UK Health Security Agency

Titanium tetrachloride

Incident management

This document provides information needed for response to a chemical incident, such as physicochemical properties, health effects and decontamination advice.

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Contents

Main points

General

Titanium tetrachloride is a colourless to light yellow liquid at room temperature. It is non-flammable.

May react violently with water to release hydrochloric acid, titanium dioxide and heat. Emits toxic fumes of hydrogen chloride when heated to decomposition.

Health

Reacts with moisture to produce hydrochloric acid, which causes toxicity.

Inhalation may cause irritation of the eyes and nose, with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion. Pulmonary oedema may take up to 36 hours to develop.

Ingestion causes burning in the mouth, throat and stomach, followed by dysphagia, drooling, abdominal pain, vomiting, haematemesis and dyspnoea; haemorrhagic or hypovolemic shock and airway obstruction may occur in severe cases.

Dermal exposure to acids may cause pain, blistering, ulceration and penetrating necrosis.

Ocular exposure may cause lacrimation, conjunctivitis, photophobia and corneal burns.

Casualty decontamination at the scene

Titanium tetrachloride reacts with tissue moisture to form hydrochloric acid, which is corrosive. Therefore, following disrobe, improvised wet decontamination should be considered.

Environment

Inform the Environment Agency where appropriate and avoid release into the environment.

Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters.

Hazard identification

Table 1. Standard (UK) dangerous goods emergency action codes for titanium tetrachloride

UN		1838	Titanium tetrachloride	
EAC		4WE	Use dry agent, water must not be allowed to come into contact with the substance. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus [note 1]. Substance can be violently or explosively reactive. Spillages, contaminated fire and decontamination run-off should be prevented from entering drains and surface and groundwaters. There may be a public safety hazard outside the immediate area of the incident [note 2].	
APP		B	Gas-tight chemical protective suit with breathing apparatus [note 3]	
Hazards	**Class**	6.1	Toxic substances	
	Sub-risks	8	Corrosive substances	
HIN		X668	Highly toxic substance, corrosive, which reacts dangerously with water	

Abbreviations

UN = United Nations number.
EAC = emergency action code.
APP = additional personal protection.
HIN = hazard identification number.

Notes to Table 1

Note 1: Chemical protective clothing with liquid tight connections for whole body (Type 3) conforming to the relevant standards such as BS 8428 or EN 14605 in combination with breathing apparatus conforming to BS EN 137.

Note 2: People should be warned to stay indoors with all doors and windows closed, preferably in rooms upstairs and facing away from the incident. Ignition sources should be eliminated and ventilation stopped. Effects may spread beyond the immediate vicinity. All non-essential personnel should be instructed to move at least 250 m away from the incident.

Note 3: Chemical protective clothing should be gas-tight conforming to BS EN 943 part 2 in combination with breathing apparatus conforming to BS EN 137

References

National Chemical Emergency Centre (NCEC), part of Ricardo-AEA. 'Dangerous Goods Emergency Action Code List' 2023 (viewed on 8 November 2024)

Table 2. The GB classification, labelling and packaging (CLP) regulation for titanium tetrachloride

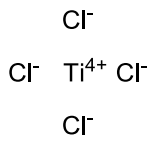
Hazard class and category	Skin Corr. 1B	Skin corrosion, category 1B	
Hazard statement	H314	Causes severe skin burns and eye damage	
	EUH014	Reacts violently with water	
Signal words	DANGER		

References

The Health and Safety Executive (HSE). 'GB CLP Regulation' (viewed on 8 November 2024).

Physicochemical properties

Table 3. Physicochemical properties

CAS number	7550-45-0
Molecular weight	189.7
Formula	$TiCl_4$
Common synonyms	Titanic chloride, titanium chloride, tetrachlorotitanium
State at room temperature	Colourless to light yellow liquid
Volatility	Vapour pressure = 1.3 kPa at 21.3°C
Specific gravity	1.7 (water = 1)
Flammability	Non-flammable
Lower explosive limit	-
Upper explosive limit	-
Water solubility	Soluble
Reactivity	Decomposes on heating. This produces toxic fumes including hydrogen chloride. Reacts violently with water. This produces heat and corrosive fumes including hydrogen chloride. Contact with air generates hydrochloric acid. Attacks many metals in the presence of water.
Odour	Penetrating acid odour
Structure	

References

World Health Organization. International Programme on Chemical Safety ‘International Chemical Safety Card entry for Titanium Tetrachloride’ ICSC 1230, 2004 (viewed on 23 October 2024)

PubChem. Bethesda (MD): National Library of Medicine (US), National Center for Biotechnology Information. ‘PubChem Compound Summary for CID 24193, Titanium Tetrachloride’ (viewed on 23 October 2024)

Reported effect levels from authoritative sources

No reported effect levels identified.

Published emergency response guidelines

Table 4. Interim acute exposure guideline levels (AEGLs)

	Concentration (ppm)				
	10 minutes	**30 minutes**	**60 minutes**	**4 hours**	**8 hours**
AEGL-1 [note 1]	NR	NR	NR	NR	NR
AEGL-2 [note 2]	7.6	2.2	1.0	0.21	0.094
AEGL-3 [note 3]	38	13	5.7	2.0	0.91

Notes to Table 4

Note 1: Level of the chemical in air at or above which the general population could experience notable discomfort.

Note 2: 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.

Note 3: 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 (EPA). 'Acute Exposure Guideline Levels' (viewed on 8 November 2024)

Exposure standards, guidelines or regulations

Table 5. Occupational standards

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m^3	ppm	mg/m^3
WEL	No values specified			

Abbreviations

WEL = workplace exposure limit.
LTEL = long-term exposure limit.
STEL = short-term exposure limit.

Table 6. Public health standards and guidelines

Drinking water standard	No value specified
WHO guideline for drinking water quality	No guideline value specified
UK indoor air quality guideline	No guideline value specified
WHO indoor air quality guideline	No guideline value specified
WHO air quality guideline	No guideline value specified

Health effects

Titanium tetrachloride is corrosive. Reacts exothermically with moisture to produce hydrochloric acid and titanium dioxide. Toxicity is due to hydrochloric acid; it is thought that the thermal injury exposes deeper tissues, thus producing more severe burns than those expected from hydrochloric acid alone.

Table 7. Signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Irritation of eyes and nose with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion. Chemical pneumonitis, tachypnoea, dyspnoea and stridor due to laryngeal oedema may follow. Optic neuropathy has been reported following inhalation. Pulmonary oedema with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36 hours to develop. In serious cases, corrosive damage to the mucous membranes of both the upper and lower respiratory tract occurs. Severe inhalation injuries may result in persistent hoarseness, pulmonary fibrosis and chronic obstructive pulmonary disease. Prolonged exposure may result in systemic effects.
Ingestion	Immediate pain with burning in the mouth, throat and stomach, which may be followed by abdominal pain, vomiting, haematemesis and dyspnoea. Pain and oedema may make swallowing difficult, causing drooling. Haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases. Stridor and respiratory complications (including pneumonitis, pulmonary oedema, ARDS and pulmonary necrosis) can develop following aspiration of corrosive materials. Acids can damage the stomach causing ulceration, gangrene, haemorrhage and perforation. In severe cases extensive areas of the gastrointestinal tract may be involved. Gastric or oesophageal perforation may occur in the early stages of severe cases. Severe injury can cause pyloric stenosis and a small, scarred, immobile stomach.

Route	Signs and symptoms
	Systemic effects include circulatory collapse, metabolic acidosis, hypoxia, respiratory failure, acute renal failure, haemolysis and disseminated intravascular coagulation (DIC).
Eyes	Pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia may occur. May cause corneal burns.
Dermal	Symptoms are more likely to occur following direct contact with solid or liquid corrosive materials, although features can also occur through contact with corrosive gases and fumes. Acids may cause pain, blistering, ulceration and penetrating necrosis. These burns may be self-limiting and superficial with the destruction of the surface epithelium and sub mucosa forming a leathery crust which limits the spread of the product. Large or prolonged exposure may result in systemic effects.

Reference

National Poisons Information Service (NPIS). TOXBASE 'Titanium tetrachloride' 2019 (viewed on 8 November 2024)

National Poisons Information Service (NPIS). TOXBASE 'Corrosives – ingestion' 2022 (viewed on 8 November 2024)

National Poisons Information Service (NPIS). TOXBASE 'Corrosives – inhalation' 2020 (viewed on 8 November 2024)

National Poisons Information Service (NPIS). TOXBASE 'Skin decontamination – corrosives' 2020 (viewed on 8 November 2024)

National Poisons Information Service (NPIS). TOXBASE 'Chemicals Splashed or Sprayed into the Eyes – features and management' 2020 (viewed on 8 November 2024)

Decontamination at the scene

Chemical specific advice

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.

Titanium tetrachloride reacts with tissue moisture to form hydrochloric acid, which is corrosive. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details).

People who are processed through improvised decontamination should subsequently be moved to a safe location, triaged and subject to health and scientific advice. Based on the outcome of the assessment, they may require further decontamination.

Emergency services and public health professionals can obtain further advice from the UK Health Security Agency (UKHSA) Radiation, Chemicals, Climate and Environmental Hazards Directorate using the 24-hour chemical hotline number: 0344 892 0555.

Disrobe

The disrobe process is highly effective at reducing exposure to HAZMAT/CBRN material when performed within 15 minutes of exposure.

Therefore, disrobe must be considered the primary action following evacuation from a contaminated area.

Where possible, disrobing should be conducted at the scene and by the casualty themselves. Disrobing should be systematic to prevent transfer of contaminant from clothing to skin. Clothing should not be pulled over the head if possible.

Clothing stuck to the casualty by the contaminant should not be forcefully removed, as this risks causing further harm.

Consideration should be given to ensuring the welfare and dignity of casualties as far as possible. Immediately after decontamination the opportunity should be provided to dry and dress in clean robes or clothes.

Improvised decontamination

Improvised decontamination is an immediate method of decontamination prior to the use of specialised resources. This should be performed on all contaminated casualties unless medical advice is received to the contrary. Improvised dry decontamination should be considered for an incident involving chemicals unless the agent appears to be corrosive or caustic.

Unprotected first responders and members of the public should not approach casualties incapacitated by exposure to administer improvised decontamination, as they may be exposed to contaminants and become a casualty themselves.

Important note: Improvised decontamination should continue until a more structured intervention, such as an Interim Operational Response is carried out, or Specialist Operational Response are present.

Improvised dry decontamination

Any available dry absorbent material can be used such as kitchen towel, paper tissues (for example blue roll) and clean cloth.

Exposed skin surfaces should be blotted first and then rubbed, starting with the face, head, and neck, and moving down and away from the body.

Blotting and rubbing should not be too aggressive, as it could drive contamination further into the skin.

Casualties should also blow their nose to remove contaminants from the nasal cavities.

All waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage.

Improvised wet decontamination

Wet decontamination should be used if contamination with a caustic chemical substance is suspected.

Wet decontamination may be performed using copious amounts of water from any available source such as taps, showers, water bottles, fixed installation hose-reels and sprinklers to gently rinse the affected skin. Other natural sources of water may be considered unless this creates greater risks to the individuals affected. Wet wipes or baby wipes may be used as an effective alternative.

Improvised decontamination should not involve overly aggressive methods to remove contamination as this could further damage affected tissues and drive the contamination further into the skin.

Where appropriate, seek professional advice on how to dispose of contaminated water and prevent run-off going into the water system.

Additional notes

Following improvised decontamination, remain cautious and observe for signs and symptoms in the decontaminated person and in unprotected staff.

If water is used to decontaminate casualties this may be contaminated, and therefore hazardous, and a potential source of further contamination spread.

All materials (paper tissues and so on) used in this process may also be contaminated and, where possible, should not be used on new casualties.

The risk from hypothermia should be considered when disrobe and any form of wet decontamination is carried out.

People who are contaminated should not eat, drink or smoke before or during the decontamination process and should avoid touching their face.

When vulnerable people are affected by a hazardous substance, they may need additional support to remove themselves, their clothing or the substance.

Casualties should remain in the area and should not leave to seek care at a hospital, as this presents a contamination risk. Further care will be administered on site by the appropriate emergency services.

Interim wet decontamination

Interim decontamination is the use of standard Fire and Rescue Service equipment to provide a planned and structured decontamination process prior to the availability of purpose-designed decontamination equipment.

Decontamination at the scene references

Home Office. ‘Initial operational response to a CBRN incident’ Version 2.0 2015 (viewed on 8 November 2024)

National Health Service England. ‘Emergency Preparedness, Resilience and Response (EPRR): Guidance for the initial management of self-presenters from incidents involving hazardous materials’ 2019 (viewed on 8 November 2024)

Joint Emergency Service Interoperability Programme. ‘Initial Operational Response IOR to Incidents Suspected to Involve Hazardous Substances or CBRN Materials’ 2024 (viewed on 8 November 2024)

Clinical decontamination and first aid

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

Detailed information on clinical management can be found on TOXBASE.

Important notes

Once body surface contaminants have been removed or if your patient was exposed by ingestion or inhalation, the risk that secondary care givers may become contaminated is very low. Secondary carers should wear standard hospital PPE as a precaution against secondary contamination from vomit and body fluids.

If the patient has not been decontaminated following surface contamination, secondary carers must wear appropriate NHS PPE for chemical exposure to avoid contaminating themselves.

The area should be well ventilated.

For comprehensive clinical advice consult TOXBASE directly.

Clinical decontamination following surface contamination

Avoid contaminating yourself.

Carry out decontamination after resuscitation. This should be performed in a well-ventilated area, preferably with its own ventilation system.

Contaminated clothing should be removed, double-bagged, sealed and stored safely.

Decontaminate open wounds first and avoid contamination of unexposed skin. Any particulate matter adherent to skin should be removed and the patient washed with copious amounts of water under low pressure for at least 10 to 15 minutes, or until pH of skin is normal (pH of the skin is 4.5 to 6 although it may be closer to 7 in children, or after irrigation). The earlier irrigation begins, the greater the benefit.

Pay special attention to skin folds, fingernails and ears.

Dermal exposure

Decontaminate (as above) the patient following surface contamination.

Recheck pH of affected areas after a period of 15 to 20 minutes and repeat irrigation if abnormal. Burns with strong solutions may require irrigation for several hours or more. Attention should be paid to avoiding hypothermia during prolonged irrigation with cool fluids. Once the pH is normal and stabilised, treat as per a thermal injury.

Burns totalling more than 15% of body surface area in adults (>10% in children) will require standard fluid resuscitation as for thermal burns.

Moderate or severe chemical burns should be reviewed by a burns specialist.

Other supportive measures as indicated by the patient's clinical condition.

Ocular exposure

Remove contact lenses if present.

Anaesthetise the eye with a topical local anaesthetic (for example, oxybuprocaine, amethocaine or similar). However, do not delay irrigation if local anaesthetic is not immediately available.

Immediately irrigate the affected eye thoroughly with 1,000mL 0.9% saline or equivalent crystalloid (for example, by an infusion bag with a giving set) for a minimum of 10 to 15 minutes irrespective of initial conjunctival pH. A Morgan Lens may be used if anaesthetic has been given.

Aim for a neutral conjunctival pH of 7 to 7.2. The conjunctivae may be tested with indicator paper. Retest at 15 to 30 minutes after irrigation and use further irrigation if necessary.

Any particles lodges in the conjunctival recesses should be removed.

Repeated instillation of local anaesthetics may reduce discomfort and help more thorough decontamination. However, prolonged use of concentrated local anaesthetics is damaging to the cornea.

Patients with corneal damage, those who have been exposed to strong acids or alkalis and those whose symptoms do not resolve rapidly should be discussed urgently with an ophthalmologist.

Other supportive measures as indicated by the patient's clinical condition.

Ingestion

Maintain airway and establish haemodynamic stability.

In severely affected patients, especially those with tachypnoea, stridor or upper airway damage, critical care input is essential with urgent assessment of the airway. A supraglottic-epiglottic burn with erythema and oedema is usually a sign that further oedema will occur that may lead to airway obstruction.

Children are at increased risk of airway obstruction.

Do not attempt gastric lavage. Do not give neutralising chemicals as heat produced during neutralisation reactions may cause further injury.

Monitor vital signs and cardiac rhythm; check the capillary blood glucose.

Check and record pupil size.

Consider the use of water or milk (maximum initial volume = 100-200 mL in an adult; 2 mL/kg in a child) as diluents for symptomatic benefit early after corrosive ingestion provided the patient does not have swallowing or breathing problems (but caution is necessary following large ingestions where mucosal damage or perforation may have already developed). There is experimental evidence to suggest that early dilution therapy with water or milk reduces acute alkali injury of the oesophagus but administration of large volumes of fluid should be avoided as they may induce vomiting and increase the risk of oedema.

Perform a 12-lead ECG in all patients who require assessment.

Other supportive measures as indicated by the patient's condition.

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Clinical decontamination and first aid references

National Poisons Information Service (NPIS). TOXBASE 'Titanium tetrachloride' 2019 (viewed on 8 November 2024)

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About the UK Health Security Agency

UKHSA is responsible for protecting every member of every community from the impact of infectious diseases, chemical, biological, radiological and nuclear incidents and other health threats. We provide intellectual, scientific and operational leadership at national and local level, as well as on the global stage, to make the nation health secure.

UKHSA is an executive agency, sponsored by the Department of Health and Social Care.

This document from the UKHSA Radiation, Chemicals, Climate and Environmental Hazards Directorate reflects understanding and evaluation of the current scientific evidence as presented and referenced here.

First published: October 2015
Update: November 2016 Health Effects, Decontamination at the Scene & Clinical Decontamination and First Aid
Full document update: November 2024

For queries relating to this document, please contact chemcompendium@ukhsa.gov.uk or enquiries@ukhsa.gov.uk

Publishing reference: GOV-17743