Public Health England

Protecting and improving the nation's health

CS Gas (2-chlorobenzylidene malononitrile)

Incident Management

Key Points

Fire

- flammable
- reacts violently with strong oxidants causing fire and explosion hazard
- reacts with strong bases acids producing ammonia; the substance decomposes on burning producing toxic fumes

Health

- CS gas is a potent sensory irritant; however symptoms should resolve 15-30 minutes after removal from exposure
- discomfort, pain, lacrimation, blurred vision, periorbital oedema and blepharospasm are common following ocular exposure
- inhalation may cause sneezing, coughing, sore throat, wheeze, shortness of breath, rhinorrhoea, bronchorrhoea and chest tightness
- may cause a stinging or burning sensation in the mouth with increased salivation, nausea and vomiting
- stinging or burning sensation, pruritus, scaling, erythema and blistering can occur following skin contact

Environment

- avoid release to the environment; inform the Environment Agency where appropriate

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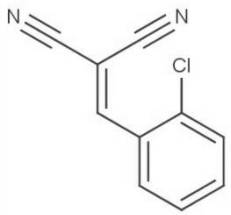
Hazard Identification

There are currently no specific dangerous goods emergency action codes and no EU CLP harmonised classification for CS Gas (2-chlorobenzylidene malononitrile).

Physicochemical Properties

CAS number	2698-41-1
Molecular weight	188.61
Formula	$C_{10}H_5ClN_2$
Common synonyms	2-chlorobenzylidene malononitrile, o-chlorobenzylidene malononitrile
State at room temperature	White crystalline solid
Volatility	Vapour pressure: 3.4 x 10^{-5} mm Hg at 20°C
Vapour density	6.5 (air=1)
Flammability	Combustible
Lower explosive limit	-
Upper explosive limit	-
Water solubility	0.1 - 0.5 g per 100 mL at 20°C (slightly soluble)
Reactivity	Reacts violently with strong oxidants causing fire and explosion hazard
Reaction or degradation products	Reacts with strong bases acids producing ammonia The substance decomposes on burning producing toxic fumes including hydrogen chloride hydrogen cyanide nitrogen oxides
Odour	Pepper like odour
Structure	

References

Hazardous Substances Data Bank. 2-chlorobenzalmalononitrile HSDB No. 4346 (last revision date 23/08/2005) US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 08/2017).

International Programme on Chemical Safety. International Chemical Safety Card entry for o-Chlorobenzylidenemalononitrile. ICSC 1065, 2002. World Health Organization: Geneva.

2-Chlorobenzylidene Malononitrile (HAZARDTEXT™ Hazard Management). In Klasco RK (Ed): TOMES® System, Truven Healthcare Analytics Inc, Greenwood Village CO, US. RightAnswer.com Inc, Midland MI, US. http://www.rightanswerknowledge.com (accessed 08/2017).

Reported Effect Levels from Authoritative Sources

Exposure by skin contact

%	Signs and symptoms	Reference
0.0005	Marked transient skin and eye irritation	a
0.001-0.005	Rapid onset of stinging eyes and skin with blapherospasm and excess lacrimation (following a full body drenching with CS in aqueous solution)	b

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

References

a Department of Health. Committees on Toxicity, Mutagenicity and carcinogenicity of chemicals in Food, Consumer Products and the Environment. Statement on 2-Chlorobenzylidene Malononitrile (CS) and CS Spray, 1999.

b Maynard, R. L. (2007) Chapter 19: Mustard Gas.T.C. Marrs, R.L. Maynard and D.R. Sidell, Chemical warfare agents: toxicology and treatment. John Wiley and Sons Ltd, Chichester.

Exposure by eye contact

%	Signs and symptoms	Reference
0.1-1	Severe pain, profuse tears and redness of the conjunctiva (following exposure to CS gas in a mixture including solvents)	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

References

a Department of Health. Committees on Toxicity, Mutagenicity and carcinogenicity of chemicals in Food, Consumer Products and the Environment. Statement on 2-Chlorobenzylidene Malononitrile (CS) and CS Spray, 1999.

Exposure by inhalation

mg/m^3	Time	Signs and symptoms	Reference
0.5-1	90 minutes	Lachrymation, blepharospasm, burning mouth, nasal irritation, chest tightness and difficulty breathing	a
<5	-	Conjunctivitis, lachrymation, sensation of eye burning and pain	b
6.7	10 minutes	severe pain, profuse tears and redness of the conjunctiva (following exposure to CS powder)	a

These values give an indication of levels of exposure that can cause adverse effects. They are not health protective standards or guideline values

References

a Department of Health. Committees on Toxicity, Mutagenicity and carcinogenicity of chemicals in Food, Consumer Products and the Environment. Statement on 2-Chlorobenzylidene Malononitrile (CS) and CS Spray, 1999.

b Maynard, R. L. (2007) Chapter 19: Mustard Gas.T.C. Marrs, R.L. Maynard and D.R. Sidell, Chemical warfare agents: toxicology and treatment. John Wiley and Sons Ltd, Chichester.

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Calculated value (ppm)	Listed value (mg/m^3)
ERPG-1*	6.5×10^{-4}	0.005
ERPG-2†	0.013	0.1
ERPG-3‡	3.24	25

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour

† Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action

‡ Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects

Reference

American Industrial Hygiene Association (AIHA). 2016 Emergency Response Planning Guideline Values. https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2015%20ERPG%20Levels.pdf (accessed 08/2017).

Acute exposure guideline levels (AEGLs)

	mg/m^3				
	10 min	**30 min**	**60 min**	**4 hours**	**8 hours**
AEGL-1*	NR	NR	NR	NR	NR
AEGL-2†	0.083	0.083	0.083	0.083	0.083
AEGL-3‡	140	29	11	1.5	1.5

* Level of the chemical in air at or above which the general population could experience notable discomfort

† Level of the chemical in air at or above which there may be irreversible or other serious long-lasting effects or impaired ability to escape

‡ Level of the chemical in air at or above which the general population could experience life-threatening health effects or death

NR Not recommended due to insufficient data

Reference

US Environmental Protection Agency. Acute Exposure Guideline Levels. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 08/2017).

Exposure Standards, Guidelines or Regulations

Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m^3	ppm	mg/m^3
WEL	No data			
WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit				

Public health guidelines

Drinking water standard	Guideline value not given
Air quality guideline	Guideline value not given
Soil guideline values and health criteria values	Guideline value not given

Health Effects

Major route of exposure

- inhalation, dermal or ocular exposure
- symptoms develop rapidly, but should resolve 15-30 minutes after removal from exposure, as CS breaks down rapidly in the body
- marked toxicity would only be expected after exposure to a high concentration within a confined space for a prolonged time

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Sneezing, coughing, sore throat, wheeze, shortness of breath, rhinorrhoea, bronchorrhoea and chest tightness. Respiration may be irregular with periods of apnoea. Exacerbation of asthma has been reported. Reactive airways dysfunction syndrome (RADS) may follow a high level exposure to CS
Ingestion	A stinging or burning sensation in the mouth with increased salivation, nausea and vomiting
Dermal	Stinging or burning sensation, pruritus, scaling, erythema and blistering occur. Prolonged contact, especially in association with wet skin or clothing, can result in chemical burns that are usually minor Rarely, allergic contact dermatitis, leukoderma, initiation or exacerbation of seborrhoeic dermatitis and aggravation of rosacea occur
Ocular	Discomfort, pain, lacrimation, blurred vision, periorbital oedema and blepharospasm are common. If CS is sprayed into the eye at close range, there may also be physical injury due to the pressure jet from the canister or particles embedded in the eye

Reference

TOXBASE. CS (2-chlorobenzylidene malononitrole), 08/2013. http://www.toxbase.org (accessed 08/2017).

Decontamination at the Scene

Summary

The approach used for decontamination at the scene will depend upon the incident, location of the casualties and the chemicals involved. Therefore, a risk assessment should be conducted to decide on the most appropriate method of decontamination.

Decontamination should not be necessary following exposure to CS gas, as the agent is expected to disperse within minutes and recovery from symptoms expected to occur spontaneously (15-30 minutes).

Emergency services and public health professionals can obtain further advice from Public Health England (Centre for Radiation, Chemical and Environmental Hazards) using the 24-hour chemical hotline number: 0344 892 0555.

Clinical Decontamination and First Aid

Clinical decontamination is the process where trained healthcare professionals using purpose-designed decontamination equipment treat contaminated people individually.

Detailed information on clinical management can be found on TOXBASE – www.toxbase.org.

Important note

- secondary care staff should not need to wear protective equipment other than routine precautions against secondary contamination with vomit and body fluids
- remove from the site of exposure, particularly if in a confines space; the agent should disperse in fresh air in a few minutes
- if exposure to CS alone is confirmed, hospital treatment is rarely needed because spontaneous recovery usually occurs rapidly (within 15 - 30 minutes of cessation of exposure), unless exposure has been to high concentrations within a confined space for a prolonged time
- see below for information if features persist for longer than 30 minutes after the end of exposure
- remove all contaminated clothing and seal in plastic bags; disposable gloves should be used when handling contaminated clothes
- wash exposed skin with soap and water only if symptoms persist, as CS particles may dissolve in the irrigation fluid and exacerbate irritation

Dermal exposure

- remove all contaminated clothing and seal in plastic bags; disposable gloves should be used when handling contaminated clothes
- wash exposed skin with soap and water only if symptoms persist, as CS particles may dissolve in the irrigation fluid and exacerbate irritation
- patients with features of severe poisoning, particularly respiratory complications, should be admitted to hospital and managed appropriately
- other supportive measures as indicated by the patient's clinical condition

Ocular exposure

- remove contact lenses; hard ones may be washed and re-used in the future; soft ones should be discarded
- if eye irritation persists, irrigate the eyes with room-temperature water or normal saline for at least 15 minutes
- refer to an ophthalmologist if eye symptoms persist

- patients with features of severe poisoning, particularly respiratory complications, should be admitted to hospital and managed appropriately
- other supportive measures as indicated by the patient's clinical condition

Inhalation/ingestion

- patients with features of severe poisoning, particularly respiratory complications, should be admitted to hospital and managed appropriately
- other supportive measures as indicated by the patient's clinical condition

Health effects and decontamination references

TOXBASE http://www.toxbase.org (accessed 08/2017)

TOXBASE CS (2-chlorobenzylidene malononitrole), 08/2013

This document from the PHE Centre for Radiation, Chemical and Environmental Hazards reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

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