摘要

本所爲維繫與國際環境分析之研究趨勢接軌、交流分析技術與成果並廣泛蒐集環境分析相關資訊，乃派員參與九十七年於英國伯明罕舉辦之第 28 屆國際有機鹵化環境污染物及持久性有機污染物研討會（通稱 2008 戴奧辛年會），並發表論文分享近年本所工作成果外，亦藉此機會吸取先進國家之經驗與技術，以提昇本所持久性有機鹵化環境污染物之檢測技術使達國際水準。

參加本次大會之重要心得與建議如下：

一、J2 SCIENTIFIC 最新之 Automated SPE 及 AccuVap 系統結合該公司原有之 GPC 可以應用於 PCDD/Fs 、DL-PXBs 及 PBDEs 之自動淨化與濃縮，適用之待測物甚至可擴及其他之有機污染物，相當適合本所發展應用。

二、德國 Environnement S.A. Deutschland 亦有高量空氣採樣器之產品，採氣流量亦趨近目前本所新購且驗證中之日本採樣器，相關之規格效能值得注意，並作爲未來本所採樣方法修定時之參考。

三、Finnigan 的最新機種 DFS HRGC/HRMS 於今年年會中，仍以其高感度之卓越表現，引起與會人員之重視與討論，非常值得本所在未來採購新機時，列爲優先考量。

四、大體積進樣器（PTV），可利用進樣技術的改變，提高 GC 或 LC 的感度，藉以簡化污染物分析時，反覆之濃縮步驟及降低偵測極

限。在會中有多篇論文討論，結果也有良好的表現，惟儀器條件的建立較爲複雜，然亦不失爲所內發展方向之參考。

五、BFRs 有更多系列化合物如 HBCDs，包含 DecPBDE 在環境中降解所產生之系列化合物均已被列入研究分析對象，分析基質則擴及各種環境水體，此研究方向值得本所觀察參考。

六、氟化物（PFCs、PFOS、PFOA）分析已經成爲近年持久性污染物分析之重要研究方向，可供本所作爲未來發展之參考。

七、鄰近日本所發表之論文在環境調查與污染物傳輸部分，除日本國內各種環境現況外，均已將研究範圍擴展至亞洲地區。國內應也可透過加強產官學各部門之合作朝此方向擴大研究領域與視野。

八、爲延續得之不易的國際檢測技術交流機會，藉以了解世界環境分析趨勢與最新技術，並把握呈現國內研究成果於國際舞台，建議所內同仁能有機會持續與會。

目次

壹、目的

戴奧辛素有「世紀之毒」的稱號，環境中之戴奧辛污染源眾多，也無所不在。除廢棄物焚化過程外，木材燃燒、車輛排氣、火災及工業製程如化學工業、金屬冶煉、紙漿加氯漂白等都可能產生戴奧辛。近二十多年來，因其強烈的毒性而受到全世界的關注。再加上戴奧辛之檢測分析屬於超微量級，在檢測分析技術的水準與儀器精密度均有相當的挑戰，成爲世界各國環境學者與儀器廠商競相投入心力的一大領域。

由於環境中戴奧辛污染影響人民健康至鉅，同時也肇因於國內廢棄物焚化處理之趨勢背景，開啓了國內戴奧辛檢測技術建立的契機。行政院環保署環境檢驗所（以下簡稱本所）於民國 84 年 8 月成立戴奧辛小組，並於同年 9 月及 85 年 6 月分別於成大及清大成立兩個超微量實驗室，積極進行焚化廠排放相關戴奧辛檢測技術建立；87 年 11 月本所國家環境檢驗大樓正式啓用，戴奧辛超微量實驗室亦正式進駐本所。多年來，由於長官的支持與同仁的努力，陸續已完成都市型垃圾焚化廠及中小型焚化廠飛灰、底灰及煙道氣樣品等檢測技術之建置與研究計畫，並提供相關成果提供本署空保處、工程處及廢管處作爲施政與管理之參考。除了焚化廠樣品之外，本所更積極建立環境基質樣品如土壤、底泥、生物樣品（魚貝類）、水質及周界空氣之檢測能力，並開始

進行台灣背景資料之建置。同時亦每年參與瑞典 Umea 大學 Bert van Bavel 主持之國際實驗室比測，並通過澳洲 NATA 認證，強化本所戴奧辛檢測技術之公信力。本所 93-94 年透過派員參與戴奧辛年會，了解戴奧辛快速篩選技術在污染場址的判定、整治有發展的優勢潛力，因此陸續完成荷蘭 DR-CALUX®生物細胞法及美國 CAPE 免疫細胞分析法等兩項戴奧辛生物快速篩選技術引進與建置。本項技術應用於環保署重要戴奧辛污染場址相關樣品之篩選檢測，其迅速篩選大量樣品的能力，獲得各界一致的肯定。並且降低超微量分析實驗室遭受高濃度樣品污染的可能性，延長 HRGC/HRMS 的使用壽命。另外，本所也全力協助衛生署藥檢局及農委會毒試所等相關政府單位建置戴奧辛快速篩選檢測技術，爲國內戴奧辛污染管制共同把關。

爲延續得之不易的國際檢測技術交流機會，藉以了解世界環境分析趨勢與最新技術，並把握呈現國內研究成果於國際舞台。本所於今（97）年派員參加於英國舉辦之第 28 屆國際有機鹵化環境污染物及持久性有機污染物研討會（通稱 2008 戴奧辛年會），參與人員除代表發表論文分享本所工作成果外，亦期藉此機會吸取先進國家之經驗與技術，以提昇本所檢測技術使達國際水準。

貳、過程

第 28 屆「國際有機鹵化環境污染物及持久性有機污染物研討會（28th International Symposium on Halogenated Persistent Organic Pollutants）」於九十七年八月十七日至二十二日假英國伯明罕之國際會議中心（International Convention Centre）舉行，如圖一。所有與主辦單位之聯繫與報名均係透過網路，網址爲 http://www.dioxin2008.org。舉凡主辦單位之邀請函，主辦城市簡介、論文投稿格式、截止日期、註冊方法、旅館飯店預定….等，均可於網站上獲得資訊。本屆大會包含約四十三個國家接近八百人與會，所發表之論文總數達六百二十餘篇（口頭宣讀二百五十五篇；壁報展示三百六十五篇）。

圖一 大會會場－英國伯明罕國際會議中心（ICC）

本次會場位於伯明罕市政府附近，周圍十分鐘步行時間內就有兩個火車站，交通相當便利。大會共租用了會議中心一、二樓所有的會議室，會場並隨時隨地可見有工作人員協助引導，使得會議進行相當流暢順利。依照慣例，研討會分成口頭論文宣讀與壁報論文展示兩種。口頭論文宣讀部分共分成五個場地同時進行，每天每個場地大約可發表十五篇，進行方式是使用 Power Point 簡報軟體進行十五分鐘簡報，然後接受五分鐘提問討論；壁報論文則是於第三場地統一共同發表，大會期間希望壁報論文發表人於規定的休息時間能站在論文旁邊，接受提問討論。由於壁報論文與儀器展示場地相同，因此參觀者可以在口頭論文宣讀的休息時間同時參觀廠商的攤位。會場周邊提供無線上網、茶水、咖啡及座位，可供與會人員交流討論、搜尋資料甚至遠距辦公之用。

圖二 壁報論文與儀器展示場地

大會於八月十七日下午開始受理報到；筆者於十六日夜抵達所居住的旅館，隔日便至會場周邊了解環境與交通狀況；並於報到後至壁報論文展場張貼此次發表之論文。而八月十八至二十二日是論文發表的時間，詳細議程如附件一；整個大會於八月二十二日中午畫下完美的句點。

參、心得

一、本次戴奧辛年會論文內容分爲了三十六個主題如下：

1. POPs in Humans: Exposure and Trends
2. Chromatographic Techniques
3. High Temperature Sources of POPs
4. University of Michigan Exposure study
5. POPs in Soils and Sediments: Levels and Processes
6. POPs in Wildlife
7. BFRs: Releases, Transformation and Fate
8. Emerging POPs
9. The Biological Effects of Dioxin and Relationship to Regulatory Guidelines
10. Global Fate and Long Range Transport
11. TEFs and non-TCDD Compounds
12. The AhR and Mechanisms of Toxicity
13. Chiral Xenobiotics and Natural Halogenated Compounds
14. Arctic and Alpine Monitoring
15. Fluorinated Compounds: Sources, Environmental Levels & Transformation
16. Dioxins and Risk Assessment

17. BFRs: Exposure and Risk Assessment
18. Sample Preparation and QA Aspects of POPs Analysis
19. Sampling Strategies
20. Vietnam
21. Dietary Exposure to POPs: Levels and Trends
22. POPs in Air: Levels and Processes
23. Perfluorinated Compounds: Analytical Approaches and Developments
24. Epidemiology of POPs
25. Urban Fate and Behaviour of POPs
26. Fluorinated Compounds: Human and Animal Exposure
27. Toxicology of Dioxins and POPs
28. Existing and Emerging Contaminants: Advances in Screening and Confirmatory Methods
29. Contaminated Sites: Cases and Remediation
30. POPs in Marine Mammals: Levels, Effects and Trends
31. POPs in Indoor Atmospheres: Sources, Exposures and Remediation Measures
32. POPs in Food and Feed
33. Brominated Flame Retardants: Analytical Approaches and Developments

34. POPs – Threats, Challenges, and Solutions for Developing Countries

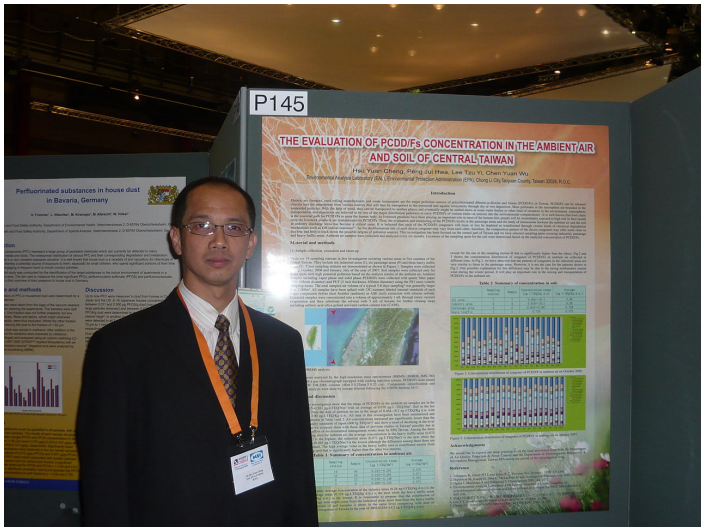
35. Cancer Risk and Dioxin Exposure Estimated from Serum Evaluation

36. Challenges in the Next Generation of Risk/Control Assessment: Mixtures, Susceptibility and Toxicology-epidemiology Discordance

二、此次與會本所共提出兩篇論文參加，一爲「THE EVALUATION OF PCDDs/Fs CONCENTRATION IN AMBIENT AND SOIL IN CENTRAL OF TAIWAN」，此篇論文係將本所於 95 至 96 年間進行之中部地區戴奧辛調查計畫之成果彙整而成。另一篇爲「COMPARISON OF DIFFERENT EXTRACTION TECHNIQUES FOR THE DETERMINATION OF PCDD/Fs IN SOIL AND SEDIMENT」則是探討本所現有各種樣品萃取方式（索氏法、快速索氏法、加速溶劑法、震盪法）之最佳條件探討與比較。其中「THE EVALUATION OF PCDDs/Fs CONCENTRATION IN AMBIENT AND SOIL IN CENTRAL OF TAIWAN」申請口頭宣讀發表，然並未通過審核。故兩篇論文均以壁報論文方式發表，論文內容詳如附件二。

「COMPARISON OF DIFFERENT EXTRACTION TECHNIQUES

FOR THE DETERMINATION OF PCDD/Fs IN SOIL AND SEDIMENT」在會議期間得到相當的矚目，目前已有國外三家實驗室來函索取相關研究資料，「THE EVALUATION OF PCDDs/Fs CONCENTRATION IN AMBIENT AND SOIL IN CENTRAL OF TAIWAN」也有一家國外實驗室來函索取相關研究資料，廣泛達到技術交流之目的，也充分提昇本所在國際環境檢測領域上的可見度。於此，也感謝各計畫執行同仁們的無私與努力。



圖三 筆者與發表之論文合影

三、過去，因所內任務導向，本所同仁與會均將學習與交流之焦點鎖定在戴奧辛類化合物之檢驗分析。然爲因應國內蓬勃發展之環境檢測潮流，所長及各級長官均致力開拓更多嶄新尖端之檢測分析，希冀本所未來能有更廣泛與全面性的蛻變。所以，此次行前時，所長及各級長官多次鼓勵叮嚀，勿侷限於現有工作業務範圍，廣泛吸取新知，了解目前環境分析之趨勢，需以宏觀的角度

與心態來學習。因此與會全程筆者儘可能將時間充分分配至多項主題，期能達成所內長官的期望。期間雖然部分學習受限於不同專業領域之差異而倍感吃力，但仍感謝所長及各級長官之鼓勵與提醒，得以藉此與會經驗與各方菁英心得交流，多元且廣泛的自我充實與提昇。

四、本次大會所發表之論文篇數以各項主題歸類區分，詳如附件三所示。其中「POPs in Humans：Exposure and Trends」所發表之論文爲 44 篇居所有主題之冠。「POPs in FOOD and Feed」、「POPs in Soils and Sediments：Levels and Processes」分居二、三。可以看出世界各國最關心的方向著重在人類的暴露以及食物攝取的潛在風險，另外土壤、底泥中污染物含量對於農作物、飼料所產生的影響，進而造成人類食用畜牧產品的風險，也是相當重要的研究方向。再者雖然此三主題在標題文字上均是採用「POPs」，但大多數的論文仍集中在 PCDD/Fs、DL-PCBs 及部分 OCPs。相信是因爲此三類化合物之檢測分析技術，目前在國際間已達穩定成熟的階段，因此研究的範圍及方向均從分析方法、檢測技術提昇轉而以人體暴露與環境污染趨勢或傳輸爲主。此趨勢與本所此次發表的論文「THE EVALUATION OF PCDDs/Fs CONCENTRATION IN AMBIENT AND SOIL IN CENTRAL OF TAIWAN」規劃之初的想法是相近的。

如西班牙 Nadal Marti 等人研究廢棄物焚化爐週邊居民血液中戴奧辛濃度的暴露趨勢，七年內三次針對居住焚化爐超過 10 年老中青三代男女居民進行的調查，居民平均血液中戴奧辛濃度由 27.0 降低至 9.4 pg-ITEQ/g lipid。以此了解該區域之暴露現況並對應該焚化爐之管理成效。另外，美國 Tachovsky JA 等人，針對密西西比南部不同河川所採集的魚體樣品中 TCDD/Fs 濃度進行主成分分析（Principal Components Analysis 簡稱 PCA），藉以了解不同區域所存在的污染差異，尋找與污染源的相關性，亦是相當有特色的課題。來自國內中央研究院的紀凱獻博士則提出戴奧辛類物質在環境空氣中經由長程傳輸的污染評估，文中述及台灣北部海岸及台北測站，在大陸沙塵暴發生期間，空氣中的懸浮微粒及類戴奧辛物質均有明顯增加趨勢，測值甚至可達平常之二到三倍。足見長程傳輸在環境污染佔有相當的影響力，也讓人們了解到環境污染已經不是一個國家或是單一地區的問題，而是全人類必須嚴肅以對的全球性課題。

五、至於 BFRs 及 Fluorinated Compound 的部分，雖然以主題區分論文數而言，似乎並非最多，但事實上是因爲開數個相關主題(「BFRs: Releases, Transformation and Fate」、「BFRs: Exposure and Risk Assessment」、「Brominated Flame Retardants: Analytical Approaches and Developments」）討論，其實以 BFRs 爲主題的論

文合計超過 60 篇以上。尤其多篇研究報告提及如 DecaBDE 在環境中自然降解成多種系列 PBDEs 而存在於環境中，其中部分污染物並非商品最初使用添加之耐燃劑材料，所以目前許多研究尚未針對該化合物進行分析，但其對人體與環境也是有相同的危害，因此恐將成爲污染防治的漏洞，因此，這個研究方向也是本所可以密切注意觀察的。

Fluorinated Compound 部分一樣也分有多項主題（「Fluorinated Compounds: Sources, Environmental」、「Perfluorinated Compounds: Analytical Approaches and Developments」、「Fluorinated Compounds: Human and Animal Exposure」）總共發表的論文篇數有 40 篇以上。Fluorinated Compound 的分析主要仍以 HPLC-MS/MS 爲主力，研究的基質包括了水體、魚體、空氣、室內粉塵及食品等。本所目前在 HPLC-MS/MS 的技術、人力與設備，均已相當健全，相信未來也可在這個領域有相當好的發展。由此也可以發現，BFRs 及 Fluorinated Compound 仍是國際上持久性有機污染物檢測分析的重點與趨勢。

在 PBDEs 口頭論文發表的部分，其中美韓兩國合作由 Youn Ju Ok 等人進行利用頭髮作爲人體飲食暴露指標，了解 PAHs 及 PBDEs 在人體的含量，結果發現美國人民在兩者污染物的濃度均高於韓國人民，而 PAHs 暴露的來源與飲食習慣較爲相關，素食者最低，非素食者第二，偏好海產食品者爲最高；但 PBDEs 的暴露和飲

食習慣則較無明顯關係，反而是與居住環境較爲相關。德國學者 Thorsten Stiehl 針對德國境內的河川底泥，進行 PBDE 和 HBCD 的監測，計畫中檢出最高濃度值爲 43.0 μg/kg d.w.（BDE-99）。日本 Hidetaka Takigami 等人則是進行飯店內空氣與粉塵中 BFRs 的調查研究，針對研究對象的飯店，PBDEs 的濃度範圍爲 9.8~1700 ng/g，平均值爲 1200 ng/g；HBCDs 濃度範圍爲 72~1300 ng/g，平均值爲 740 ng/g，研究結果也驗證了 HEPA 空氣清淨機對室內粉塵及空氣中 PBDEs 的去除效果。

德國學者 Annekatrin 進行北海環境空氣中 Polyfluorinated Compounds 之檢測，挪威學者 Huber Sandra 等人也針對室內粉塵及空氣進行 Pre- and polyfluorinated compounds（PFCs）的檢測，兩者都是利用 PUF-XAD-2-PUF 的吸收管採樣後，離子化之 PFCs 以 LC-Q-TOF-MS 進行分析，中性之 PFCs 以 GC-MS 分析。法國的 Bruno VEYRAND 等人利用 LC-MS/MS 檢測河川水體樣品中十四種 PFCs，報告中指出其 LOD 從 0.01~0.12 ng/L，回收率則是從 55~102% ，其中檢出率最高的污染物爲 PFOS 及 PFOA 均達 50% 。可見 PFOS 及 PFOA 在環境中的流布亦是相當廣泛，值得觀察注意。

六、「Chromatographic Techniques」 部分，可以發現二維氣相分析儀（GC×GC）的高解析度，已普遍被廣爲運用。若只針對 OCPs 而

言，結合 CED 或μECD 偵測器已經綽綽有餘。飛行式時間質譜儀（TOFMS）也是此次會議論文討論的重點之一，如再搭配二維氣相分析儀（GC×GC），可一次同步分析多種有機污染物，然而其資料的龐大與數據處理繁瑣，一旦環境樣品基質複雜時，待測物波峰確認更加困難，也在會議中引起相當的討論。另外，爲解決樣品處理過程中繁瑣的濃縮步驟及可能發生待測物損失之問題，大體積進樣器（PTV）也漸漸被應用在實際的分析技術上，也由於進樣量大，提高了待測物的感度，相對地降低儀器偵測極限。因此在許多微量分析上，不失爲一個可以考量採用的技術。然而此進樣器在應用時，條件最適化之建立較爲複雜。

美國食品藥物管理局（FDA）Douglas G. Hayward 等人所發表之論文，即利用多重殘留分析之前處理技術結合 GC/MS 、LC/MS/MS 及 GC/HR-TOFMS 執行水果、蔬菜中多項除草劑及持久性污染物之分析。而 Thermo 公司 Krumwiede D.等人則是針對大體積進樣器（PTV）應用於 GC-HRMS 、GC-MS 及 LC-MS 分析 POPs 的效能提出論文驗證，其樣品注射體積最大可達 100μL，除了增加儀器的靈敏度和解析度外，亦大幅降低了方法偵測極限，且因爲進樣體積大，可以省卻一部份的濃縮步驟，減少操作的誤差產生。西班牙學者 Ortiz X 等人則以 HPLC，採用一支 2-(1-Pyrenyl)ethyl silica Column 成功將魚體樣品中之 TCDD/Fs、DL-PCBs、OCPs 及 PBDEs 分流成三部份再分別以 HRGC-HRMS 及 HRGC-ECD 檢測。

七、本所於 93 完成荷蘭 DR-CALUX®戴奧辛快速篩選技術後，便持續密切注意該項技術之發展。本次年會中關於生物檢測與快速篩選法的部分仍有開闢專題討論「**Existing and Emerging Contaminants: Advances in Screening and Confirmatory Methods**」，其中日本學者 Okimoto M 便利用 CALUX 生物檢測進行 PBDD/Fs 及 PXDD/Fs 毒性評估。美國 Michael S. Denison 的論文中，談到了第三代 CALUX 細胞在選擇性和感度的良好表現。另外荷蘭的 Hoogenboom Ron 則是利用 DR-CALUX®應用在戴奧辛類化合物的風險評估上。而美國 eichrom 公司的 CARIOU Ronan 也發表論文談及 Procept® DNA-Binding Bioassay 在低濃度（ppt）魚體中的檢測應用。由於 Dr. Ronan 曾於 97 年初來所協助建置 Procept®技術，此次異地相逢格外親切，Dr. Ronan 也表示未來該公司在技術上，如有任何新的資訊都會與本所保持聯繫。

圖四　筆者與美國 eichrom 公司 DR. Ronan 等人合影

八、在會議中就各項污染物在環境監測部分，發現多數的研究報告探討的範圍漸漸不再侷限於單一個城市、地區甚至國家，而是擴及到更大範圍的區域調查與污染物長程傳輸之影響等相關議題（如「Global Fate and Long Range Transport」、「Arctic and Alpine Monitoring」）。日本學者 Abe Sachiko 便以北大西洋和日本海爲範圍進行對掌性 POPs 的對稱選擇性分析（Enantioselective Analysis）研究，採樣範圍包含的 16 個北大西洋測站和 26 個日本海測站。另外，有一篇日本的報告甚至就以亞洲各城市的飲用水爲研究基質，當看到台灣出現在報告中的採樣點上時，感觸相當深。以國內的檢測技術水平，如能再結合更多的產學各界合作將研究觸角延伸至更大區域，相信應該會有更高更好的學術成就與貢獻。例如學術界一般擁有較豐富的理論基礎和數據統計評估能力，甚至是海外合作的資源，商業實驗室或工程顧問公司則擁有豐沛的人力資源和經驗，所內如能以自身的特長（檢測技術、設備與行政資源）與之合作，在很多研究發展上應當會有許多的突破。

九、美國 FMS 公司（Fluid Management System, inc.）今年亦在會場展示其發展之全自動高壓萃取系統（PLE），再搭配 Power-Prep™ 可串聯成一套自動化的萃取淨化系統。會中有數篇論文採用，也獲致相當不錯的成果。例如：荷蘭 Traag WA 等人結合了加速溶劑萃取（ASE）及 FMS 大幅度縮減了 TCDD/Fs 及 DL-PCBs 樣品的

前處理時間，藉以大量檢測食品及飼料樣品。瑞典的 Hagberg, J. 等人則是以該公司的 PLE（Pressurized Liquid Extraction）再連接 Power-Prep™ 系統處理土壤樣品。然而其效能雖高，但本所使用的經驗了解，該系統儀器本身的高單價，還有耗材與溶劑的使用量及成本均相當驚人，因此，對於方法的應用與推廣有很大的困難。這部分本所與該公司數度接觸時，均有提供意見供其參考。

十、美國 J2 Scientific 公司推出 Automated SPE 及 AccuVap 兩個系統，搭配其公司原有之 GPC Cleanup 系統，亦可以串聯出一套全自動的淨化濃縮系統。也因爲這套系統，使得前述 FMS 公司面臨更大的競爭者。依照 J2 Scientific 公司所提供之技術資料，可以同時淨化分離 PCDD/Fs、DL-PCBs 及 PBDEs。亦即將萃取後之樣品，首先經過 GPC 去除大分子及小分子的雜質，再利用其 SPE 系統進行管柱淨化步驟，淨化後之樣品再進入 AccuVap 系統，即可濃縮至約 2 mL 之注射瓶內。

這套系統最大的優勢在於其 Automated SPE 系統可適用各種現有市售之 SPE 管柱，大幅降低耗材的費用（Power-Prep™ 系統只能使用 FMS 公司產品，且單價高），而且市售 SPE 管柱材質種類繁多，也擴大了系統的適用範圍；再加上整套系統可以隨使用者的需求，改變其各單元的管線連接順序，再透過電腦軟體控制操作，也提高該系統的應用廣度，亦即國內現有以固相萃取進行分

析之待測物均有可能適用，如此，對於本所目前的有機分析業務將會有很大的幫助，相當值得本所引進使用。

討論過程，筆者問及此系統是否可以直接進行水樣的 SPE 萃取，廠商表示目前的硬體僅提供約 200 mL 的樣品進樣體積。但筆者表示許多有機污染物在水中含量極小，一般的萃取體積往往需達 1 L 以上。廠商也表示後續的硬體更新會往此方向考量。

十一、進行戴奧辛分析所採用之高解析氣相質譜儀（HRGC/HRMS），目前只有 Micromass、JEOL、Finnigan 三家公司之產品。會中仍只有 Finngan 的最新機種 DFS HRGC/HRMS 吸引眾人的目光，因爲其高噪訊比（S/N）可以輕易達到 100 以上（60m 管柱，100 fgTCDD），使得進行低濃度樣品（環境空氣、水體、食品及血液等）分析時，獲致很大的突破與便利性。國內工研院能源與環境研究所水科技與環境分析技術組環境鑑識技術研究室、中央大學張木彬教授實驗室已各採購乙部。筆者於會中向杜敬民研究員與紀凱獻博士徵詢該儀器之實際應用狀況，兩人也都對該部儀器給予肯定的評價。相信未來本所如有機會引進，應可對檢測技術的提昇與研究方向的發展，提供更多元化的正面幫助。

圖四 Finngan 的最新機種 DFS HRGC/HRMS

十二、在環境空氣戴奧辛採樣的部分，本所已於今年初引進日本 YOTSUBISHI 公司之高量採樣器，並著手進行與國內現行公告方法之驗證比對計畫。在此次會場中，德國 Environnement S.A. Deutschland 亦有展示其最新之高量空氣採樣器，採氣流量亦趨近目前本所新購且驗證中之日本採樣器（可達 1000 L/min），噪音值小於 35 分貝。其相關之規格與效能值得本所注意，作爲未來本所採樣方法修定時之參考。

肆、建議

一、 美國 J2 Scientific 公司推出 Automated SPE 及 AccuVap 兩個系統，搭配其公司原有之 GPC Cleanup 系統，可以串聯出一套全自動的淨化濃縮系統。同時淨化分離 PCDD/Fs、DL-PCBs 及 PBDEs。且其 Automated SPE 系統可適用各種現有市售之 SPE 管柱，大幅降低耗材的費用，延伸系統的適用範圍；再加上整套系統可以隨使用者的需求，改變其各單元的管線連接順序，再透過電腦軟體控制操作，也提高該系統的應用廣度，亦即國內現有以固相萃取進行分析之待測物均有可能適用。如此，對於本所目前的有機分析業務將會有很大的幫助，建議本所能引進使用。

二、 Finngan 的最新機種 DFS HRGC/HRMS 吸引眾人的目光，因爲其高噪訊比（S/N）可以輕易達到 100 以上（60m 管柱，100 fg-TCDD），使得進行低濃度樣品（環境空氣、水體、食品及血液等）分析時，獲致很大的突破與便利性。相信未來本所如有機會引進，應可對檢測技術的提昇與研究方向的發展，提供更多元化的正面幫助。

三、 本所在針對環境水體戴奧辛類化合物分析之採樣技術，在過去幾年有相當成功的突破，且已開發成熟之採樣設備。未來在各

種水體及其他 POPs 的檢測上，將是很好的發展方向。如此，本所在各項環境基質中 POPs 之檢測技術，將更趨於完備；也使得國內環境污染監測能有更全面性的了解。

四、德國 Environnement S.A. Deutschland 生產之高量空氣採樣器，採氣流量亦趨近目前本所新購且驗證中之日本採樣器，相關之規格效能值得注意，並作爲未來本所採樣方法修定時之參考。也有鑑於 POPs 檢測日益受到重視，採樣技術的建立也必然是重要的一環。所內對於新型高量空氣採樣器之驗證已有初步的成果，後續方法修訂、所內人員對於新型空氣採樣器的技術建立與設備增購，必然是未來須積極進行的方向。

五、POPs 種類繁多，如何精確且有效率的進行樣品檢測，在最短時間內達對對於環境污染現況的掌控與處理，是目前最迫切的課題。雖然解析度與定量的精準度不及於 HRGC/HRMS，但 GC×GC-TOFMS 由於可以在一次分析中，獲得幾乎全部污染物的分析圖譜資料，大幅減少爲分析不同種類化合物時，須不斷重複上機的繁瑣程序，因此被視爲未來最重要的環境分析利器。或者當面對複雜而完全未知的樣品，可以藉此迅速且完全了解樣品中污染物的種類和數量，提供進一步分析的重要依據，相信都是很有潛力的發展方向。目前本所已擁有 GC×GC-TOFMS 乙部，同仁們也

積極朝此方向努力，相信在此發展上，是可以與國際環境分析趨勢接軌。

六、從最近幾年會議中可以了解，氟化物（PFCs、PFOS、PFOA）分析已經成爲近年持久性污染物分析之重要研究方向，且該污染物在環境中的流布也是相當廣泛，值得國內環保機關密切注意；因此，該類化合物的檢測技術建立、國內污染現況與環境背景調查，或可供作本所現有 HPLC-MS/MS 未來發展之參考。

七、鄰近日本所發表之論文在環境調查與污染物傳輸部分，除日本國內各種環境現況外，均已將研究範圍擴展至亞洲地區。國內也可透過加強產官學各部門之合作朝此方向擴大研究領域與視野。例如學術界一般擁有較豐富的理論基礎和數據統計評估能力，甚至是海外合作的資源；商業實驗室或工程顧問公司則擁有豐沛的人力資源和經驗，所內如能以自身的特長（檢測技術與公部門的資源）與之合作，在很多研究發展上應當會有許多的突破。

八、在 BFRs 的分析研究上，許多資料顯示，居住環境對人體的危害往往勝於飲食的攝入。因此，室內空氣及粉塵中 BFRs 的檢測倍受重視。所內過去一年多來，開始著手於這部分的研究，也獲得初步的成果，未來也規劃採購新型室內空氣高量採樣器，在此領

域也將有更進一步的發展。

九、爲延續得之不易的國際檢測技術交流機會，藉以了解世界環境分析趨勢與最新技術，並把握呈現國內研究成果於國際舞台，建議所內同仁能有機會持續與會。

伍、參考資料

一、第 28 屆「國際有機鹵化環境污染物及持久性有機污染物研討會」大會網站 http://www.dioxin2008.org。

二、第 28 屆「國際有機鹵化環境污染物及持久性有機污染物研討會」論文集。

三、參加第 27 屆「國際有機鹵化環境污染物及持久性有機污染物研討會」出國報告。

附件一　大會主要議程

Monday 18 August

Hall 1					
08.30–09.15	Welcome Address (Robert Watson, Chief Scientist, UK Department of Environment, Foodand Rural Affairs). Opening Ceremony				
09.15–10.00	Plenary – The Global Cycling of POPs, Kevin Jones, Lancaster University, UK				
Hall 3					
10.00–10.30	Coffee Break				
	Hall 1	**Hall 5**	**Hall 8**	**Hall 9**	**Hall 11**
10.30–12.50 (7 lectures)	POPs in Humans – Exposure and Trends I	Chromatographic Techniques I (sponsored by SGE Analytical Science)	High Temperature Sources of POPs I	University of Michigan Dioxin Exposure Study	POPs in Soils and Sediments – Levels and Processes
12.50–14.00	Lunch, Exhibition and Poster Viewing, Hall 3				
14.00–15.20 (4 lectures)	POPs in Wildlife	BFRs: Releases, Transformation, and Fate	Emerging POPs	Special workshop The Biological Effects of Dioxin and Relationship to Regulatory Guidelines to 15.40	Global Fate and Long Range Transport
15.20–15.50	Coffee Break, Hall 3				
15.50–17.10 (4 lectures)	POPs in Wildlife	BFRs: Releases, Transformation, and Fate	Emerging POPs	Special workshop The Biological Effects of Dioxin and Relationship to Regulatory Guidelines Commences 16.00 to 17.00	TEFs and Non-TCDD Compounds
Hall 3					
17.10–18.10	Manned Poster Session I and Exhibition. Authors of odd numbered posters to be in attendance				
19.30–20.00	Reception at Birmingham Museum and Art Gallery – Delegates to walk (5 minutes distance)				

Tuesday 19 August

Hall 1					
08.30–09.15	Plenary – Human Health Impacts of Exposure to POPs: Unanswered Questions, Linda Birnbaum, US EPA. Sponsored by the Environment, Sustainability, and Energy Forum (ESEF) of the Royal Society of Chemistry				
Hall 3					
09.15–09.45	Coffee Break				
	Hall 1	**Hall 5**	**Hall 8**	**Hall 9**	**Hall 11**
09.45–12.05 (7 lectures)	The AhR and Mechanisms of Toxicity (5 lectures)	POPs in Humans: Exposure and Trends II	Chiral Xenobiotics and Natural Halogenated Compounds	Arctic and Alpine Monitoring	Fluorinated Compounds: Sources, Environmental Levels and Transformation
12.05–13.45	Lunch, Exhibition and Poster Viewing, Hall 3				
13.45–15.05 (4 lectures)	Dioxins and Risk Assessment (Sponsored by ESEF, the Royal Society of Chemistry)	BFRs: Exposure and Risk Assessment	Chromatographic Techniques II (Sponsored by SGE Analytical Science)	Sample Preparation and QA Aspects of POPs Analysis	Vietnam
15.05–15.35	Coffee Break, Hall 3				
15.35–16.55 (4 lectures)	Dioxins and Risk Assessment (Sponsored by ESEF, the Royal Society of Chemistry)	BFRs: Exposure and Risk Assessment	High Temperature Sources of POPs II	Sampling Strategies	Vietnam
Hall 3					
17.00–18.10	Manned Poster Session II and Exhibition. Authors of even numbered posters to be in attendance				

Wednesday 20 August

Hall 1					
08.30–09.15	Plenary – The Simpsons, POPs, and Chemical Management. Miriam Diamond, University of Toronto, Canada				
Hall 3					
09.15–09.45	Coffee Break				
	Hall 1	**Hall 5**	**Hall 8**	**Hall 9**	**Hall 11**
09.45–12.05 (7 lectures)	Dietary Exposure to POPs: Levels and Trends	POPs in Air (Levels and Processes)	Perfluorinated Compounds: Analytical Approaches and Developments	Epidemiology of POPs	Urban Fate and Behaviour of POPs
12.05–13.00	Exhibition and Poster Viewing, Hall 3				
13.00–19.00	Optional Excursion to Stratford-upon-Avon, Delegates with pre-purchased tickets depart by coach from outside venue at 13.00				

Thursday 21 August

Hall 1					
08.30–09.15	Plenary – Emerging Hyphenated Analytical Techniques for POPs. Jef Focant, University of Liege, Belgium				
Hall 3					
09.15–09.45	Coffee Break				
	Hall 1	**Hall 5**	**Hall 8**	**Hall 9**	**Hall 11**
09.45–12.05 (7 lectures)	Fluorinated Compounds: Human and Animal Exposure	Toxicology of Dioxins and POPs	Existing and Emerging Contaminants: Advances in Screening and Confirmatory Methods	Contaminated Sites: Cases and Remediation	POPs in Marine Mammals: Levels, Effects and Trends
12.05–13.45	Lunch, Exhibition and Poster Viewing, Hall 3				
13.45–15.05 (4 lectures)	POPs in Indoor Atmospheres: Sources, Exposures and Remediation Measures	POPs in Food and Feed	Brominated Flame Retardants Analytical Approaches and Developments	POPs: Threats, Challenges, and Solutions for Developing Countries	Cancer Risk and Dioxin Exposure Estimated from Serum Evaluation
15.05–15.35	Coffee Break, Hall 3				
15.35–16.55 (4 lectures)	POPs in Indoor Atmospheres: Sources, Exposures and Remediation Measures	POPs in Food and Feed	Brominated Flame Retardants Analytical Approaches and Developments	POPs: Threats, Challenges, and Solutions for Developing Countries	Challenges in the Next of Risk/Control Assessment: Mixtures, Susceptibility and Toxicology-epidemiology discordance. Runs to 17.35
Hall 3					
17.00–18.00	Exhibition				
18.00–23.00	Optional Symposium Banquet at Villa Park (Aston Villa Football Club), Delegates with pre-purchased tickets only. Departure from outside the Conference venue is by coach between 17.30 and 18.30. Please catch the earlier coaches only if you wish to take the stadium tour as well as attend the banquet.				

Friday 22 August

Hall 1	
08:30 – 09:15	Plenary – Debromination of the Flame Retardant DecaBDE: Is it Environmentally Relevant? Heather Stapleton, Duke University, USA
Foyer	
9.15–09.45	Coffee Break
Hall 1	
09.45–12.00	Session Summaries. Otto Hutzinger Student Awards. Dioxin 2009. Closing Address
12.00	Symposium Closes

附件二 本所發表之論文

THE EVALUATION OF PCDD/Fs CONCENTRATION IN THE AMBIENT AIR AND SOIL OF CENTRAL TAIWAN

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Introduction

Electric arc furnaces, steel rolling manufacturers and waste incinerators are the major pollution sources of polychlorinated dibenzo-p-dioxins and furans （PCDD/Fs）in Taiwan. PCDD/Fs can be released directly into the atmosphere from various sources that will then be transported to the terrestrial and aquatic ecosystems through dry or wet deposition. Most pollutants in the atmosphere are bounded to the suspended particles. With the help of wind, they can be transported to another places and eventually might be settled down at some water bodies or other kind of receptors in the environment. Atmospheric transportation and deposition are believed to be two of the major distribution pathways to carry PCDD/Fs of various emission sources into the environmental compartments[1]. It is well known that food chain is the essential path for PCDD/Fs to enter the human body. As livestock products have been playing an important role in most of the human diet, people will be immediately exposed to high risk in their health once the livestock products are contaminated by PCDD/Fs. Thus, the evaluation and monitoring of the PCDD/Fs levels in the pasturage areas and the study of interactions between the ambient air and the soil in industry discharge areas has become a critical issue. It is believed that each of the PCDD/Fs congeners will more or less be depleted or transformed through certain kinds of chemical degradation mechanisms such as OH radical reactions[2-3]. As the dechlorination rate of each dioxin congener may vary from each other, therefore, the composition pattern of the dioxin congeners may offer some clues to disclose and help to track down the possible origins of pollution sources. This investigation has been focused on the central part of Taiwan and we have selected sampling spots covering industrial, pasturage and heavy traffic areas. Ambient air samples were collected and analyzed every six months. Locations of the sampling spots for the soil were determined based on the analyzed concentration of PCDD/Fs.

Material and methods

(1) Sample collection, extraction and clean-up

There are 19 sampling stations in this investigation covering various areas in five counties of the central Taiwan. They include ten industrial areas (I), six pasturage areas (P) and three heavy traffic areas (T). These sampling stations are demonstrated as shown in Figure 1. Samples were collected during October, 2006 and January, July of the year of 2007. Soil samples were collected only for those spots with high potential pollution based on the analysis results of the ambient air. Ambient samples including vapor phase and solid phase PCDD/Fs were collected with quartz filter paper (102~105mm

diameter) and PUF (3 inch thickness, 630mm diameter) using the PS1 semi-volatile sampling trains. The total sampled air volume of a typical 5-6 days sampling[4] was generally larger than 2,000m^3. All samples have been spiked with 13C-isotopes labeled internal standards of each target compounds before their Soxhlet (ambient) or ASE (soil) extraction with toluene solvent. Extracted samples were concentrated into a volume of approximately 1 mL through rotary vacuum evaporation and then substitute the solvent with 5 mL of hexane for further cleanup steps including sulfuric acid silica geland activated carbon column kits (CAPE).

(2) HRGC/HRMS analysis

PCDD/Fs were analyzed by the high-resolution mass spectrometer (HRMS) (JEMOL JMS-700) coupled with a gas chromatograph equipped with cooling injection system. PCDD/Fs were eluted with a J&W DB-5MS column (60m×0.25mm×0.25 μ m). Compounds identification and quantitative analysis were done by isotope dilution following the USEPA Method 1613.

Results and discussion

Results of the investigation show that the range of PCDD/Fs in the ambient air samples are in the range of 0.015~0.261 pg-I-TEQ/Nm^3 with an average of 0.070 pg-I -TEQ/Nm^3. Soil in the hot spots judging from the data of ambient air are in the range of 0.464~18.1 ng-I-TEQ/Kg d.w. with an averageof 3.90 ng-I-TEQ/Kg d.w.. All data in this investigation have been summarized and illustrated as shown in Table 1and 2. All concentrations measured are significantly lower than the ambient air quality standards of Japan (600 fg-TEQ/m^3)[5] and show a trend of declining in the level of PCDD/Fs as we compare them with those data of previous studies in Taiwan[6] possibly due to the successful effort of environmental management works done by EPA Taiwan. Among the three kind of sampling sites for ambient air, the average concentration in the heavy traffic areas (0.075 pg-I-TEQ/Nm^3) is the highest, the industrial areas (0.071 pg-I-TEQ/Nm^3) is the next while the pasturage areas (0.065 pg-I-TEQ/Nm^3) is the lowest although the difference among these three are actually quite small. The high average value in the heavy traffic area is contributed mostly from the H3 sampling spot that is significantly higher than the other two stations.

As to the soil samples, average concentration of the industry areas (6.28 ng-I-TEQ/kg d.w.) is the highest, the pasturage areas (0.728 ng-I-TEQ/kg d.w.) is the next while the heavy traffic areas (0.075 ng-I-TEQ/kg d.w.) is the lowest. It is reasonable to propose that the contribution of PCDD/F in pasturage area might come from the industrial areas more than from the heavy traffic areas. PCDD/Fs result of soil samples is about in the same level comparing with data of agricultural soil investigation of Taiwan in the year of 2001(0.254~15.2 ng-I-TEQ/Kg d.w.)[7] except for the one in the sampling station I6 that is significantly higher than the others. Fig.2 and 3 shows the concentration distribution of congener of PCDD/Fs in ambient air collected in different time. In Fig.3, we have observed that the patterns of congeners in the industrial areas are very similar to those in the pasturage areas. However, it is not the case for the patterns shown in Fig.2. One possible explanation for this difference may be due to the strong northeastern season wind during the winter period. It will play an important role in the mixing and transportation of PCDD/Fs in the ambient air.

Acknowledgments
We would like to express our deep gratitude to all the kind assistances from both the Department of Air Quality Protection & Noise Control and the Department of Environmental Monitoring & Information Management, Taiwan EPA during the period of this investigation work.

Reference

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Table 1　Summary of concentration in ambient air.

	Sampling station	Sample	Concentration range (pg I-TEQ/Nm^3)	Average (pg I-TEQ/Nm^3)
All area	19	46	0.015~0.261	0.070
Industry area	10	20	0.015~0.261	0.071
Pasturage area	6	12	0.018~0.148	0.065
Heavy traffic	3	6	0.030~0.133	0.075

Table 2　Summary of concentration in soil.

	Sampling station	Sample	Concentration range (ng I-TEQ/Kg d.w.)	Average (ng I-TEQ/Kg d.w.)
All area	7	7	0.464~18.1	3.90
Industry area	4	4	0.818~18.1	6.28
Pasturage area	2	2	0.464~0.991	0.728
Heavy traffic	1	1	0.729	0.075

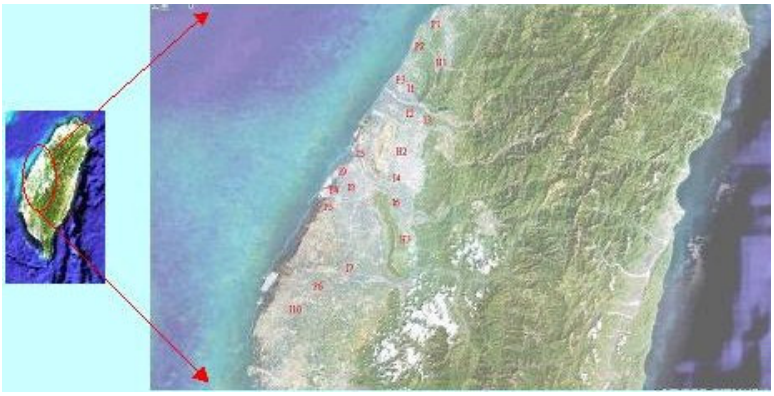

Figure 1 Location of sampling station in central of Taiwan

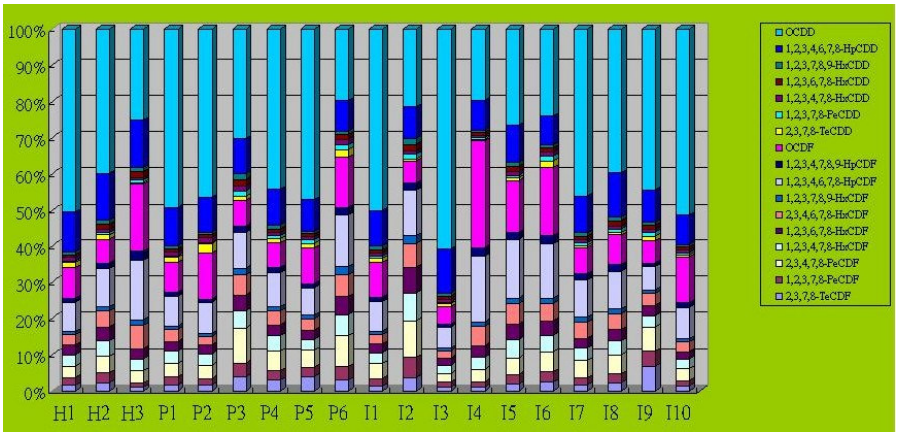

Figure 2 Concentration distribution of congener of PCDD/F in ambient air on October 2006

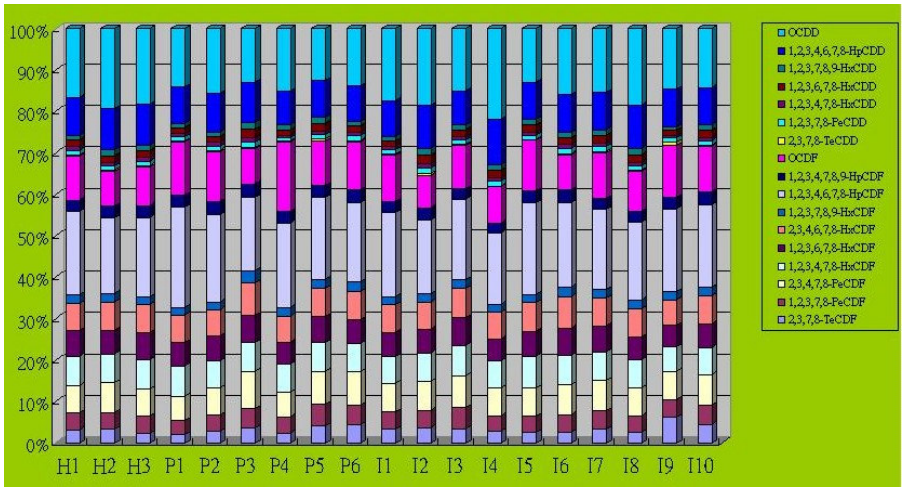

Figure 3 Concentration distribution of congener of PCDD/F in ambient air on January 2007.

COMPARISON OF DIFFERENT EXTRACTION TECHNIQUES FOR THE DETERMINATION OF PCDD/Fs IN SOIL AND SEDIMENT

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Introduction

The determination of polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/Fs) requires complicated and time-consuming procedures in sample extraction and clean up. Conventional Soxhlet extraction is probably the most widely used extraction method for organics in different matrix. There are many alternative methods applied for reducing time and solvent consumption. Accelerated Solvent Extraction[1,2] (ASE) and Microwave-Assisted Extraction[3] (MAE) extract samples under relative high temperature and pressure. Soxtherm is a kind of automated soxhlet extraction using shorter extraction time[4]. Shake Solvent Extraction[5] (SSE), a sample pretreatment procedure of DR CALUX®, is a low cost technique available by only flasks and shakers. To compare performances of these extraction techniques, validation tests with these five methods were carried out by analysis of two kinds of certified reference materials EDF-2513 (soil) and DX-1 (sediment) in this investigation.

Materials and Methods

Sample extraction

0.5g EDF-2513 (Cambridge Isotope Laboratories) and 1g DX-1 (National Water Research Institute, Canada) were weighed in quadruplicate. All samples were spiked with ^{13}C-isotopes labeled PCDD/Fs internal standards prior to extraction. Conditions used to extract PCDD/Fs are list in Table 1.

Table 1. extraction conditions for Soxhlet, MAE, ASE, Soxtherm and SSE

Method	Solvent	Extraction conditions	Apparatus
Soxhlet	toluene 300 mL	24hr	
MAE	toluene/acetone (4:1 v/v) 50 mL	Extraction temperature 125℃; hold 20 min	CEM MARS
ASE	toluene	Pressure 2500 psi; temperature 195℃; flush volume 90%; purge time 60 s; static time 5 min	DIONEX ASE 200
Soxtherm	toluene 135 mL	Hot extraction 270℃ 1 hr; rinsing time 1.5 hr	Gerhardt SOX416
SSE	30 mL water/isopropanol (1:1 v/v); 30mL n-hexane/diethyl ether (DEE)(97:3 v/v) as extraction solution	Shake 200±20 strokes per minute for 1 hr then transfer the organic layer; repeat adding again 30.0 mL extraction solution and shaking for 30 min and transfer twice.	

Clean-up

Extracts were concentrated to dryness and solvent exchanged to n-hexane for further clean-ups using

sulfuric acid silica gel and activated carbon column kits[4] (CAPE).

HRGC/HRMS

The analysis of samples was performed on a HRGC (HP 6890)/ HRMS (JEOL JMS-700) using DB-5MS column. Compounds identification and quantitative analysis were done by isotope dilution following the USEPA Method 1613B.

Results and Discussion

Table 2 shows the mean concentrations (n=4) of PCDD/Fs obtained by each of the five extraction methods in comparison with the certified value. To compare the mean recoveries obtained by individual method, the ratios of the method value to the certified value for each PCDD/Fs congener are given in fig. 1. Data form all methods, excluding SSE, are within the Lower and Upper bounds for the reference material. Most of the values obtained from ASE and Soxtherm approaches have higher than those from classic Soxhlet extraction. The values obtained using MAE were comparable to the soxhlet results however they were consistently lower the certified reference value (73% to 93%). In comparison, shake solvent extraction was not very efficient since only four congeners were within the certified values acceptance criteria.

The reproducibility of all extraction methods is expressed by the relative standard deviation (RSD) showed in Table2. The RSD values ranged from 4.3 to 9.1% for Soxhlet and from 3.7 to 9.1% for MAE, from 2.3 to 11.1% for ASE, from 1.5 to 10.6% for Soxtherm and from 2.5 to 16.5% for SSE. The mean RSD of each method ranged from 4.6% (Soxtherm) to 8.3% (SSE).

Table 2 concentration (ng/g) of PCDD/Fs in the EDF-2513 obtained by different extraction techniques

Compound	Soxhlet(n=4)		MAE(n=4)		ASE(n=4)		Soxtherm(N=4)		SSE(n=4)		EDF-2513		
	mean	RSD(%)	mean	RSD(%)	mean	RSD(%)	mean	RSD(%)	mean	RSD(%)	Target value	Lower Bound	Upper Bound
2,3,7,8-TeCDF	0.462	9.1	0.402	3.7	0.507	6.4	0.531	4.9	0.135	9.4	0.5	0.26	0.64
1,2,3,7,8-PeCDF	0.952	6.3	0.873	7.1	1.06	3.8	1.13	1.5	0.313	7.2	1.0	0.59	1.15
2,3,4,7,8-PeCDF	0.940	6.7	0.847	5.6	1.02	5.1	1.10	3.6	0.355	7.2	1.0	0.41	1.31
1,2,3,4,7,8-HxCDF	0.927	8.1	0.820	6.6	1.04	4.4	1.07	3.4	0.395	7.3	1.0	0.53	1.23
1,2,3,6,7,8-HxCDF	0.957	7.1	0.93	5.8	1.09	2.3	1.11	3.5	0.403	8.1	1.0	0.34	1.56
2,3,4,6,7,8-HxCDF	0.940	6.2	0.897	8.1	1.03	3.9	1.13	5.2	0.453	7.7	1.0	0.48	1.35
1,2,3,7,8,9-HxCDF	0.924	8.4	0.845	3.7	0.980	7.6	1.05	4.2	0.316	11.2	1.0	0.39	1.26
1,2,3,4,6,7,8-HpCDF	1.55	8.3	1.31	3.7	1.54	4.7	1.62	2.5	0.679	7.7	1.5	0.52	2.01
1,2,3,4,7,8,9-HpCDF	1.38	8.9	1.20	9.1	1.56	4.5	1.55	4.4	0.564	10.9	1.5	0.25	1.98
OCDF	2.28	6.7	2.17	6.4	2.35	4.9	2.58	5.6	1.03	16.5	2.5	1.17	3.33
2,3,7,8-TeCDD	0.421	7.4	0.375	7.1	0.553	11.1	0.514	5.7	0.112	8.5	0.5	0.26	0.67
1,2,3,7,8-PeCDD	0.944	7.4	0.852	5.7	1.03	4.2	1.00	5.2	0.308	9.2	1.0	0.56	1.37
1,2,3,4,7,8-HxCDD	0.821	9.1	0.726	7.8	0.953	4.1	0.928	5.8	0.372	7.2	1.0	0.50	1.29
1,2,3,6,7,8-HxCDD	0.836	8.6	0.790	8.1	0.852	3.2	0.933	10.6	0.382	8.3	1.0	0.52	1.21
1,2,3,7,8,9-HxCDD	0.883	7.7	0.766	6.4	0.921	2.7	0.874	4.6	0.384	2.5	1.0	0.46	1.33
1,2,3,4,6,7,8-HpCDD	1.38	6.2	1.28	3.7	1.47	4.4	1.56	3.4	0.726	6.3	1.5	0.71	2.07
OCDD	3.73	4.3	2.96	4.9	3.52	8.9	3.40	3.8	1.89	6.1	3.5	1.98	5.03
Average RSD(%)		7.5		6.1		5.1		4.6		8.3			

Concentrations and the reproducibility of PCDD/Fs from reference sediment DX-1 are summarized in Table 3 for the different extraction methods. The ratios of the method value to the certified value for each PCDD/Fs congener are shown in fig. 2. Excepting 2,3,7,8-TeCDF, recoveries were higher than 85%, varying between 91 to 175% for soxhlet extraction; 86 to 185% for MAE and 85 to 185% for ASE. Soxtherm is comparable to these three methods with slightly lower recovery ranges. Similarly to EDF-2513 case, lower recovery were observed for solvent shake extraction. However, only two

congeners, namely 2,3,7,8-TeCDF and 2,3,7,8-TeCDD, were outside the acceptance criteria. For the other congeners, recoveries ranged from 76 to 151% using SSE.

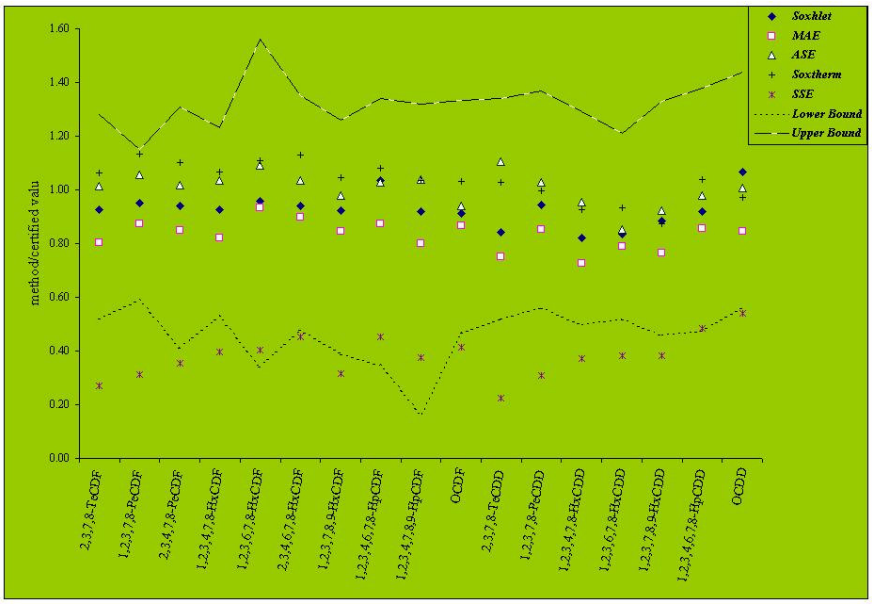

Fig.1 ratio of method value to certified value for PCDD/Fs extracted from EDF-2513

The reproducibility of all extraction methods is better than that in the extractions of EDF-2513. The RSD values ranged from 2.1 to 7.1% for Soxhlet and from 1.3 to 11.5% for MAE, from 1.9 to 6.6% for ASE, from 0.7 to 4.3% for Soxtherm and from 0.9 to 27.4% for SSE. The mean RSD of each method ranged from2.4% (Soxtherm) to 5.4% (SSE) showed good precision for most of extraction methods.

There was a high RSD value (OCDD, 27.4%) in SSE that came from a notable high value in one of the four experiment data (5797, 3594, 3534, and 3510 pg/g, respectively). If this data was excluded, SSE showed better yield and reproducibility in extracting DX-1 than EDF-2513. This is probably because DX-1 (sediment) is smaller and lighter than EDF-2513 (soil). Such fine particles suspend readily and contact with solvent more frequently.

MAE, ASE, and Soxtherm have been proved to be comparable with traditional Soxhlet method for extracting PCDD/Fs from soil and sediment reference material in this investigation. All of them can reduce extraction time and solvent consumption. Solvent shake extraction is an alternative technique, but the operating parameters must be optimized to obtain good performance.

References

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Table 3 concentration (pg/g) of PCDD/Fs in the DX-1 obtained by different extraction techniques

Compound	Soxhlet(n=4)		MAE(n=4)		ASE(n=4)		Soxtherm(N=4)		Shake(n=4)		DX-1		
	mean	RSD(%)	mean	RSD(%)	mean	RSD(%)	mean	RSD(%)	mean	RSD(%)	Certified value	Lower Bound	Upper Bound
2,3,7,8-TeCDF	52	6.4	48	4.1	48	3.2	49	4.5	38	4.1	89	45	133
1,2,3,7,8-PeCDF	47	6.7	45	3.2	46	2.0	43	1.6	36	1.9	39	25	53
2,3,4,7,8-PeCDF	91	2.1	93	1.3	91	2.8	92	0.7	83	4.4	62	30	94
1,2,3,4,7,8-HxCDF	681	2.4	629	4.8	671	3.4	600	2.4	544	2.3	714	438	990
1,2,3,6,7,8-HxCDF	138	7.1	137	5.5	137	2.6	132	3.0	123	1.3	116	79	153
2,3,4,6,7,8-HxCDF	66	5.9	64	2.1	67	2.9	62	1.9	56	4.9	57	21	93
1,2,3,7,8,9-HxCDF	49	6.1	52	1.8	52	4.0	49	2.6	42	2.9	28	0	70
1,2,3,4,6,7,8-HpCDF	2723	5.9	2608	1.5	2620	3.8	2458	1.4	2288	2.9	2397	1601	3193
1,2,3,4,7,8,9-HpCDF	157	4.4	155	2.2	164	4.3	151	2.9	133	0.9	137	75	199
OCDF	7733	5.0	7208	3.1	7286	3.0	6666	4.3	6060	5.4	7122	4716	9528
2,3,7,8-TeCDD	278	4.2	250	2.5	260	1.9	258	0.9	197	2.7	263	210	316
1,2,3,7,8-PeCDD	26	7.0	24	3.8	24	3.2	22	1.3	20	4.0	22	14	30
1,2,3,4,7,8-HxCDD	22	4.1	23	11.5	24	6.4	21	4.2	20	4.4	23	16	30
1,2,3,6,7,8-HxCDD	87	5.9	73	5.3	79	6.6	74	3.1	67	3.5	77	50	104
1,2,3,7,8,9-HxCDD	48	4.3	46	2.6	45	3.0	44	2.9	44	10.2	53	29	77
1,2,3,4,6,7,8-HpCDD	709	4.7	680	3.0	709	2.2	638	2.4	611	7.9	634	452	816
OCDD	4372	5.7	4163	2.4	4201	2.3	3779	1.7	4109	27.4	3932	2999	4865
Average RSD(%)		5.1		3.6		3.4		2.4		5.4			

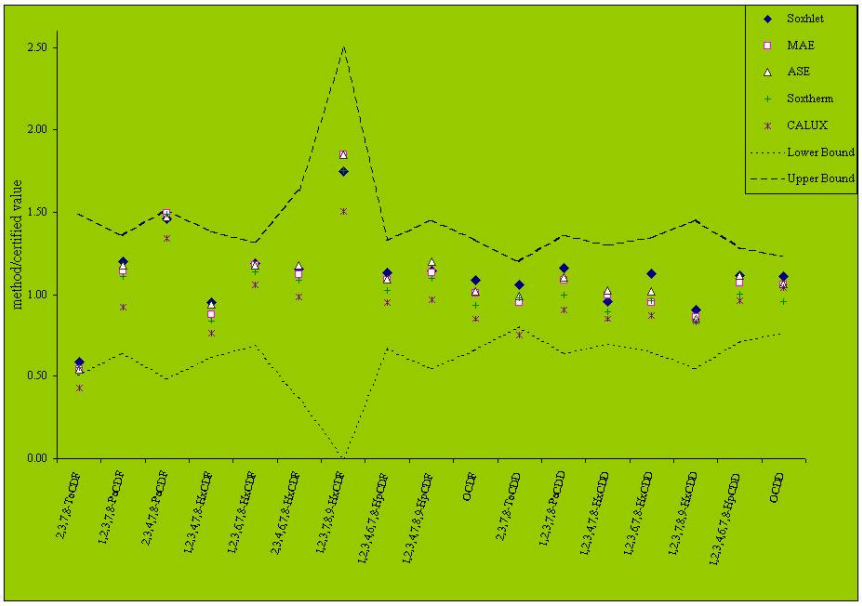

Fig. 2 Ratio of method value to certified value for PCDD/Fs extracted from DX-1

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O-143 **EVIDENCE FOR A DECLINE IN BACKGROUND EXPOSURE OF AMERICANS TO DIOXINS FROM THE 1990'S TO THE 2000'S**

Matthew Lorber, Donald G. Patterson, Jr., Janice Huwe[3], and Larry L. Needham

O-48 **TEMPORAL TREND IN THE LEVELS OF PCDD/Fs IN PLASMA OF A NONOCCUPATIONALLY EXPOSED POPULATION LIVING NEARBY A HAZARDOUS WASTE INCINERATOR**

Nadal Marti, Perelló Gemma, Schuhmacher Marta., Cid Joan and Domingo Jose L

O-475 **CONCENTRATIONS OF PERSISTENT ORGANIC CHEMICALS IN POOLED SERUM FROM CHILDREN PARTICIPATING IN NHANES 2001-2002**

Larry L. Needham, Antonia M. Calafat, Wayman Turner, Andreas Sjödin, and Lee-Yang Wong

O-469 **VARIATION IN SEVERAL CLASSES OF POPs (PCDD/Fs, PCBs, PBDEs, HBCDs) FROM A SINGLE WOMAN WITHIN AND BETWEEN TWO LACTATIONS**

John Jake Ryan, Bruce C. Wainman[1], Dorothea F. Rawn, Wing F. Sun, Ivana Kosarac and Amy Sadler

O-334 **DDTs AND OTHER PERSISTENT ORGANIC POLLUTANTS IN PLASMA OF DELIVERING WOMEN FROM SELECTED AREAS OF SOUTH AFRICA – RESULTS OF A PILOT STUDY**

Röllin HB, Sandanger TM, Odland J Ø,

O-123 **Relationship between child birth weight and concentration of polychlorinated biphenyls (PCBs) of the mother in Japan.–Tohoku Study of Child Development (TSCD)–**

Naoyuki Kurokawa[1], Kunihiko Nakai[1], Keita Suzuki[1,2], Tomoyuki Nakamura[1,4], Kozue Sakurai[1], Miyuki Shimada[1], Takashi Ohba[1], Chieko Satoh[1], Satomi Kameo[1], Kunihiro Okamura[3], Hiroshi Satoh[1]

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O-122 **HEXABROMOCYCLODODECANE IN HUMAN BREAST MILK: LEVELS ANDENANTIOMERIC PATTERNS**

Guerra P, Martínez E, Farré M, Eljarrat E, Barceló D

O-57 **U.S. CURRENT PBDE LEVELS AND CONGENERS: HUMAN MILK AND BLOOD; INDIVIDUAL MILK/BLOOD PARTITIONING; LEVELS IN VEGETABLES; AND FAST FOOD PER SERVING**

Schecter, A. J., Shah, N. C., Brummitt, S., Harris, T. R., Päpke, O.

O-427 **Hair as an Indicator of Dietary Exposure to Polycyclic Aromatic Hydrocarbons (PAHs) and Polybrominated Diphenyl Ethers (PBDEs)**

Youn Ju Ok., Donna Mooney ., Gon Ok., Kurunthachalam Kannan., Sunung Min Hwang

O-390 **SERUM PCB LEVELS IN THE U.S. POPULATION FROM THE 2003-2004 NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY**

Wayman E. Turner, Donald G. Patterson Jr., Lee-Yang Wong, Emily S. DiPietro, Troy P. Cash, P. Cheryl McClure and Larry L. Needham

O-286 **PHENOLIC ORGANOHALOGENATED CONTAMINANTS IN HUMAN SERUM FROM BELGIUM AND ROMANIA**

Dirtu Alin C, Jaspers Veerle LB, Cernat Roberta, Neels Hugo, Covaci Adrian

O-225 **THIRD FOLLOW-UP OF A DUTCH COHORT STUDY ON THE EFFECTS OF OCCUPATIONAL EXPOSURE TO CHLOROPHENOXY HERBICIDES, CHLOROPHENOLS AND CONTAMINANTS**

Daisy Boers, Lutzen Portengen, Bas Bueno-de-Mesquita, Dick Heederik, Roel Vermeulen

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Dahlgren JG, Waters M, Klein J, Takhar H

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O-364 **AUTOMATION OF CHEMICAL ANALYSIS OF PCDD/FS, DIOXIN-LIKE PCBS, INDICATOR PCBS AND POLYBROMINATED DIPHENYL ETHERS IN FOOD AND FEED**

Traag WA, Immerzeel J, Onstenk C, Kraats C, Lee MK, Van der Weg G, Mol H, Hoogenboom LAP

O-811 **COUNTER-CURRENT CHROMATOGRAPHIC SEPARATION OF TOXAPHENE – PART 1: POLAR CONSTITUENTS**

Thomas Kapp†and Walter Vetter

O-615 **DETERMINATION OF PCBs, OC PESTICIDES, CHLOROBENZENES IN SLUDGE AND SEDIMENT SAMPLES BY GCxGC-ECD**

A. Muscalu[1, 2], E.J. Reiner[1], S. Liss

O-722 **DEVELOPMENT AND COMPARISON OF METHODS FOR THE SIMULTANEOUS DETERMINATION OF VOLATILE BROMINATED FLAME RETARDANTS AND DERIVATES IN WATER**

López Patricia, Brandsma Sico, Leonards Pim, de Boer Jacob

O-193 **MULTI-RESIDUE ANALYSIS OF PESTICIDES AND POPS IN FRUITS, VEGETABLES AND DRIED GINSENG POWDERS**

Douglas G. Hayward, Jon Wong, Frank J. Schenck, Kai Zhang, Alexander J. Krynitsky and Timothy Begley

O-685 **Screening of organohalogen compounds accumulated in marine mammals by using GC-HRTOFMS**

Matsukami H[1], Takemori H[1], Takahashi S[2], Isobe T[2], Takasuga T[1,2], Tanabe S

O-464 **THERMAL EXTRACTION AND ANALYSIS OF ATMOSPHERIC SEMIVOLATILE ORGANIC COMPOUNDS FROM MULTICAPILLARY COLLECTION DEVICES**

Rowe, Mark D., and Perlinger, Judith A

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O-42 **DISCUSSION ON THE SEPARATION OF 2378-SUBSTITUTED ISOMERS FROM ALL 136 TETRA- THROUGH OCTA- POLYCHLORINATED DIBENZO-P-DIOXINS AND DIBENZOFURANS ON SI-ARYLENE STATIONARY PHASE**

Fishman VN, Martin GD, Wilken M

O-849 **UTILISING THE ENHANCED RESOLUTION OF ULTRA PERFORMANCE LIQUID CHROMATOGRAPHY TO INCREASE THE NUMBER OF TARGET ANALYTES WITHIN MULTI-RESIDUE METHODS**

Worrall, K; Morphet, J; Hancock, P

O-677 **COMPARISON OF QUANTIFICATION METHODS FOR ANALYSIS OF POLYCHLORINATED ALKANES MEASURED WITH ELECTRONE CAPTURE NEGATIVE IONIZATION**

Rusina Tatsiana, Korytár Peter, de Boer Jacob

O-213 **The Application of Large Volume Injection Techniques for increased Productivity and Sensitivity in Routine POPs Analysis with GC-HRMS and TripleQuad GC-MS**

Krumwiede D.[1], Munari F.[2], Münster H.[1]

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K-514 **DIOXINS, FURANS AND DIOXIN-LIKE PCBs IN AMBIENT AIR FROM CAMP DE TARRAGONA (CATALONIA, SPAIN). SEASONAL VARIATION.**

Gasser M, Martí R, Montaña MJ, Díaz-Ferrero J

O-344 **EVALUATION OF ATMOSPHERIC DIOXIN DEPOSITION IN NORTHERN TAIWAN VIA AUTOMATED AND TRADITIONAL SAMPLERS**

Chi KH[1] , Lee TY[2] , Liu KT[3], Chang SH[3], Chang MB[3]

O-224 **EXPOSURE ASSESSMENT OF WORKERS TO PCDD/Fs AND WHO-12 PCBs AT AN ELECTRIC ARC FURNACE AND A BASIC OXYGEN STEELMAKING PLANT IN THE UK**

Eric Aries, Raymond Fisher, David R. Anderson

O-231 **ATMOSPHERIC PERSISTENT ORGANIC POLLUTANTS IN MAINLAND CHINA RECORDED BY TREE BARKS AND A TREE BARK POCKET**

Zhao Yuli,[1)] Yang Limin[1)] and Wang Qiuquan*

K-521 **AIR CONCENTRATIONS OF PERSISTENT ORGANIC POLLUTANTS (POPS) IN URBAN AND INDUSTRIAL AREAS OF CENTRAL CHILE, USING PASSIVE AIR SAMPLERS**

Pozo Karla[1], Harner Tom[2], Rudolph Anny[3], Oyola German[4], Mariottini Michela[1], Volpi Valerio[1], Perra Guido[1], Ahumada-Rudolph Ramon[3], Medina Paulina[3], Mabilia Rosanna[5] and Focardi Silvano

O-141 **ATMOSPHERIC POP LEVELS AND TRENDS IN VARIOUS GEOGRAPHIC AND CLIMATIC CONDITIONS DERIVED FROM PASSIVE AIR SAMPLING**

Klánová Jana, Čupr Pavel, Kohoutek Jiří, Holoubek Ivan

O-455 **ATMOSPHERIC TRANSPORT AND AIR-WATER EXCHANGE OF HEXACHLOROBENZENE IN LAKE SUPERIOR**

Perlinger, Judith A., Rowe, Mark D., and Tobias, David E.

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O-847 **On the potential origin of dioxins and furans from surface sediments and fish tissues from four regions in Mexico.**

J. Vinicio Macías-Zamora, Yunuén Canedo-López

O-817 **DIOXIN-LIKE PCB PATTERN IN SEDIMENTS AND COMPARISON WITH FISH**

Bhavsar SP[1], Reiner EJ[2], Fletcher R[1], Gewurtz SB[2, 3], Helm PA[1], Marvin CH[4], Hayton A[1]

O-147 **IMPACT OF MUNICIPAL SOLID WASTE INCINEARATORS ON AMBIENT SOIL PCDD/F LEVELS: A CASE STUDY IN HANGZHOU, CHINA**

Xu Meng-xia[1], Yan Jian-hua[1], Lu Sheng-yong[1], Li Xiao-dong[1], Chen Tong[1], Ni Ming-jiang[1], Dai Hui-fen[2] and Cen Ke-fa

O-462 **PBDES IN SURFICIAL SEDIMENTS OF THE GREAT LAKES: LAKES SUPERIOR, HURON AND MICHIGAN**

Li Shen, Sarah Gewurtz, Eric Reiner, Terry Kolic, Karen MacPherson, Paul Helm, Todd Howell, Debbie Burniston, Ian Brindle, Chris Marvin

O-125 **LEVELS PBDES IN SEDIMENT FISH AND SEA EAGLES FROM SYDNEY HARBOUR, AUSTRALIA: SPATIAL PATTERNS AND PROFILES.**

Roach Anthony[1], Symons Robert[2], Stevenson Gavin[2] and Therese Manning[1]

O-31 **LEVELS AND FATE OF PERSISTENT ORGANIC POLLUTANTS IN MOUNTAIN SOILS**

Kukučka P, Klánová J, Holoubek I

O-855 **IN VITRO ASSESSMENT OF INTERACTION OF HUMIC SUBSTANCES WITH 2,3,7,8-TCDD**

Bittner Michal, Hilscherova Klara[1] and Giesy John P.

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O-577 **PCBs, PBDEs AND THEIR HYDROXYLATED METABOLITES IN SERUM OF FREE-RANGING HARBOUR SEALS (*PHOCA VITULINA*): LEVELS AND PROFILES**

Weijs Liesbeth, Das Krishna, Siebert Ursula, Neels Hugo, Blust Ronny and Covaci Adrian

O-831 **BIOACCUMULATION OF PBDES AND HBCD IN THE NORTHWEST ATLANTIC MARINE FOOD WEB**

Shaw, Susan D, Berger, Michelle L, Brenner, Diane, Lohmann, Nina, and Paepke, Olaf

O-563 **BIOACCUMULATION OF BROMINATED FLAME RETARDANTS IN HARBOUR SEAL**

Leonards Pim, Jol Johan1, Brandsma Sicco, Kruijt Alwin, Kwadijk Christiaan, Vethaak Dick, De Boer Jacob

O-629 **HOW IMPORTANT ARE THE HYDROXYLATED PCB METABOLITES (OH-PCB) IN HARBOUR SEALS (*PHOCA VITULINA*)?**

Løken Katharina B., Lie Elisabeth, Sørmo Eugen Gravningen, Jenssen Bjørn Munro, Skaare Janneche Utne

O-416 **CONTAMINANTS IN BALTIC SEA MALE AND FEMALE GREY SEALS (*HALICHOERUS GRYPUS*) OF DIFFERENT AGES**

Lundstedt-Enke Katrin, Roos Anna, Nylund Kerstin and Asplund Lillemor

O-617 **BROMINATED ORGANIC COMPOUNDS IN A HIGH TROPHIC ARCTIC FISH SPECIES, GREENLAND SHARK *(SOMNIOSUS MICROCEPHALUS)***

Anna Strid, Maria Athanasiadou, Ioannis Athanassiadis, Jörundur Svavarsson and Åke Bergman

O-781 **CONCENTRATIONS OF ORGANOBROMINATED COMPOUNDS OF NATURAL AND INDUSTRIAL ORIGIN IN TOP PREDATORS FROM BRAZILIAN WATERS**

Dorneles Paulo, Lailson-Brito José, Covaci Adrian, Dirtu Alin C., Weijs Liesbeth, Azevedo Alexandre, Torres João, Malm Olaf, Neels Hugo , Blust Ronny and Das Krishna

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O-755 **DIOXIN CONGENER PROFILES OF HOUSEHOLD DUST SHAPED BY INDOOR ACTIVITIES**

Yves Tondeur, Ph.D., Jerry Hart

O-610 **POLYCHLORINATED BIPHENYLS (PCBS) AND INDOOR AIR: SOURCE INVESTIGATION AND REMEDIAL APPROACH FOR A PUBLIC SCHOOL BUILDING IN NEW BEDFORD, MASSACHUSETTS, USA**

Sullivan, D M, Hunt, G T, Alfonse, S

O-74 **TRI- TO DECABROMINATED DIPHENYL ETHERS AND HBCD IN INDOOR AIR AND DUST FROM STOCKHOLM MICROENVIRONMENTS**

de Wit Cynthia A., Thuresson Kaj and Björklund Justina

O-220 **POLYBROMINATED DIPHENYL ETHERS IN THE INDOOR ENVIRONMENT – PRELIMINARY RESULTS FROM AN EXPOSURE STUDY IN DENMARK**

Vorkamp Katrin[a]; Frederiksen Marie; Thomsen Marianne

O-479 **PBDEs FATE IN THE INDOOR ENVIRONMENT- A MULTIMEDIA MODEL STUDY**

Zhang X, Diamond M, Harrad S [2], Ibarra C

O-267 **IDENTIFYING SOURCES OF DECA-BDE IN INDOOR ENVIRONMENTS USING FORENSIC MICROSCOPY**

Webster, Thomas F.; Harrad, Stuart; Millette, James R.;Holbrook, R. David; Davis, Jeff M.; Stapleton, Heather M.; Allen, Joseph G.; McClean, Michael M.; Ibarra, Catalina;Abou-Elwafa Abdallah, ohamed; Covaci, Adrian

O-323 **DUST FROM PRIMARY SCHOOL AND NURSERY CLASSROOMS IN THE UK: ITS SIGNIFICANCE AS A PATHWAY OF EXPOSURE OF YOUNG CHILDREN TO PFOS, PFOA, HBCDS, AND TBBP-A**

Goosey Emma, Abou-Elwafa Abdallah Mohamed and Harrad Stuart

O-146 **PFOS AND PFOA IN DUST FROM STOCKHOLM MICROENVIRONMENTS**

Björklund Justina, Thuresson Kaj and de Wit Cynthia A.

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O-824 **DECLINING LEVELS OF PERSISTENT ORGANIC POLLUTANTS IN SCOTTISH FRESHWATERS**

Macgregor Kenneth, Peters Adam, Harris Lynsay

O-418 **ANALYSIS OF FISH TISSUE CONCENTRATIONS OF DIOXINS AND FURANS USING PRINCIPAL COMPONENTS ANALYSIS (PCA)**

Tachovsky JA[1], Harris MA[2], Staskal DF[1], Scott LF[2], Luksemburg WJ[3], Paustenbach DP[4], Haws LC[1]

O-586 **UNEXPLAINED GONAD ALTERATIONS IN WHITEFISH FROM LAKE THUN, SWITZERLAND: LEVELS OF PERSISTENT ORGANIC POLLUTANTS IN DIFFERENT MORPHS**

Christian Bogdal, Peter Schmid, Michael Naef, Markus Zennegg, Martin Kohler, Daniel Bernet, Martin Scheringer and Konrad Hungerbühler

O-656 **BIOACCUMULATION OF POLYCHLORINATED BIPHENYLS IN LEOPARD FROGS FROM MAJOR RIVER BASINS AND A WETLAND**

JEONG Gi Ho, MOON Ji Yong, KIM Young Bok, LEE Eun-Hwa, CHOI Kyunghee

O-640 **GEOGRAPHICAL DISTRIBUTION OF PBDEs AND PCBs IN SAN FRANCISCO BAY**

She Jianwen, Adelsbach Terrence L, Yee Julie L, Zhu Kunning[1], Lunder Sonya, Sharp Renee[4] and Schwarzbach Steven E.

O-581 **ORGANOHALOGEN COMPOUNDS IN THE EGGS OF PEREGRINE FALCONS AND OTHER WILD BIRD SPECIES IN BADEN-WÜRTTEMBERG – PRESENT STATE AND TIME TREND**

von der Trenck KT[1], Schilling F[2], Schmidt D[3], Behnisch PA[4], Brouwer A[4]

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O-756 **EFFECTS OF PH ON THE WATER SOLUBILITY AND 1-OCTANOL PARTITION COEFFICIENT OF TETRABROMOBISPHENOLA**

Kuramochi Hidetoshi, Kawamoto Katsuya, Sakai Shin-ichi

O-331 **LEVELS OF BROMINATED DIPHENYLETHER, DIBENZO-*P*-DIOXIN, AND DIBENZOFURAN IN FLUE GASES OF A MUNICIPAL WASTE COMBUSTOR**

Barbara Wyrzykowska, Brian K. Gullett, Dennis Tabor, Abderrahmane Touati

O-625 **AEROBIC AND ANAEROBIC DEGRADATION OF POLYBROMINATED DIPHENYL ETHERS IN SEWAGE SLUDGE**

Stiborová Hana, Zlámalíková Jana, Pulkrabová Jana, Hrádková Petra, Nápravníková Michaela, Hajšlová Jana, Macková Martina and Demnerová Kateřina

O-796 **PBDEs IN DUST FROM PRINTED CIRCUIT BOARD RECYCLING AT AN E-WASTE HOTSPOT IN SOUTHEASTERN CHINA**

Leung AOW, Zheng GJ, Wong MH

O-374 **FLAME RETARDANTS IN INDOOR AIR AND DUST OF A HOTEL IN JAPAN**

Hidetaka Takigami, Go Suzuki, Yasuhiro Hirai, Yukari Ishikawa, Masakiyo Sunami, Shin-ichi Sakai

O-646 **THE EFFECT OF LIGHT ON HEXABROMOCYCLODODECANEs (HBCDs) IN INDOOR DUST**

Abou-Elwafa Abdallah Mohamed, Harrad Stuart, Covaci Adrian

O-647 **CAN BIOTRANSFORMATION OF BDE-209 CAUSE BIOACCUMULATION OF MORE TOXIC, LOWER BDEs (e.g., BDE-47, -99) IN FISH OVER THE LONG TERM?**

Bhavsar Satyendra P_{1}, Gandhi Nilima$_{2}$, Gewurtz Sarah $B_{1,3}$, Tomy Gregg$_{4}$, Stapleton Heather M_{5}

O-139 **MODELING THE CONTRIBUTION OF DECA-BDE TO LEVELS OF LIGHT PBDES IN THE ENVIRONMENT: THE IMPORTANCE OF DIRECT PHOTOLYSIS**

Schenker U, Soltermann F, Scheringer M, Hungerbühler K

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O-131 **POLYBROMINATED BIPHENYLS IN TASMANIAN DEVILS AS DETERMINED BY GC/ECNI-MSMS AND GC/EI-HRMS MEASUREMENTS**

Walter Vetter, Roland von der Recke, Robert Symons and Stephen Pyecroft

O-234 **PULSED LARGE VOLUME INJECTION GC-MS IN ELECRON CAPTURE NEGATIVE IONIZATION MODE UTILIZING ISOTOPIC DILUTION FOR SIMULTANEOUS DETERMINATION OF PBDEs, PBBs, PCBs AND OCPs**

Zhao Yuli Yang Limin and Wang Qiuquan

O-426 **IDENTIFICATION OF THE BROMINE COMPONENT PRESENT IN INDOOR DUST**

Go SUZUKI[1,2], Akiko KIDA[1], Shin-ichi SAKAI[3], and Hidetaka TAKIGAMI

O-447 **GAS CHROMATOGRAPHIC RETENTION DATA OF ENVIRONMENTALLY RELEVANT POLYBROMINATED COMPOUNDS**

Natalie Rosenfelder and Walter Vetter

O-490 **DART–TOFMS: A CHALLENGING APPROACH IN RAPID MONITORING OF BROMINATED FLAME RETARDANTS IN ENVIRONMENTAL MATRICES**

Hajslova Jana, Vaclavik Lukas, Pulkrabova Jana, Poustka Jan and Cajka Tomas

O-451 **ANALYSIS AND OCCURRENCE OF NEW BROMINATED FLAME RETARDANTS IN THE ENVIRONMENT**

Leonards Pim, Lopez Patricia and De Boer Jacob

P-819 **HBCD stereoisomers: Thermal interconversion and enantiospecific trace analysis in biota**

Robert Köppen, Roland Becker, Marcus Weber, Vedat Durmaz, Irene Nehls

O-199 **Identification of decabromodiphenyl ethane (DBDPE) in plastics by thermal desorption GC-MS**

Franky Puype[1] and Jiří Samsonek[1]

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O-167 **ALTERNATE AND NEW BROMINATED FLAME RETARDANTS DETECTED IN U.S. HOUSE DUST**

[1]Stapleton, Heather M., Allen, Joseph G., Kelly, Shannon M., Konstantinov, Alex, Klosterhaus, Susan, McClean, Michael D., Webster, Thomas F

O-104 **HEXABROMOCYCLODODECANES AND TETRABROMOBISPHENOL-A IN INDOOR AIR AND DUST IN BIRMINGHAM, UK: IMPLICATIONS FOR HUMAN EXPOSURE**

Abou-Elwafa Abdallah Mohamed, Harrad Stuart Covaci Adrian

O-101 **DIETARY EXPOSURE TO PBDES AND LEVELS IN BREAST MILK OF WOMEN LIVING IN CENTRAL ITALY**

Guerranti Cristiana, Mariottin Michela, Focardi Silvano

O-422 **PRINCIPAL COMPONENTS ANALYSIS (PCA) OF PBDE CONCENTRATIONS IN FISH TISSUE FROM SOUTHERN MISSISSIPPI**

Tachovsky JA, Staskal DF, Harris MA, Scott LF, Luksemburg WJ Paustenbach DP[4], Haws LC

O-421 **COMPUTATIONAL ECOTOXICOLOGY; MODELLING THE BIOMAGNIFICATION OF ORGANOCHLORINES AND BROMINATED FLAME RETARDANTS IN A BALTIC SEA FOOD WEB**

Lundstedt-Enke, Katrin Lek, Per M. Lundstedt, Torbjörn and Örberg, Jan

O-232 **PBDEs IN HUMAN PLACENTA - PRELIMINARY CONCENTRATION LEVELS AND CORRELATIONS WITH PHYSIOLOGICAL PARAMETERS**

Frederiksen Marie, Thomsen Marianne, Vorkamp Katrin, and Knudsen Lisbeth E.

O-24 **POLYBROMINATED DIPHENYL ETHER (PBDE) CONCENTRATIONS DECREASE WITH AGE: ANALYSIS OF POOLED HUMAN BLOOD SERUM IN THE AUSTRALIAN POPULATION**

Leisa-Maree L. Toms, Andreas Sjödin, Olaf Paepke, Fiona Harden, Peter Hobson, Laurence Hearn, Richard Jones, Emily Edenfield and Jochen F. Mueller

O-145 **MATERNAL FISH CONSUMPTION REDUCES LIVER CONCENTRATIONS BUT DOES NOT AMELIORATE EFFECTS OF PBDE47 ON EARLY REFLEX DEVELOPMENT IN MURINE OFFSPRING**

Haave Marte[1], Folven Kristin Ingvaldsen [1], Glover Chris Neill [2], Lundebye Anne -Katrine

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O-405 **USE OF POLYFLUORINATED COMPOUNDS IN CONSUMER ARTICLES IN DENMARK**

Poulsen Pia Brunn, Jensen Allan Astrup, Bossi Rossana, Jensen Frank, Olsen Lona

O-621 **PER- AND POLYFLUORINATED COMPOUNDS IN HOUSE DUST AND INDOOR AIR OF NORTHERN NORWAY**

Huber Sandra, Småstuen Haug Line, Schlabach Martin

O-596 **PERFLUOROALKYL CONTAMINANTS IN WINDOW FILM: URBAN/RURAL, INDOOR/OUTDOOR, AND SUMMER/WINTER GRADIENTS**

Gewurtz Sarah B, Crozier Patrick W, Bhavsar Satyendra P, Diamond Miriam L, Helm Paul A, Marvin ChrisH, Reiner Eric J

O-589 **Polyfluorinated organic compounds (PFC) in wastewater treatment plants, fire drill sites and recipients in Norway**

Herzke D[a], Schlabach M[a], Green N[b]

O-252 **CONTAMINATION OF PERFLUORINATED COMPOUNDS IN WATER ENVIRONMENT OF ASIAN COUNTRIES**

S. Tanaka, S. Fujii, N.P.H.Lien, M. Nozoe, K. Chinagarn, K. Kimura, B. Shivakoti, A. Anton, M. Maketab, W. Wirojanagud, J.Y. Hu, S. Kitpati, J. Shimizu, S. Tittlemier, G. Lindstrom, and N. Saito

O-4 **LONGITUDINAL AND LATITUDINAL DISTRIBUTION OF POLYFLUORINATED COMPOUNDS IN SURFACE WATER IN THE ATLANTIC OCEAN**

Ahrens Lutz, Barber Jonathan L., Xie Zhiyong, Ebinghaus Ralf

O-533 **SPATIAL AND VERTICAL DISTRIBTUION OF PERFLUORINATED COMPOUNDS IN CANADIAN ARCTIC AND SUB-ARCTIC OCEAN WATER**

Rosenberg Bruno, DeLaronde Joanne, MacHutchon Allison, Stern Gary, Spencer Chris, Scott Brian, Lopez, Emma, Muir Derek and Tomy Gregg

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O-241 **SIGNIFICANT IMPROVEMENTS IN ANALYSIS OF PERFLUORINATED COMPOUNDS IN WATER AND FISH: RESULTS FROM AN INTERLABORATORY METHOD EVALUATION STUDY**

van Leeuwen Stefan, Swart Kees, van der Veen, Ike and de Boer, Jacob

O-568 **IMPORTANT CONSIDERATIONS IN SAMPLING, ANALYSIS, AND INTERPRETATION OF ANALYTICAL DATA FROM MEASUREMENTS OF HIGHLY FLUORINATED SUBSTANCES**

Mary A. Kaiser, Miguel A. Botelho, Catherine A. Barton, and Robert C. Buck, E. I. du Pont de Nemours

O-194 **A NEW ANALYTICAL METHOD FOR PERFLUORINATED COMPOUNDS USING ENZYMATIC DIGESTION COUPLED WITH SOLID PHASE EXTRACTION**

Wang Y, Yeung LWY, Taniyasu S, So MK, Lam PKS and Yamashita N

O-503 **Polymeric type polyfluorinated compounds in technical standards and from food contact materials**

Trier, X. T. [1,2], Christensen, J. H. [1] and Granby, K.

O-556 **POLYFLUOROALKYL CHEMICALS IN HOUSE DUST**

Kayoko Kato, Antonia M. Calafat, and Larry L. Needham

O-585 **PERFLUORINATED ACID ISOMER PROFILING IN OCEAN WATER BY LARGE VOLUME INJECTION-HPLC-MS/MS**

Benskin, Jonathan P; Yamashita, Nobuyoshi; Taniyasu, Sachi; Lam, Paul KS; Tomy, Gregg T; Muir, Derek CG; Scott, Brian F; Spencer, Christine; Rosenberg, Bruno; Martin, Jonathan W

O-55 **A SIMPLE AND SENSITIVE METHOD FOR DETERMINATION OF A WIDE RANGE OF POLYFLUORINATED COMPOUNDS IN SERUM**

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Trudel David, Horowitz Lea, Wormuth Matthias, Scheringer Martin, Cousins Ian T and Hungerbühler Konrad

O-358 **PFOA COMMUNITY HEALTH STUDIES: EXPOSURE VIA DRINKING WATER CONTAMINATED BY A TEFLON MANUFACTURING FACILITY**

Vieira Veronica, Webster Thomas, Bartell Scott, Steenland Kyle Savitz David, and Fletcher Tony

O-350 **SINGLE APPLICATION OF FIRE FIGHTING FOAM HAS INCREASED LEVELS OF PERFLUOROOCTANESULFONATE (PFOS) IN RECEIVING WATERS AND FISH**

Schlummer Martin[a], Gruber Ludwig[a], Schmitt Adam[b] and Lange Frank Thomas

O-509 **DETERMINATION OF PERFLUORINATED COMPOUNDS IN HUMAN MILK**

T. Bernsmann and P. Fürst

O-597 **DETERMINATION OF PERFLUORINATED ORGANIC COMPOUNDS IN FOOD AND DUST**

de Voogt P, van der Wielen FWM, Westerveld J, D'Hollander W, Bervoets L

O-343 **Polyfluoroalkyl chemicals (PFCs) in Australian human blood serum**

Leisa-Maree L. Toms, Antonia M. Calafat, Andreas Sjödin, Fiona Harden, Peter Hobson, Kayoko Kato, Jack Thompson and Jochen F. Mueller

O-258 **COMPETITIVE BINDING OF PERFLUORINATED COMPOUNDS TO THE THYROID HORMONE TRANSPORT PROTEIN TRANSTHYRETIN**

Weiss J M, Lamoree M H, Leonards P E G, van Leeuwen S P J, Hamers T

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Marie Russell, Lynda Webster, Pam Walsham, Gill Packer and Colin F. Moffat

O-177 **EXPLORING THE WAYS HOW CONTAMINATED SOILS AFFECT A GLOBAL FATE AND CYCLING OF POPS – CONCEPTUAL APPROACH**

Holoubek Ivan, Klanova Jana, Dusek Ladislav, Cupr Pavel, Koblizkova Martina, Ruzickova Petra, Kukucka Petr, Bartos Tomas, Hofman Jakub, Sanka Milan, Jarkovsky Jiri

O-240 **DISTRIBUTIONS AND SOURCES OF POLYCYCLIC AROMATIC HYDROCARBONS IN THE SURFACE SEAWATER FROM THE NORTHERN SOUTH CHINA SEA**

Cai MG*, Wang Y, Li WQ, Wang XH, Liu XY, Guo JQ, Qi AX, Sun JH, Qiu CR, Huang SY, Hong LY

O-346 **EVALUATION OF DIOXIN-LIKE POLLUTANTS IN AMBIENT AIR VIA LONG RANGE TRANSPORT**

Chi KH [1], Peng CM [2], Wang HS [3], Chang MB

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O-312 **APPLICATION OF NONLINEAR DOSE-RESPONSE METHODS BASED ON MODE OF ACTION SHOWS REDUCED CANCER RISKS FROM PCBs**

Keenan, Russell E., Gwinn, Patrick O., Schell, John D., Carlson, Erik A. and Silkworth, Jay B.

O-164 **WEIGHT OF EVIDENCE EVALUATION OF THE MODE OF ACTION FOR PCB-PROMOTED RAT LIVER TUMORS USING THE HUMAN RELEVANCE FRAMEWORK**

Golden, Robert, Carlson, Erik and Silkworth, Jay

O-132 **HEALTH RISK ASSESSMENT OF PCDD/Fs FOR A POPULATION LIVING IN THE VICINITY OF A HAZARDOUS WASTE LANDFILL**

Nadal Marti, Mari Montse, Schuhmacher Marta and Domingo José L.

O-198 **Mortality among Yusho patients: 40 Years of Follow-Up**

Takesumi Yoshimura, Daisuke Onozuka, Satoshi Kaneko, and Masutaka Furue

O-520 **EVALUATION ON TOXIC CONTRIBUTION OF PCDDs, PCDFs AND DIOXIN-LIKE PCBs DETERMINED IN THE PRESERVED UMBILICAL CORD OF YUSHO PATIENTS**

Junya Nagayama, Takashi Todaka , Hironori Hirakawa, Junboku Kajiwara, Takesumi Yoshimura, Masutaka Furue

O-495 **SUPERINDUCTION OF THE CALUX BIOASSAY BY ENVIRONMENTAL EXTRACTS: CONSIDERATIONS IN SAMPLE ANALYSIS AND POTENCY DETERMINATION**

David S. Baston, Elaine M. Khan and Michael S. Denison

O-124 **CALUX BIOASSAY AND ECOLOGICAL RISK ASSESSMENT OF PCDD/FS AND DL-PCBS IN SEDIMENT OF HAIHE RIVER, CHINA**

Bin Wang, Gang Yu, Tingting Zhang, Jun Huang, Tai Wang, Hiroshi Murata, Junqing Huang, Masafumi Nakamura

O-377 **ASSESSMENT OF THE IMPACT OF USING WEIGHTED DISTRIBUTIONS OF REPs TO DEVELOP EXPOSURE ESTIMATES FOR DIOXIN-LIKE COMPOUNDS**

Haws, Laurie C; Unice, Ken M; Tachovsky, Andrew; Harris, Mark A; DeVito, Mike J; Walker, Nige J; Birnbaum, Linda S; Farland, William H; Nguyen, Ly; and Staskal, Daniele F

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Mehran Alaee[1], Grazina Pacepavicius, Eric Reiner[2], Karen MacPherson[2], Laila Fayez, Teruyuki Nakao[3] and Souichi Ohta

O-785 **PROFILES OF DECHLORANE PLUS AND NEW RELATED COMPOUNDS IN A LAKE ONTARIO SEDIMENT CORE**

Sverko E, Reiner E, Marvin C H, Zaruk D, Arsenault G, McCrindle B, Shen L, Tomy G T, MacPherson K, McCarry B

O-140 **DETERMINATION OF SHORT-CHAIN CHLORINATED PARAFFINS BY CARBON SKELETON GAS CHROMATOGRAPHY**

Pellizzato Francesca, Ricci Marina, Held Andrea, Emons Hendrik

O-246 **HYDROXYLATED POLYCHLOROBORNANES – SYNTHESIS AND CHARACTERISATION OF NEW POTENTIAL TOXAPHENE METABOLITES**

Thomas Kapp and Walter Vetter

O-375 **THIRD GENERATION CALUX LUCIFERASE REPORTER VECTORS – AMPLIFICATION OF DIOXIN RESPONSIVE ELEMENTS DRAMATICALLY INCREASES CALUX BIOASSAY SENSITIVITY AND RESPONSIVENESS**

Guochun He, David S. Baston[1] M ichael S. D eniso n and Tomoaki Tsutsumi

O-430 **THE USE OF THE DR CALUX® ASSAY FOR IDENTIFICATION OF NOVEL RISKS**

Hoogenboom Ron, Van Ede Karin, Portier Liza, Bor Gerrit, Bovee Toine and Traag Wim

O-385 **APPLYING PRESSURIZED LIQUID EXTRACTION (PLE) AND AUTOMATED CLEANUP (Power Prep) FOR PBDD/F ANALYSIS IN SOIL**

Hagberg, J., Ábalos, M., Abad, E., van Bavel, B.

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Stuart Batterman, Sergei Chernyak, Chunrong Jia, Simone Charles, Christopher Godwin

O-313 **FLAME RETARDANTS IN THE ATMOSPHERE OF CITIES NEAR THE NORTH AMERICAN GREAT LAKES**

Marta Venier and Ronald A. Hites

O-322 **RESIDENTIAL EXPOSURE TO PBDEs: FROM PRODUCT TO PERSON**

Webster, Thomas F.; McClean, Michael M; Allen, Joseph G.; Stapleton, Heather M

O-871 **CONTINUING SOURCES OF PCBS: THE SIGNIFICANCE OF BUILDING SEALANTS**

Melymuk, Lisa, Robson, Matthew, Csiszar, Susan, Diamond, Miriam, Helm, Paul, Blanchard, Pierrette and Backus, Sean

O-848 **MINERALOGICAL, CHEMICAL AND TOXICOLOGICAL CHARACTERIZATION OF THE URBAN AIR PARTICLES**

Klánová Jana, Čupr Pavel, Franců Juraj, Flegrová Zuzana, Landlová Linda, Jiří Novák, Bartoš Tomáš

O-872 **Comparison of Concentrations and Loadings of PCBs and PAHs in Urban and Rural Streams during Base Flow and Storm Events**

Robson, Matthew, Melymuk, Lisa, Gilbert, Beth, Helm, Paul, Diamond, Miriam, Blanchard, Pierrette and Backus, Sean

O-696 **HYDROXYLATED PCBS AND PCBS; THEIR DETECTION IN WATER SAMPLES AND SUSPECTED SOURCES**

Satoshi Nanba, Yuma Shiki, Masahide Kawano, Muneaki Matsuda, Masatoshi Morita

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Seyed Jamaleddin Shahtaheri[1], Derek Stevenson[2], Peter Kwasowski[2]

O-150 **QUALITY ASSURANCE AND QUALITY CONTROL FOR SERUM DIOXIN ANALYSIS ON TRICHLOROPHENOL WORKERS IN NEW PLYMOUTH**

Michael Wilken, James J. Collins, Philip Bridgen, Noel Humphry

O-639 **SIMPLIFIED GEL PERMEATION METHOD FOR THE ANALYSIS OF PCDD/FS IN STACK EMISSION AND WASTE SOLID SAMPLES FROM VARIOUS THERMAL INDUSTRIAL PROCESSES**

Guerriero E, Rotatori M, Mosca S, Rossetti G, Manni A

O-583 **TOWARDS LESS MANIPULATED REFERENCE MATERIALS FOR FOOD AND ENVIRONMENTAL ANALYSIS**

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Abou-Elwafa Abdallah Mohamed and Harrad Stuart

O-414 **Validation Tests for PCDD/F Long-Term Monitoring Systems: Short Comings of Short Term Sampling and Other Lessons Learned**

Reinmann Jürgen[1*], Weber Roland [2], Watson Alan

O-830 **SITE CHARACTERIZATION USING A DIOXIN SCREENING METHOD: FORMER SAWMILL, CALIFORNIA, UNITED STATES OF AMERICA**

Croteau Darren, Bernhardt Todd, Holbrow Ann, Conti Edward, and Ellery Bob

O-584 **METHODS FOR COLLECTING SAMPLES FOR ASSESSING DIOXINS AND OTHER ENVIRONMENTAL CONTAMINANTS IN ATTIC DUST: A REVIEW**

Wu Crystal D, Rosenfeld Paul E, Hesse Rob C, Clark James J

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Abdelbagi Azhari Omer

O-450 **PERSISTENT ORGANIC POLLUTANTS (POPs) CONTAMINATED SITES IN GHANA: SCREENING AND DETERMINATION OF LEVELS OF POLYCHLORINATED BIPHENYLS (PCBs) IN SELECTED POSSIBLE PCB-CONTAINING EQUIPMENT AND ENVIRONMENTAL SAMPLES**

Adu-Kumi, S_1; Ephraim, J. $H._2$; Asamoah, K. A

O-727 **HUMAN BODY LOADINGS OF PCDD/Fs, PBDEs AND PCBs DUE TO UNCONTROLLED E-WASTE RECYCLING**

Wong MH, Leung AOW, Chan JKY, Xing GH, Wu SC, XU Y, Chen LX, Liang Y, Leung CKM

O-561 **THE UNIVERSITY OF MICHIGAN DIOXIN EXPOSURE STUDY: A FOLLOW-UP INVESTIGATION OF CASES WITH HIGH SERUM CONCENTRATIONS OF 2,3,4,7,8-pentaCDF**

Franzblau Alfred, Hedgeman Elizabeth, Knutson Kristine, Chen Qixuan, Hong Biling, Adriaens Peter, Demond Avery, Garabrant David Hay, Gillespie Brenda Wilson, Lepkowski James

O-603 **HOW MUCH DO WE KNOW ABOUT THE POPS IN AFRICA ?? MONET_AFRICA – DEVELOPMENT OF THE AIR MONITORING OF POPS**

Holoubek Ivan, Klanova Jana, Cupr Pavel

O-676 **POPS ANALYSIS CAPACITY DEVELOPMENT AND MONITORING IN 10 ASIAN COUNTRIES**

Fukuya Iino, Zita Sebesvari, Takaharu Kitsuwa, Masatoshi Morita, Yasuyuki Shibata, Huang Yeru, Babu Rajendran Ramaswamy, Halimah Syafrul, Won Joon Shim, Mustafa Ali Mohd, Muhammad Aslam Tahir, Evangeline Santiago, Monthip Sriratana Tabucanon, Hian Kee Lee, Pham Hung Viet, Fabrice Renaud,

O-419 **ACADEMIC AND RESEARCH PROGRAMS FOR CAPACITY DEVELOPMENT IN ASIA: BUILDING AN ENVIRONMENTAL CHEMISTRY NETWORK AND ITS OUTCOMES ON PERSISTENT ORGANIC POLLUTANTS AND RELATED COMPOUNDS**

Takahashi Shin, Ramu Karri, Sudaryanto Agus, Isobe Tomohiko, Subramanian Annamalai, Takasuga Takumi and Tanabe Shinsuke

O-823 **COMPARISON OF PCDD/F SOURCES BETWEEN NORTHERN AND SOUTHERN HEMISPHERES**

Rialet Pieters, Henk Bouwman and Suria Ellis

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Balzer Wolfgang, Gaus Martin, Gaus Caroline, Urban Ulrich, Weber Roland

O-403 **FORMATION OF POLYCHLORINATED NAPHTHALENES IN A FORMER LEBLANC SODA FACTORY**

Christian Bogdal, Roland Weber, Peter Schmid, Markus Zennegg

O-524 **An Integrated Approach for CPDC An-Shun Site Remediation and Re-Development**

Chih C. Chao, K. H. Lin, W. J. Lee, Juuen Chang, H. J. Jhang

O-618 **A CONTAMINATED SITE FROM THE CHLORINE/ORGANOCHLORINE INDUSTRY AS SOURCE OF PCDD/F CONTAMINATION OF CITRUS PULP PELLETS USED AS ANIMAL FEED IN EUROPE DURING THE LATE 1990´s**

Torres Joao Paulo Machado[A], Leite Claudio[B], Krauss Thomas[C], Weber Roland[D]

O-492 **Remediation of the large waste dumpsite " Volgermeerpolder"**

Kees Olie1, Hans C.N. van der Pal2 and Gerald J.M. Bockting

O-207 **PCB-CONTAMINATED SITES IN BELARUS: REVEALING, LEVELS OF POLLUTION, PROBLEMS OF MANAGEMENT**

Kukharchyk Tamara, Kakareka Sergey, Khomich Valery

O-367 **E-WASTE RECYCLING HEAVILY CONTAMINATES A CHINESE CITY WITH CHLORINATED, BROMINATED AND MIXED HALOGENATED DIOXINS**

Yu Xiezhi, Zennegg Markus, Engwall Magnus, Rotander Anna, Larsson Maria, Wong Ming Hung, Weber Roland