Public Health England

Protecting and improving the nation's health

Sulphuric Acid

Incident Management

Key Points

General

- liquid at room temperature, miscible in water
- odourless
- non-flammable, reactions may cause fire or explosion
- releases toxic and irritating oxides of sulphur fumes when heated to decomposition
- corrodes many common metals and releases flammable/explosive hydrogen gas

Health effects

- corrosive by inhalation, ingestion, eye contact and skin contact
- inhalation causes irritation of eyes and nose, with sore throat, cough, chest tightness, headache, fever, wheeze, tachycardia and confusion
- ingestion causes immediate pain, with burning in the mouth, throat and stomach; in severe cases, extensive areas of the gastrointestinal tract may be involved
- dermal exposure causes pain, blistering, ulceration and penetrating necrosis
- ocular exposure causes pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia

Casualty decontamination at the scene

- sulphuric acid is corrosive; therefore, following disrobe, improvised wet decontamination should be considered (see below for details on wet decontamination)

Environment

- hazardous to the environment; inform the Environment Agency where appropriate
- spillages and decontamination run-off should be prevented from entering watercourses

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Hazard Identification

Standard (UK) dangerous goods emergency action codes

Sulphuric acid, with more than 51% acid

UN		1830	Sulphuric acid with more than 51% acid	
EAC		2P	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Danger that the substance can be violently or explosively reactive. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses	
APP		–	–	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive material	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* 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 BS EN 137

Reference

Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.

Sulphuric acid, fuming

UN		1831	Sulphuric acid, fuming	
EAC		4WE	Use dry agent. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. Danger substance can be violently or explosively reactive. There may be a public safety hazard outside the immediate area of the incident†	
APP		B	Gas-tight chemical protective suit in combination with breathing apparatus‡	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	6.1	Toxic substance	
HIN		X886	Highly corrosive substance, toxic which reacts dangerously with water	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* 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 BS EN 137

† People should stay indoors with windows and doors closed, ignition sources should be eliminated and ventilation stopped. Non-essential personnel should move at least 250 m away from the incident

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

Reference

Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.

Sulphuric acid, spent

UN		1832	Sulphuric acid, spent	
EAC		2W	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and surface and ground waters. Substance can be violently or explosively reactive	
APP		–	–	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive material	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* 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 BS EN 137

Reference

Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.

Sulphuric acid, with not more than 51% acid or battery fluid, acid

UN		2796	Sulphuric acid, with not more than 51% acid or battery fluid, acid	
EAC		2R	Use fine water spray. Wear chemical protective clothing with liquid-tight connections for whole body in combination with breathing apparatus*. Spillages and decontamination run-off may be washed to drains with large quantities of water. Due care must, however, still be exercised to avoid unnecessary pollution to watercourses	
APP		–	–	
Hazards	**Class**	8	Corrosive substance	
	Sub-risks	–	–	
HIN		80	Corrosive or slightly corrosive material	

UN – United Nations number, EAC – emergency action code, APP – additional personal protection, HIN – hazard identification number

* 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 BS EN 137

Reference

Dangerous Goods Emergency Action Code List. National Chemical Emergency Centre (NCEC), Part of Ricardo-AEA. The Stationery Office, 2019.

Classification, labelling and packaging (CLP)*

Hazard class and category	Skin Corr. 1A	Skin corrosion, category 1A	
Hazard statement	H314	Causes severe skin burns and eye damage	
Signal words	DANGER		

* Implemented in the EU on 20 January 2009

Reference

European Commission. Harmonised classification – Annex VI of Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 03/2019).

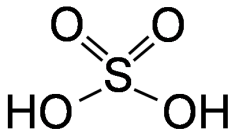
Specific concentration limits

Concentration	Hazard class and category	Hazard statement	
C ≥ 15%	Skin Corr. 1A	H314	Causes severe skin burns and eye damage
5% ≤ C < 15%	Skin Irrit. 2	H315	Causes skin irritation
5% ≤ C < 15%	Eye Irrit. 2	H319	Causes serious eye irritation

Reference

European Commission. Harmonised classification – Annex VI of Regulation (EC) No. 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures. http://echa.europa.eu/information-on-chemicals/cl-inventory-database (accessed 03/2019).

Physicochemical Properties

CAS number	7664-93-9
Molecular weight	98
Formula	H_2SO_4
Common synonyms	Sulfuric acid, oil of vitriol
State at room temperature	Liquid
Volatility	Non-volatile at 25°C
Relative density **Relative vapour density**	1.8 (water = 1) 3.4 (air = 1)
Flammability	Non-flammable, reactions may cause fire or explosion
Lower explosive limit	–
Upper explosive limit	–
Water solubility	Miscible with water
Reactivity	Sulphuric acid is a strong oxidiser. Reacts with combustible and reducing materials and organic materials generating fire and explosion hazards. Reacts violently with water generating heat and fire or explosion hazard. Attacks many plastics
Reaction or degradation products	Releases toxic and corrosive oxides of sulphur fumes when heated to decomposition. Strong acid that reacts violently with bases and is corrosive to most common metals forming a flammable/explosive gas
Odour	Odourless
Structure	

References

Hazardous Substances Data Bank. Sulfuric acid. HSDB No. 1811 (last revision date 22/09/2016). US National Library of Medicine: Bethesda MD. http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB (accessed 03/2019).

International Programme on Chemical Safety. International chemical safety card entry for sulfuric acid. ICSC 0362, 2016. World Health Organization: Geneva.

Reported Effect Levels from Authoritative Sources

Data not available

Published Emergency Response Guidelines

Emergency response planning guideline (ERPG) values

	Listed value (mg/m^3)	Calculated value (ppm)
ERPG-1*	2(1)	0.5
ERPG-2†	10	2.5
ERPG-3‡	120	30

* 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

(1) Odour should be detectable near ERPG-1

Reference

American Industrial Hygiene Association (AIHA). 2015 Emergency Response Planning Guideline Values. https://www.aiha.org/get-involved/AIHAGuidelineFoundation/EmergencyResponsePlanningGuidelines/Documents/2016%20ERPG%20Table.pdf (accessed 03/2019).

Interim acute exposure guideline levels (AEGLs)

	Concentration (mg/m^3)				
	10 min	**30 min**	**60 min**	**4 hours**	**8 hours**
AEGL-1*	0.2	0.2	0.2	0.2	0.2
AEGL-2†	8.7	8.7	8.7	8.7	8.7
AEGL-3‡	270	200	160	110	93

* 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

Reference

US Environmental Protection Agency. Acute Exposure Guideline Levels. http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 03/2019).

Exposure Standards, Guidelines or Regulations

Occupational standards *(see note)*

	LTEL (8-hour reference period)		STEL (15-min reference period)	
	ppm	mg/m^3	ppm	mg/m^3
WEL	–	0.05	–	–

Note Values relate to sulphuric acid mist (the mist is defined as the thoracic fraction)

WEL – workplace exposure limit, LTEL – long-term exposure limit, STEL – short-term exposure limit

Reference

Health and Safety Executive (HSE). EH40/2005 Workplace Exposure Limits, 3rd Edition, 2018.

Public health guidelines

Drinking water standard	No guideline values specified
Air quality guideline	No guideline values specified

Health Effects

Major route of exposure

- inhalation, ingestion, dermal and ocular exposure

Immediate signs or symptoms of acute exposure

Route	Signs and symptoms
Inhalation	Inhalation causes irritation of the 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. Pulmonary oedema, with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36 hours to develop. Optic neuropathy has been reported following acute inhalation 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 airway disease Prolonged exposure may result in systemic effects
Ingestion	Ingestion causes immediate pain, with burning in the mouth, throat and stomach. This 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, acute respiratory distress syndrome and pulmonary necrosis) can develop following aspiration of corrosive materials Acids tend to damage the stomach, with ulceration, gangrene, haemorrhage and perforation. However, in severe cases extensive areas of the gastrointestinal tract may be involved **Systemic features** may include circulatory collapse, metabolic acidosis, hypoxia, respiratory failure, acute renal failure, haemolysis and disseminated intravascular coagulation (DIC)
Dermal	Acids may cause pain, blistering, ulceration and penetrating necrosis. Coagulation burns may develop, which can 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
Ocular	Pain, blepharospasm, lacrimation, conjunctivitis, oedema and photophobia may occur. Acidic solutions may cause corneal burns and limbal ischaemia (whitening/blanching around the edge of the cornea where it meets the sclera)

References

TOXBASE. Sulphuric acid, 09/2017. http://www.toxbase.org (accessed 03/2019).

TOXBASE. Corrosives – inhalation, 11/2018. http://www.toxbase.org (accessed 03/2019).

TOXBASE. Corrosives – ingestion, 09/2017. http://www.toxbase.org (accessed 03/2019).

TOXBASE. Skin decontamination – corrosives, 01/2018. http://www.toxbase.org (accessed 03/2019).

TOXBASE. Chemicals splashed or sprayed into the eyes, 06/2017. http://www.toxbase.org (accessed 03/2019).

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.

Sulphuric acid liquid and vapour are corrosive. Therefore, following disrobe, improvised wet decontamination should be considered (see below for details on wet decontamination).

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.

General advice on disrobe and decontamination

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, disrobe at the scene should be conducted by the casualty themselves and should be systematic to avoid transferring any contamination from clothing to the skin. Consideration should be given to ensuring the welfare and dignity of casualties as far as possible.

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.**

Improvised dry decontamination

- any available dry absorbent material can be used, such as kitchen towel, paper tissues (e.g. blue roll) and clean cloth

- exposed skin surfaces should be blotted and rubbed, starting with the face, head and neck and moving down and away from the body
- rubbing and blotting should not be too aggressive, or it could drive contamination further into the skin
- all waste material arising from decontamination should be left in situ, and ideally bagged, for disposal at a later stage

Improvised wet decontamination

- water should only be used for decontamination where casualty signs and symptoms are consistent with exposure to caustic or corrosive substances such as acids or alkalis
- wet decontamination may be performed using any available source of water such as taps, showers, fixed installation hose-reels and sprinklers
- when using water, it is important to try and limit the duration of decontamination to between 45 and 90 seconds and, ideally, to use a washing aid such as cloth or sponge
- improvised decontamination should not involve overly aggressive methods to remove contamination as this could 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 etc) 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
- 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/clothes
- 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

Interim wet decontamination

Interim decontamination is the use of standard fire and rescue Service (FRS) 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, July 2015.

NHS England. Emergency Preparedness, Resilience and Response (EPRR). Guidance for the initial management of self presenters from incidents involving hazardous materials. February 2019.

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

- **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

Clinical decontamination following surface contamination

- carry out decontamination after resuscitation
- this should be performed in a well-ventilated area, preferably with its own ventilation system
- do **not** apply neutralising chemicals as heat produced during neutralization reactions may cause thermal burns, and increase injury
- 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 10–15 minutes, or until the pH of the skin is normal (pH of the skin is 4.5–6, although it may be closer to 7 in children, or after irrigation). **The earlier irrigation begins, the greater the benefit**
- pay particular attention to mucous membranes, moist areas such as skin folds, fingernails and ears

Dermal exposure

- decontaminate (as above) the patient following surface contamination
- following decontamination, recheck the pH of affected areas after a period of 15–20 minutes and repeat irrigation if abnormal. Burns with strong solutions may require irrigation for several hours or more
- once the pH is normal and stabilised, treat as for a thermal injury
- burns totalling more than 15% of body surface area in adults (more than 10% in children) will require standard fluid resuscitation as for thermal burns

- moderate/severe chemical burns should be reviewed by a burns specialist; excision or skin grafting may be required
- 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 (e.g. oxybuprocaine, amethocaine or similar); **however, do not delay irrigation if local anaesthetic is not immediately available**
- immediately irrigate the affected eye thoroughly with 1,000 mL 0.9% saline (e.g. by an infusion bag with a giving set) for a minimum of 10-15 minutes irrespective of initial conjunctival pH. Amphoteric solutions are available and may be used. A Morgan Lens may be used if anaesthetic has been given. Aim for a final conjunctival pH of 7.5–8.0. The conjunctivae may be tested with indicator paper. Retest 20 minutes after irrigation and use further irrigation if necessary
- 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

Inhalation

- maintain a clear airway and adequate ventilation
- give oxygen if required
- monitor respiratory rate and oxygen saturation
- perform a 12 lead ECG in all patient who require assessment
- other supportive measures as indicated by the patient's clinical condition

Ingestion

- **maintain airway and establish haemodynamic stability**
- in severely affected patients critical care input is essential. Urgent assessment of the airway is required. 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 increase injury
- monitor blood pressure, pulse and oxygen saturation
- perform 12 lead ECG in all patients that require assessment
- other supportive measures as indicated by the patient's condition

Clinical decontamination and first aid references

TOXBASE http://www.toxbase.org (accessed 03/2019)

TOXBASE Sulphuric acid, 09/2017

TOXBASE Chemicals splashed or sprayed into the eyes, 06/2017

TOXBASE Skin decontamination – corrosives, 01/2018

TOXBASE Corrosives – inhalation, 11/2018

TOXBASE Corrosives – ingestion, 09/2017

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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