



# THE ANALYSIS OF TEAR GAS IN HONG KONG

The gas monitoring of ambient HCN at the areas  
affected by Tear Gas on 2 & 17 Nov 2019

## Abstract

Hong Kong Police Force (thereafter called 'HKPF') is using a huge amount of tear gas since June 2019 for the crowd control. The press media found that the origin of tear gas's manufacturers chosen by HKPF included China and the United States.

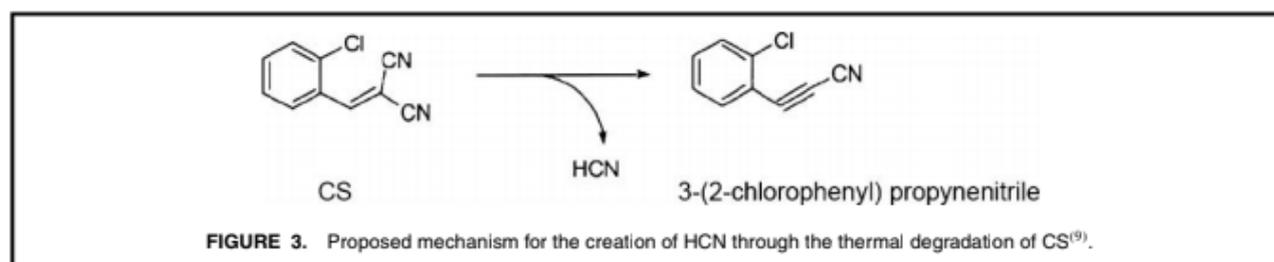
We take reference to the previous research that CS is broken down drilling emission and release Hydrogen Cyanide (thereafter called 'HCN'). Therefore, our team would like to monitor the ambient HCN level in different demonstration scenes. Based on our monitoring results, we found that numerous readings of gas monitors were higher than the warning limit and some cases were even shown as 'OL' which means 'overload'. We hope that the report can raise the public concerns about the abuse of tear gas and the quality of Chinese-made tear gas.

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## Introduction

From 12 June 2019 to 22 November 2019, HKPF already used more than 10,000 rounds tear gas in different demonstration scenes. Although the Hong Kong Police claimed that the Tear Gas was safe to use for dispelling the crowd. However, most of the citizens in Hong Kong worried about the health impact of Hong Kong Police using Tear Gas in residential area.



According to the Journal of Occupational and Environmental Hygiene, 7: 352–357 with the topic named as ‘Identification of Compounds Formed During Low Temperature Thermal Dispersion of Encapsulated o-Chlorobenzylidene Malononitrile (CS Riot Control Agent)’, one product of particular interest was 3-(2-chlorophenyl) propynenitrile, which previous research has shown to evolve only at temperatures greater than 500°C. Detection of this compound, which was similar to 2-chloroquinoline and 4-chloroquinoline, suggested that it existed only in the vapor phase at the temperatures specified in this study. This compound is formed through the loss of a cyanide molecule from the parent CS molecule and suggests the presence of Hydrogen Cyanide (HCN) as shown in Figure 3. HCN presence could not be validated during this work due to the MS scan range used, but the identification of 3-(2-chlorophenyl) propynenitrile at temperatures above 250°C suggests the presence of HCN as a thermal degradation product. Other thermal degradation products identified in this study may also result in the formation of HCN, but this mechanism is the only one documented in peer-reviewed literature. We took reference to the above information that the 2-Chlorobenzalmalononitrile is broken down during emission and release Hydrogen Cyanide<sup>1</sup> (thereafter called ‘HCN’). Therefore, our team would like to monitor the ambient HCN level in different demonstration scenes.

## Method

A single gas detector was used for monitoring the HCN level in different demonstration scenes. The model of gas detector was GasAlert Extreme - HCN gas manufactured by BW Technologies by Honeywell, the detection range is 0-30 ppm and all gas monitors were calibrated from the manufacturer.

### Sensor Specification<sup>2</sup>

Gas	Measuring Range (ppm)	Operating Temperature	Relative Humidity (non-condensing)
HCN	0-30.0	-40 to +122°F/-40 to +50°C	15% - 90%

<sup>1</sup> Kluchinsky, A.J., P.B. Savage, R. Fitz, and P.A. Smith: Liberation of hydrogen cyanide and hydrogen chloride during high-temperature dispersion of CS riot control agent. Am. Ind. Hyg. Assoc. J. 63:493–496 (2002).

<sup>2</sup> single gas detector - Honeywell Analytics <https://www.honeywellanalytics.com/~media/honeywell-analytics/products/gasalert-extreme/documents/english/gasalertextremedatasheet555812en.pdf?la=en>

## Monitoring Results

### Case 1

Date : 2 November 2019

Location : Causeway bay, Main Door of Sogo

Video link : [https://www.youtube.com/watch?v=hS\\_hpuhK8Wc&feature=youtu.be](https://www.youtube.com/watch?v=hS_hpuhK8Wc&feature=youtu.be)

Maximum Reading : 5.0ppm

### Case 2

Date : 2 November 2019

Location : 298, Hennessy Road

Video link : [https://www.youtube.com/watch?v=hS\\_hpuhK8Wc&feature=youtu.be](https://www.youtube.com/watch?v=hS_hpuhK8Wc&feature=youtu.be)

Maximum Reading : 0.5ppm

### Case 3

Date : 2 November 2019

Location : Caltex Wan Chai, Hennessy Road, Wan Chai

Video link : [https://www.youtube.com/watch?v=Upp6\\_C0jZIE&feature=youtu.be](https://www.youtube.com/watch?v=Upp6_C0jZIE&feature=youtu.be)

Maximum Reading : 12.1ppm

### Case 4

Date : 2 November 2019

Location : Cross road between Tang Lung Street and Percival Street

Video link : [https://www.youtube.com/watch?v=i0Zxnja5KZY&feature=emb\\_logo](https://www.youtube.com/watch?v=i0Zxnja5KZY&feature=emb_logo)

Maximum Reading : Unidentified (Red warning signal light is flashing)

Remark : Our team reporter said that another reporter was faint on the street, he tried to move the other reporter out of that area, but the reporter too heavy and his gas mask could not prevent him from those gases. Meanwhile, our reporter put the gas detector into his pocket, unlike the usual procedure, holding the detector by hand.

### Case 5

Date : 17 November 2019

Location : The Hong Kong Polytechnic University

Video link : <https://www.youtube.com/watch?v=uxdH-sBzNsw>

Maximum Reading : 28.6 ppm

### Case 6

Date : 17 November 2019

Location : The Hong Kong Polytechnic University

Video link : <https://www.youtube.com/watch?v=uxdH-sBzNsw>

Maximum Reading : OL (means overloaded) , Maximum reading: 30 ppm

### Case 7

Date : 17 November 2019

Location : The Hong Kong Polytechnic University

Video link : <https://www.youtube.com/watch?v=uxdH-sBzNsw>

Maximum Reading : OL (means overloaded) , Maximum reading: 30 ppm

### Case 8

Date : 17 November 2019

Location : The Hong Kong Polytechnic University

Video link : <https://www.youtube.com/watch?v=n3NRifM1fxg&feature=youtu.be>

Maximum Reading : OL (means overloaded), Maximum reading: 30 ppm

### Case 9

Date : 17 November 2019

Location : The Hong Kong Polytechnic University

Video link : <https://www.youtube.com/watch?v=n3NRifM1fxg&feature=youtu.be>

Maximum Reading : 29.7 ppm

## Findings

We confirmed that 2-Chlorobenzalmalononitrile can be broken down to Hydrogen Cyanide during the emission of tear gas. When comparing between the exposure limit of different countries, the results were listed as shown below table 1. Based on our monitoring results, although the concentration of ambient HCN was higher than the warning limit and there're even some cases about the reading of ambient HCN concentration shown as 'OL' which means 'overloaded' and reaches the maximum ambient HCN concentration, i.e. 30ppm in the surroundings, the international standard limits also consider the time of exposure. Therefore, all the results did NOT indicate over the below international exposure limits.

Table 1. Table of the international standard of occupational exposure limits

International Standards	Occupational Exposure Limits
United States (ACGIH)	4.7 ppm (5 mg/m <sup>3</sup> )
United Kingdom	STEL 10 ppm 11 mg/m <sup>3</sup> (STEL - Short Term Exposure Level, 15 mins)
France	VME 2 ppm 2 mg/m <sup>3</sup> VLE 10 ppm 10 mg/m <sup>3</sup> (VME/VLE - Valeur Maximum Exposition/Valeur Limited' Exposition)
Germany (MAK)	8hr TWA 1.9 ppm 2.1 mg/m <sup>3</sup> STEL 3.8 ppm 4.2 mg/m <sup>3</sup>
Netherlands	8hr TWA 1 mg/m <sup>3</sup> 15 min 10 mg/m <sup>3</sup>

Based on the analysis of our monitoring results, the concentration of ambient HCN was obviously decreased when the reporters went far away from the affected area. As per previous news, there were numerous improper and abusive cases about the tear gas deployed in high-density residential area. Although HCN can be dispersed in the air during the combustion of tear gas canisters and its concentration is decreased gradually, the risk of cyanide poisoning can be increased if the tear gas were fired in the large amount of tear gas continuously, especially those made in China, or in enclosed area such as MTR station and poor ventilation areas such as narrow alley.

## Further studies

As we had taken results over the detection limit of our gas monitor, we will use another gas detector with wider detection range for monitoring the ambient HCN content after firing tear gas in the future. Moreover, we decided to perform other tests to measure the concentration of ambient HCN in order to improve the accuracy and precision of the results.

We would like to perform another experiment in the laboratory to find out the correlation between the heating temperature of 2-Chlorobenzalmalononitrile (CS) and the concentration of HCN produced during the heating process. With the results, we can determine the actual temperature of the tear gas based on the amount of HCN detected in the future. Due to the restriction of Hong Kong Law, we might entrust laboratory from foreign country or international organization to conduct the research.