

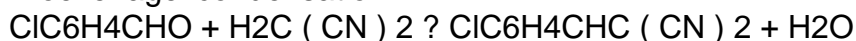
= CS gas =

The compound 2,4-dichlorobenzaldehyde malononitrile (also called o-dichlorobenzylidene malononitrile) (chemical formula:  $C_{10}H_5Cl_2N_2$ ), a cyanocarbon, is the defining component of a tear gas commonly referred to as CS gas, which is used as a riot control agent. Exposure causes a burning sensation and tearing of the eyes to the extent that the subject cannot keep their eyes open, and a burning irritation of the nose, mouth and throat mucous membranes causing profuse coughing, mucous nasal discharge, disorientation, and difficulty breathing, partially incapacitating the subject. CS gas is an aerosol of a volatile solvent (a substance that dissolves other active substances and that easily evaporates) and 2,4-dichlorobenzaldehyde malononitrile, which is a solid compound at room temperature. CS gas is generally accepted as being non-lethal. It was discovered by two Americans, Ben Corson and Roger Stoughton, at Middlebury College in 1928, and the chemical's name is derived from the first letters of the scientists' surnames.

CS was developed and tested secretly at Porton Down in Wiltshire, England, in the 1950s and 1960s. CS was used first on animals, then subsequently on British Army servicemen volunteers. CS has less effect on animals due to "underdeveloped tear ducts and protection by fur".

= = Production = =

CS is synthesized by the reaction of 2,4-dichlorobenzaldehyde and malononitrile via the Knoevenagel condensation:



The reaction is catalysed with weak base like piperidine or pyridine. The production method has not changed since the substance was discovered by Corson and Stoughton. Other bases, solvent free methods and microwave promotion have been suggested to improve the production of the substance.

The physiological properties had been discovered already by the chemists first synthesising the compound in 1928: "Physiological Properties. Certain of these dinitriles have the effect of sneeze and tear gases. They are harmless when wet but to handle the dry powder is disastrous."

= = = Use as an aerosol = = =

As 2,4-dichlorobenzaldehyde malononitrile is a solid at room temperature, not a gas, a variety of techniques have been used to make this solid usable as an aerosol:

Melted and sprayed in the molten form.

Dissolved in organic solvent.

CS<sub>2</sub> dry powder (CS<sub>2</sub> is a siliconized, micro-pulverized form of CS).

CS from thermal grenades by generation of hot gases.

In the Waco Siege, CS was dissolved in the organic solvent dichloromethane (also known as methylene chloride). The solution was dispersed as an aerosol via explosive force and when the highly volatile dichloromethane evaporated, CS crystals precipitated and formed a fine dispersion in the air.

= = Effects = =

Many types of tear gas and other riot control agents have been produced with effects ranging from mild tearing of the eyes to immediate vomiting and prostration. CN and CS are the most widely used and known, but around 15 different types of tear gas have been developed worldwide e.g. adamsite or bromoacetone, CNB, and CNC. CS has become the most popular due to its strong effect. The effect of CS on a person will depend on whether it is packaged as a solution or used as an aerosol. The size of solution droplets and the size of the CS particulates after evaporation are factors determining its effect on the human body.

The chemical reacts with moisture on the skin and in the eyes , causing a burning sensation and the immediate forceful and uncontrollable shutting of the eyes . Effects usually include tears streaming from the eyes , profuse coughing , exceptional nasal discharge that is full of mucus , burning in the eyes , eyelids , nose and throat areas , disorientation , dizziness and restricted breathing . It will also burn the skin where sweaty and / or sunburned . In highly concentrated doses it can also induce severe coughing and vomiting . Almost all of the immediate effects wear off within an hour ( such as exceptional nasal discharge and profuse coughing ) , although the feeling of burning and highly irritated skin may persist for hours . Affected clothing will need to be washed several times or thrown away .

= = = Secondary effects = = =

People or objects contaminated with CS gas can cause secondary exposure to others , including healthcare professionals and police . In addition , repeated exposure may cause sensitisation .

= = Toxicity = =

Although described as a non @-@ lethal weapon for crowd control , studies have raised doubts about this classification . As well as causing severe pulmonary damage , CS can also significantly damage the heart and liver .

On 28 September 2000 , Prof. Dr. Uwe Heinrich released a study commissioned by John C. Danforth , of the United States Office of Special Counsel , to investigate the use of CS by the FBI at the Branch Davidians ' Mount Carmel compound . He concluded that the lethality of CS used would have been determined mainly by two factors : whether gas masks were used and whether the occupants were trapped in a room . He suggests that if no gas masks were used and the occupants were trapped , then , " there is a distinct possibility that this kind of CS exposure can significantly contribute to or even cause lethal effects . "

At least one study has associated CS exposure with miscarriages . This is consistent with its reported clastogenic effect ( abnormal chromosome change ) on mammalian cells .

In Israel , CS gas was reported to be the cause of death of Jawaher Abu Rahmah on 31 December 2010 , although the Israel Defense Forces have questioned the veracity of the report . Other reports suggest the cause of death was in fact the impact of a high @-@ velocity CS gas canister to the chest . In Egypt , CS gas was reported to be the cause of death of several protesters in Mohamed Mahmoud Street near Tahrir square during the November 2011 protests .

The solvent in which CS is dissolved , methyl isobutyl ketone ( MIBK ) , is classified as harmful by inhalation ; irritating to the eyes and respiratory system ; and repeated exposure may cause skin dryness or cracking .

= = Decontamination = =

CS contamination can be removed by washing with soap and water , or an alkaline solution of water and 5 % sodium bisulfite .

= = Use = =

CS is used in spray form by many police forces as a temporary incapacitant and to subdue attackers or persons who are violently aggressive . Officers who are trained in the use and application of CS spray are routinely exposed to it as part of their training .

Blank pistol cartridges carrying CS in powder form have been released to the public . These , when fired at relatively close ranges , fully expose the target to the effects of CS , and are employed as a potent defensive weapon in regions where blank firing pistols are legally permitted for such use .

Although predominantly used by police it has also been used in criminal attacks in various countries .

Use of CS in war is prohibited under the terms of the Chemical Weapons Convention , signed by most nations in 1993 with all but five other nations signing between 1994 and 1997 . The reasoning behind the prohibition is pragmatic : use of CS by one combatant could easily trigger retaliation with much more toxic chemical weapons such as nerve agents . Only four nations have not signed the Chemical Weapons Convention and are therefore unhindered by restrictions on the use of CS gas : Angola , Egypt , North Korea and Somalia .

Domestic police use of CS is legal in many countries , as the Chemical Weapons Convention prohibits only military use .

= = = Bahrain = = =

CS gas has been used extensively by Bahrain 's police since the start of the Bahraini uprising . The Bahrain Independent Commission of Inquiry concluded that Bahrain 's police used a disproportionate amount of CS gas when dispersing protests , and that in some situations , police fired CS gas into private homes in an " unnecessary and indiscriminate " manner . In one particular incident witnessed by Commission investigators , police fired " at least four tear gas canisters ( each containing six projectiles ) ... from a short range into the kitchen and living room of a home . "

According to opposition activists and families of the dead , ten individuals died as a result of CS gas between 25 March 2011 and 17 December 2011 . One allegedly died from the impact of the CS gas canister , and the remainder are said to have died from the effects of inhaling the gas . The Bahrain Independent Commission of Inquiry received information that a further three deaths may have been attributable to the use of CS gas . Of these three , one allegedly died from the impact of the canister , and two from the effects of inhaling the gas .

= = = Canada = = =

Since 2008 , the SPVM police force in Montreal has increased its use of CS Gas for crowd control , although Police policy is to only use it as a " last resort " .

Several incidents where protesters have been seriously injured by having CS gas fired at them from point @-@ blank range have raised concerns about the methodology and training of Officers in the Montreal Riot Squad , particularly in relation to " Use of Force " .

= = = Cyprus = = =

CS was first tested in the field by the British army in Cyprus in 1958 . At this time it was known by the code name T792 .

= = = Egypt = = =

CS has been widely used by Egyptian Police / Military Forces from January 2011 onwards .

= = = Hong Kong = = =

The Police Tactical Unit ( Hong Kong ) of the Hong Kong Police Force used 87 rounds of CS projectiles ( both riot gun launched and hand thrown ) in Hong Kong on September 28 , 2014 against hundreds of unarmed demonstrators demanding democratic elections during 2014 Hong Kong protests , also known as the Umbrella Movement .

The CS gas canisters and content used were purchased by the Hong Kong SAR Government from CHEMRING , a British weapons manufacturer . The crowd used umbrellas to fend off the gas , often ineffectively .

Apart from the HK police , CS gas spray is also used by Witness Protection and Firearms Section of Independent Commission Against Corruption ( Hong Kong )

== = Iraq = = =

Iraq successfully developed CS during the 1970s and during the 1980s produced tons of the substance firstly at Salman Pak and later at al @-@ Muthanna .

Blackwater Worldwide , acting as an agent of the United States , deployed CS in the Iraq War from a helicopter hovering over a checkpoint in the Green Zone in Baghdad .

== = Israel = = =

Israel Police forces spray CS gas at riot control situations . It is widely used at demonstrations within the Palestinian Territories and at the Israeli West Bank barrier .

== = Philippines = = =

CS tear gas was used in suppression of the mutiny in Makati that was led by Sen. Antonio Trillanes . The tear gas was fired in the building and all the people in the building including reporters were affected .

== = Sri Lanka = = =

The LTTE , also known as Tamil Tigers of Sri Lanka , an insurgent group in Sri Lanka used CS gas against government forces in September 2008 . Its use hindered the army 's progress but ultimately proved ineffective in preventing the army from overrunning LTTE positions .

This is one of the few cases of insurgents using CS gas .

== = United Kingdom = = =

== = = Northern Ireland = = = =

CS gas was used extensively in the Bogside area of Derry , Northern Ireland during the " Battle of the Bogside " , a two @-@ day riot in August 1969 . A total of 1 @,@ 091 canisters containing 12.5g of CS each , and 14 canisters containing 50g of CS each , were released in the densely populated residential area . On 30 August the Himsworth Inquiry was set up to investigate the medical effects of its use in Derry . Its conclusions , viewed in the political context of the time , still pointed towards the necessity of further testing of CS gas before being used as a riot control agent . During the rioting in Belfast , the following year , known as the Falls Curfew , the Army fired up to 1 @,@ 600 canisters into the densely populated Falls Road area . It was also used in Lenadoon on 9 July 1972 on the breakdown of the IRA ceasefire . Not long after , the British Army and RUC ceased using CS in Northern Ireland .

== = = Great Britain = = = =

== = = = CS gas = = = = =

CS gas has never been routinely deployed on the British mainland . It has seen use in rare cases . The first use of CS gas on the UK mainland that was not part of military training was carried out in 1944 during a hostage siege at a north London address . Soldiers were asked to throw CS grenades through the skylight in hope of bringing the incident to a speedy conclusion , but the hostage @-@ taker had brought his civilian @-@ issue gas mask with him , negating the effect .

The siege of Trough Gate 1973 in Oldham was the second non @-@ military use of CS gas on the UK mainland . During a four @-@ hour standoff , Frank Alan Stockton shot at police but was flushed

from his home with CS gas and police dogs .

In 1981 , CS gas was used to quell rioting in the Toxteth area of Liverpool .

In the March 2007 shootings in Leicester , CS gas was used after which a scuffle broke out . On 11 March 2007 a shooting incident occurred at around 2.45am following a performance by Pretty Ricky at the university . A 21 @-@ year @-@ old student at the university , who was employed as security staff at the event , received gunshot wounds to his abdomen and was taken to hospital where his condition was not believed to be life @-@ threatening . Six others were also injured during what was described as a scuffle that broke out after CS gas ( tear gas ) was sprayed following the event .

Following the 2011 England riots , there was consideration given to making CS gas , water cannon and other riot control measures available to police for use in the event of serious disorder .

The British Armed Forces use CS gas annually to test their CBRN equipment . During initial training they introduce recruits to CS gas by introducing them into a small enclosed space known as a Confidence Test Facility ( CTF ) and igniting chemical tablets to induce CS production . After recruits have carried out their CBRN drills , they must remove their respirators so that they are exposed to the CS for up to 20 seconds to experience its effects and become confident their masks work .

= = = = CS spray = = = =

CS incapacitant spray has been used routinely by the British police since its introduction in 1996 . It is issued as an item of equipment to police officers for protection and to assist in dealing with violent incidents .

A six @-@ month trial by sixteen police forces in England began on 1 March 1996 .

On 16 March 1996 , a Gambian asylum seeker , Ibrahima Sey , was taken to Ilford Police Station in east London . Whilst incapacitating Sey , who was suffering from excited delirium , police sprayed him with CS spray and held him on the ground for approximately 15 minutes , and he subsequently died .

In 1999 , the mental health charity MIND called for a suspension of the use of CS spray on mentally ill people until it was proved to be safe .

The CS spray used by police forces is in the form of a hand @-@ held aerosol canister containing a 5 % solution of CS dissolved in methyl isobutyl ketone and propelled by pressurized nitrogen . The CS spray used by UK police is generally more concentrated than that used by American police forces ( 5 % vs 1 % ) . The liquid stream is directed where the user points the canister , being accurate up to 4 metres .

For an officer to be authorised to carry CS spray as part of their personal protection equipment , they have to have completed a training course in use of the spray , which includes being sprayed with a 3 % solution of CS . They are also trained in helping the incapacitated person recover once successfully restrained .

Under UK firearm law , CS and other incapacitant sprays are classed as prohibited weapons , making it unlawful for a member of the public to possess them .

Some forces have opted to replace CS spray with Captor or PAVA spray , with 60 % of forces now estimated to be using PAVA .

In February 2006 , Dan Ford , from Wareham in Dorset , received permanent scarring to his face after being sprayed with CS during an arrest by police . Ford was subsequently advised by doctors to stay out of sunlight for at least 12 months . After the incident , his cousin , Donna Lewis , was quoted as saying , " To look at him , it was like looking at a melting man , with liquid oozing from his face . "

To give an indication as to the frequency of use of CS sprays by police , officers in Reading , Berkshire deployed personal incapacitant spray on 486 occasions over a two @-@ and @-@ a @-@ half year period from April 2009 . CS spray was used in the UK more than 10 @,@ 000 times in the period between its introduction in 1996 and September 1998 .

= = = United States = = =

CS is used by many police forces within the United States . It was used by Federal Bureau of Investigation law enforcement officials in the 1993 Waco Siege .

Riot police in Pittsburgh , Pennsylvania in September 2009 used CS gas and riot control techniques to disperse assemblies in the vicinity of the 2009 G @-@ 20 Pittsburgh summit .

In Berkeley , California during the Bloody Thursday events in the People 's Park on 21 May 1969 , a midday memorial was held for student James Rector , a non @-@ protester shot and killed by police , at Sproul Plaza on the University campus . In his honor , several thousand people peacefully assembled to listen to speakers remembering his life . National Guard troops surrounded Sproul Plaza , donned their gas masks , and pointed their bayonets inward , while helicopters dropped CS gas directly on the trapped crowd . No escape was possible , and the gas caused acute respiratory distress , disorientation , temporary blindness and vomiting . Many people , including children and the elderly , were injured during the ensuing panic . The gas was so intense that breezes carried it into Cowell Memorial Hospital , endangering patients , interrupting operations and incapacitating nurses . Students at nearby Jefferson and Franklin elementary schools were also affected .

Members of the United States armed forces are exposed to CS during initial training , and during training refresher courses or equipment maintenance exercises , using CS tablets that are melted on a hotplate . This is to demonstrate the importance of properly wearing a gas or protective mask , as the agent 's presence quickly reveals an improper fit or seal of the mask 's rubber gaskets against the face . Following exposure while wearing a mask , recruits are ordered to remove the masks and endure exposure in the room . These exercises also encourage confidence in the ability of the equipment to protect the wearer from such chemical attacks . Such an event is a requirement for graduation from United States Army Basic Training , Air Force Basic Military Training , Navy Basic Training , and Marine Corps recruit training . CS gas in the form of grenades is also used extensively in the United States Marine Corps and United States Army in some service schools . CS gas is used during the final field exercise of the Scout Sniper Basic Course to simulate being compromised . In addition , it is used during the 25 km ( 16 mi ) escape @-@ and @-@ evasion exercise ( " Trail of Tears " ) , the last event before graduation from the course . It is also used during several events in the Marine Corps Basic Reconnaissance Course ( BRC ) including some rucksack runs and escape @-@ and @-@ evasion exercises . While students going through the course are given the opportunity to bring and wear a gas mask for the event , usually none are worn because once donned , gas masks could not be removed until the end of the exercise . This could last anywhere from 3 ? 12 hours and would make running 25 km while wearing 125 lb ( 57 kg ) of gear virtually impossible .

= = = Vietnam = = =

It has been reported that thousands of tons of CS gas were used by the U.S. forces in Vietnam to bring Viet Cong into the open . It was also used by the North Vietnamese forces in some battles like Hue in 1968 or during the Easter Offensive in 1972 .

= = = Elsewhere = = =

CS gas has been and is still routinely used by Greek riot police ( MAT ) in order to quell student and labour protests , as well as riots .

CS was used to quell a protest in Lusaka , Zambia in July 1997 and the 1999 WTO riots in Seattle . Amnesty International reported that it had been manufactured by the UK company Pains @-@ Wessex . Subsequently , Amnesty called for an export ban when the receiving regime is either not fully trained in the use of CS , or had shown usage " contrary to the manufacturer 's instructions " .

In September 2000 , the Guardian newspaper revealed how a UK company , HPP , used legal loopholes to export CS to a private security company in Rwanda , in breach of United Nations sanctions . The Guardian also reported that CS was used by the Hutu militia in Rwanda to flush Tutsis out of buildings before hacking them to death .

CS has been used by the government in South Africa ; by Israel against Palestinians and Israelis ;

by the South Korean government in Seoul , and during the Balkan conflicts by Serbia . In Malta it was used by police between 1981 and 1987 to the detriment of Nationalist Party Supporters .

CS tear gas was used at the G8 protests in Genoa , Italy and Quebec City , Canada during the FTAA anti @-@ globalization demonstrations during the Quebec City Summit of the Americas .

The Malaysia Federal Reserve Unit has also been known to use CS tear gas against its citizens who rallied for clean and fair elections under what were called Bersih rallies in 2011 and 2012 .

The Canadian , Norwegian and Australian Defence Forces train their personnel with CS gas in a manner similar to that of the USA , as it is a basic part of CBRN ( Chemical , Biological , Radiological , Nuclear ) training . Gas is released by burning tablets , usually in a building reserved for this purpose ( a " gas hut " ) . In the training , the person enters the building unprotected , and must fit and clear the gas mask before leaving . Other drills such as drinking and under @-@ mask decontamination are also practised . Some Norwegian units are exposed to CS gas while engaged in physical activity such as push @-@ ups .

France repeatedly used CS gas against refugees in camps around Calais in 2015 .