Annex B

The Level of Dioxins in Air in Hong Kong

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(21 February 2020)

The Dioxins Monitoring Results

There are no major dioxins emission sources in Hong Kong. The trace amount of dioxins comes mainly from different types of combustion processes including vehicle engines, incineration facilities, occasional fires and hill fires. Therefore, the level of dioxins in the air has been very low.

The Environmental Protection Department (EPD) has been monitoring the dioxin levels at Central/Western and Tsuen Wan for many years. The Dioxins in Air report for January 2020 have been uploaded to the EPD webpage. The monitoring results show that the dioxin levels in Hong Kong are very low and have been decreasing for the past two decades. The annual average in 2019 is about 0.02 pg/m^3 and is close to the lower detection limit. (See Fig. 1)

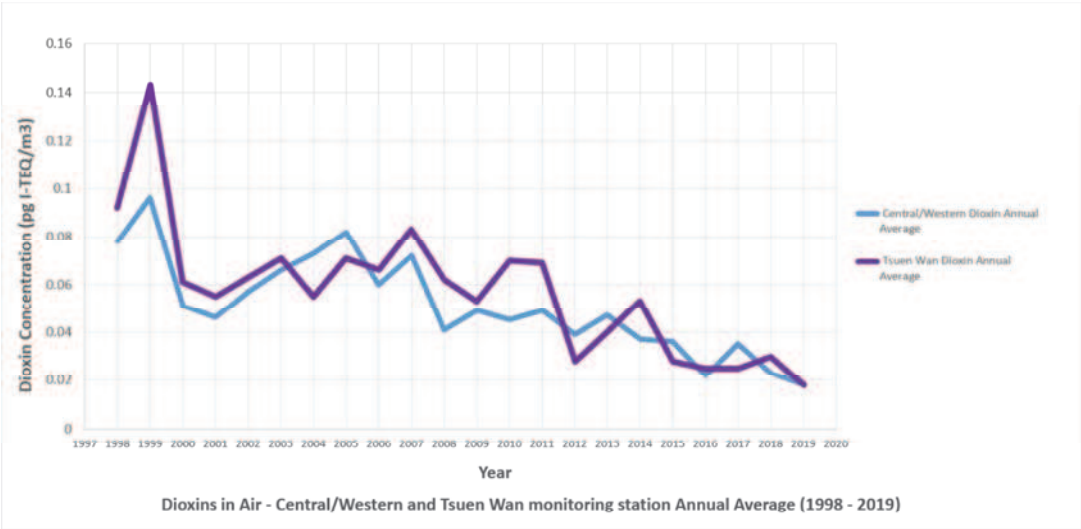

Fig. 1 The Annual Trend of Dioxins 1998 - 2019

Fig. 2 and Fig. 3 illustrate the 24-hr average levels of dioxins in the past 5 years. They are much lower than the Japan annual standard and the Canada 24-hr standard. As the prevailing wind direction differs in winter and summer, the dioxin concentration levels also vary with the seasons. The levels in winter are higher than that in summer. Dioxins have a long life time. If there were large amount of dioxins produced during the social events in the past few months, either from the actions of the demonstrators or from tear gas projectiles, the background levels as monitored by EPD would have increased significantly. However, the monitoring data obtained by EPD in the past few months up till January 2020 does not show any abnormal increases. This indicates that the amount of dioxins in the air has not been increased substantially by the social events in the past few months.

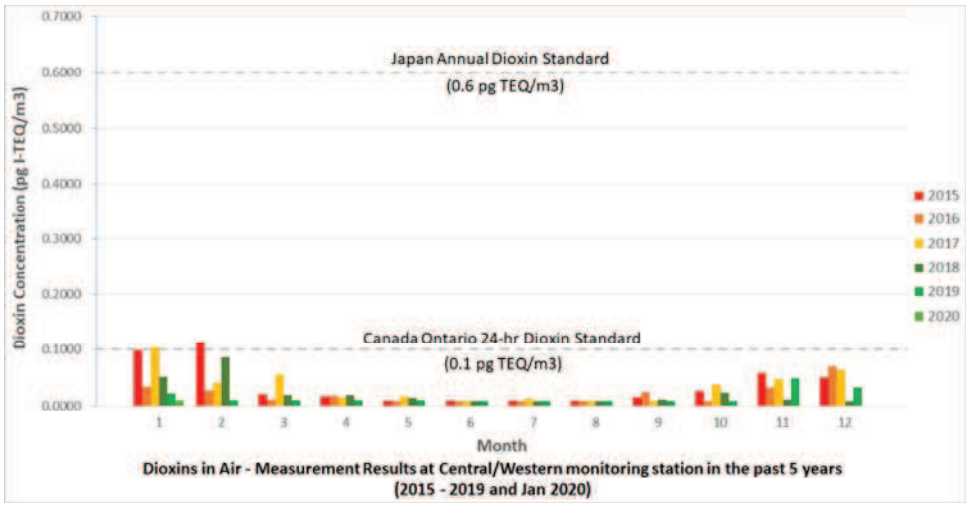

Fig. 2 The 24-hr Average Dioxin Concentrations Measured at Central/Western Monitoring Station 2015 – 2019 and Jan 2020

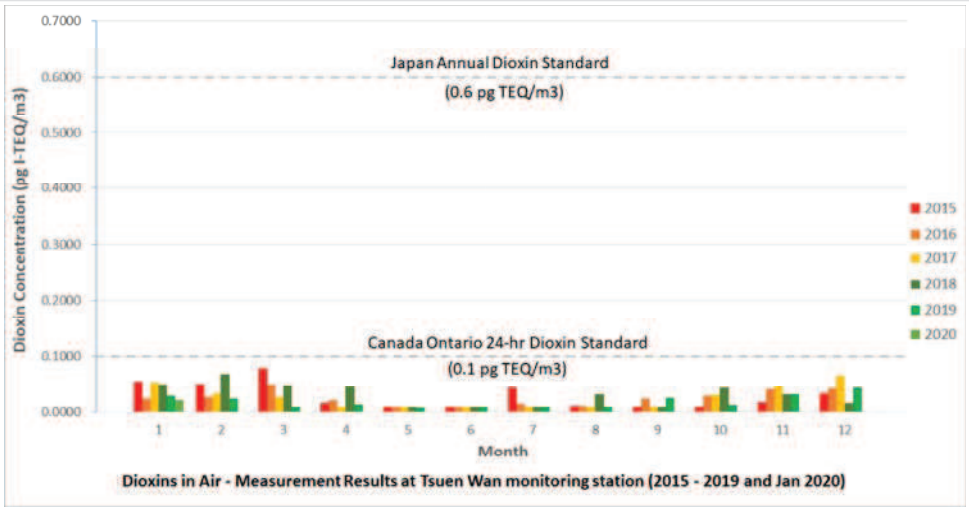

Fig. 3 The 24-hr Average Dioxin Concentrations Measured at Tsuen Wan Monitoring Station 2015 – 2019 and Jan 2020

Dioxins Produced by Burning Process

According to international literatures (Ref. 1-4), dioxins would be formed during combustion as long as the material has a small amount of chloride such as PVC or salt. In Hong Kong, PVC is commonly found in electric wirings, cables, plastic pipes, plastic floor tiles, auto parts, road plastic fences and traffic cones. There are also folding tables, folding chairs and office chairs which are made of plastic. Since Hong Kong is an offshore city, sea salt is extensively present in our environment. Therefore, burning waste in the open air can indeed produce a small amount of dioxins. The Chinese University of Hong Kong (CUHK) has collected soil samples containing black smoky substance near a charred mattress. The analysis results show that the levels of dioxin concentrations are significantly higher than the background levels as found in the other samples, and consider that this higher levels may be caused by burning plastic or the plastic part of the mattress. This matches with the findings in international literatures. However, the dioxin concentrations found do not pose any health risks.

Would Tear Gas Produce Dioxins

One of the main components of tear gas is CS, which contains chlorine molecules. In theory, it is possible that a small amount of dioxins would be produced when it is burned at a high temperature, just like other chlorine-containing materials. However, when a tear gas projectile is launched, the duration of it staying at a high temperature is very short. Therefore, the amount of dioxins produced is much less than that produced by open burning of other materials. There are several international studies on the chemical substances released from CS at various temperatures, but dioxins were not found in any of the research reports (Ref. 5-10).

The CUHK and The Hong Kong Polytechnic University have collected air, water and soil samples at locations where large numbers of tear gas projectiles were deployed as well as other various locations within the campus. The Hong Kong Science and Technology Parks Corporation has also conducted a similar exercise at Hong Kong Science Park. So far, the dioxin levels measured have been within the safety standard values. This indicates that the tear gas did not increase the dioxin levels in these venues which matches with the findings in international literatures.

Reference

Major sources and emission factors of dioxins

1. Mengmei Zhang, Alfons Buekens & Xiaodong Li (2017) “Open burning as a source of dioxins.” Critical Reviews in Environmental Science and Technology, 47:8, 543-620, DOI: 10.1080/10643389.2017.1320154.
2. UNEP (2013) “Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention.” January 2013.
3. Takayuki Shibamoto, Akio Yasuhara, and Takeo Katami (2007) “Dioxin Formation from Waste Incineration.” Reviews of Environmental Contamination and Toxicology. 190:1–41.
4. Schleicher O., Jensen A.A., Blinksbjerg P., Thomsen E., Schilling B. (2002) “Dioxin emissions from biomass fired energy plants and other sources in Denmark.” Organohalogen Compounds 56 (2002), pp. 147-150. (Emissions from BBQ)

Study on thermal decomposition of tear gas material

5. Kluchinsky, A.J., P.B. Savage, M.V. Sheely, R.J. Thomas, and P.A. Smith. (2001) “Identification of CS-derived compounds formed during heat dispersion of CS riot control agent.” J. Microcolumn Sep. 13:186–190.
6. Smith, P.A., T.A. Kluchinsky, P.B. Savage, et al. (2002) “Traditional sampling with laboratory analysis and solid phase microextraction sampling with field gas chromatography/mass spectrometry by military industrial hygienists.” Am. Ind. Hyg. Assoc. J. 63:284–292.
7. Kluchinsky, A.J., M.V. Sheely, P.B. Savage, and P.A. Smith (2002) “Formation of 2-chlorobenzlidenemalononitrile (CS riot control agent) thermal degradation products at elevated temperatures.” J. Chromatogr. 952:205– 213.
8. Timothy A. Kluchinsky , Paul B. Savage , Robert Fitz & Philip A. Smith (2002) Liberation of Hydrogen Cyanide and Hydrogen Chloride During High-Temperature Dispersion of CS Riot Control Agent, AIHA Journal, 63:4, 493-496, DOI: 10.1080/15428110208984739.
9. Joseph J. Hout , Gary L. Hook , Peter T. LaPuma & Duvel W. White. (2010) “Identification of Compounds Formed During Low Temperature Thermal Dispersion of Encapsulated o-Chlorobenzylidene Malononitrile (CS Riot Control Agent).” Journal of Occupational and Environmental Hygiene. 7:6, 352-357, DOI: 10.1080/15459621003732721.
10. Xue, Tian, Zhao, Qi-zhi, Han Yong-he, Lyu, Ning. (2015) “Thermal Decomposition of CS by TG/DSC-FITR and PY-GC/MS.” International Conference on Mechatronics, Electronic, Industrial and Control Engineering (MEIC 2015).

附件二

本港空氣中二噁英的水平

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(2020年2月21日)

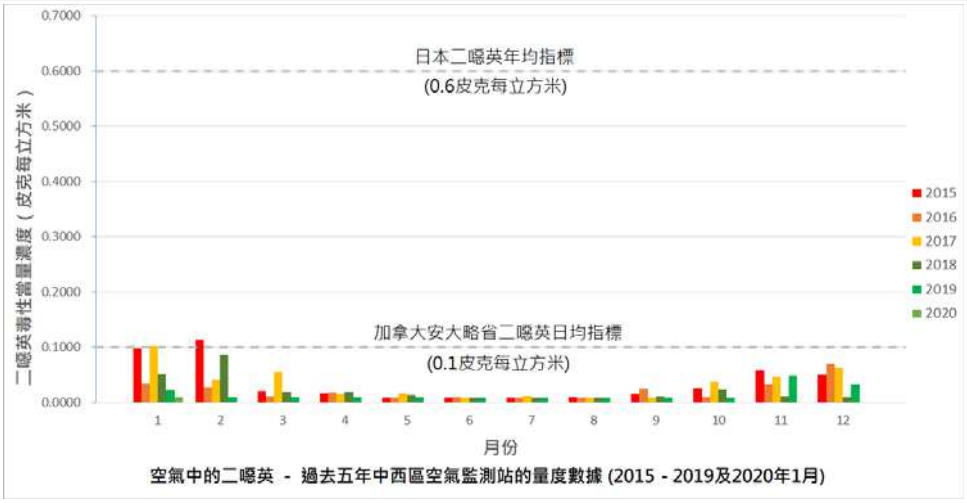
二噁英監測數據

本港沒有大量二噁英的源頭。微量二噁英主要源於各種燃燒活動，包括車輛引擎、一些焚化設施以及偶有的火警和山火等，所以空氣中的二噁英一直以來都是在很低水平。

環境保護署(環保署)一直於中西區及荃灣定期監測二噁英，2020年1月空氣中的二噁英含量報告已經上載環保署網頁。監測數據顯示，本港的二噁英水平十分低，而且過去二十年不斷下降， 2019年的年平均約為每立方米0.02皮克，貼近可測量值的下限(見圖一)。

圖一 1998-2019年的二噁英年均濃度趨勢

圖二和圖三顯示本港過去五年的二噁英水平日平均值，遠遠低於日本的年均標準值，亦低於加拿大的日平均標準值。因冬、夏季節有不同的主流風向，二噁英的濃度水平也有季節變化，冬季的水平高於夏季的水平。二噁英的存在週期是很長的。過去數月的社會運動如果曾經產生大量二噁英，不論是源自示威者的活動或是催淚彈，環境保護署監測得的背景濃度也會明顯提升。環境保護署近幾個月的數據直至2020年1月也沒有顯示異常提升，反映過去一段時間香港空氣中的二噁英沒有大量增加。



圖二 2015-2019年及2020年1月於中西區監測站錄得的二噁英日均濃度

圖三 2015-2019年及2020年1月於荃灣監測站錄得的二噁英日均濃度

<u>焚燒產生的二噁英</u>

根據不少國際文獻顯示(參考文獻1-4)，只要物料有少量氯化物例如PVC或鹽分，已足以形成二噁英。在本港，PVC常用於電線、電纜、膠喉管、膠地板、汽車配件、馬路膠圍欄和路上的「雪糕筒」，也有PVC製成的膠摺枱、摺椅及辦公椅等；由於香港是近海城市，鹽分也廣泛存在於環境中。故此露天焚燒垃圾，確實可以產生少量二噁英。香港中文大學在一個被火燒焦的墊褥附近採集含有黑色煙燻物質的泥土樣本，化驗結果發現有較其他樣本的背景濃度明顯為高的二噁英，並且認為這個略高的數值可能是由燃燒塑膠或墊褥的塑料部分引起，與國際文獻的資料相符合，但濃度並未構成健康風險。

<u>催淚煙是否會產生二噁英</u>

催淚煙的主要成分CS有氯分子，理論上在高溫下有可能如焚燒其他含氯物料一樣產生小量二噁英。然而，當爆發時，催淚煙處於高溫的時間極短，因此相比焚燒其他物料產生的二噁英更少。國際間有數個研究CS在不同溫度所分解的化學物質，所有研究報告均沒有發現二噁英(參考文獻5-10)。

香港中文大學及香港理工大學在曾經發放多個催淚煙的地點及校園其他不同地點採取空氣，水質及泥土樣本。香港科技園公司亦曾在香港科學園進行類似採樣行動。至今，測量得的二噁英含量低於安全標準值，顯示催淚煙並沒有引至這些場地的二噁英水平大幅增加，結果與國際文獻的資料相符。

參考文獻

<u>二噁英的主要源頭及排放因子</u>

1. Mengmei Zhang, Alfons Buekens & Xiaodong Li (2017) “Open burning as a source of dioxins.” Critical Reviews in Environmental Science and Technology, 47:8, 543-620, DOI: 10.1080/10643389.2017.1320154.
2. UNEP (2013) “Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs under Article 5 of the Stockholm Convention.” January 2013.
3. Takayuki Shibamoto, Akio Yasuhara, and Takeo Katami (2007) “Dioxin Formation from Waste Incineration.” Reviews of Environmental Contamination and Toxicology. 190:1–41.
4. Schleicher O., Jensen A.A., Blinksbjerg P., Thomsen E., Schilling B. (2002) “Dioxin emissions from biomass fired energy plants and other sources in Denmark.” Organohalogen Compounds 56 (2002), pp. 147- 150. (燒烤食物-BBQ)

<u>催淚煙物質熱分解研究</u>

5. Kluchinsky, A.J., P.B. Savage, M.V. Sheely, R.J. Thomas, and P.A. Smith. (2001) “Identification of CS-derived compounds formed during heat dispersion of CS riot control agent.” J. Microcolumn Sep. 13:186–190.
6. Smith, P.A., T.A. Kluchinsky, P.B. Savage, et al. (2002) “Traditional sampling with laboratory analysis and solid phase microextraction sampling with field gas chromatography/mass spectrometry by military industrial hygienists.” Am. Ind. Hyg. Assoc. J. 63:284–292.
7. Kluchinsky, A.J., M.V. Sheely, P.B. Savage, and P.A. Smith (2002) “Formation of 2-chlorobenzlidenemalononitrile (CS riot control agent) thermal degradation products at elevated temperatures.” J. Chromatogr. 952:205– 213.
8. Timothy A. Kluchinsky , Paul B. Savage , Robert Fitz & Philip A. Smith (2002) Liberation of Hydrogen Cyanide and Hydrogen Chloride During High-Temperature Dispersion of CS Riot Control Agent, AIHA Journal, 63:4, 493-496, DOI: 10.1080/15428110208984739.
9. Joseph J. Hout , Gary L. Hook , Peter T. LaPuma & Duvel W. White. (2010) “Identification of Compounds Formed During Low Temperature Thermal Dispersion of Encapsulated o-Chlorobenzylidene Malononitrile (CS Riot Control Agent).” Journal of Occupational and Environmental Hygiene. 7:6, 352-357, DOI: 10.1080/15459621003732721.

10. Xue, Tian, Zhao, Qi-zhi, Han Yong-he, Lyu, Ning. (2015) “Thermal Decomposition of CS by TG/DSC-FITR and PY-GC/MS.” International Conference on Mechatronics, Electronic, Industrial and Control Engineering (MEIC 2015).