS 年會總參加人數達一萬二千人以上，發表論文近千篇，參與國際人士亦無法計數（僅國際委員會之歡迎茶會即有 400 人參加）。如同筆者往年常參與之 AWWA 年會，ACS 年會亦兼具學術與實務功能，除了專業學術論文發表外，亦針對化學領域實務操作及管理議題加以探討，此點與我國舉辦之學術會議參加人員幾全爲學術界人事之現象有很大之差異。

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