HPA Compendium of Chemical Hazards

Sulphuric acid

Key Points

Fire

- Non flammable under normal conditions
- Highly reactive
- Releases toxic and irritating fumes when heated to decomposition
- Do not use water on fuming acid
- In the event of a fire involving sulphuric acid, use fine water spray and liquid-tight protective clothing with breathing apparatus
- Gas-tight protective suits with breathing apparatus required for fuming acid

Health

- Exposure may occur following ingestion, inhalation, skin or eye exposure
- Corrosive
- Acute inhalation may result in irritation of eyes and nose with sore throat, cough, chest tightness, headache and confusion
- Acute ingestion results in burns to the mouth and throat
- Acute skin exposure can result in irritation, erythema or burns
- Acute eye exposure may cause inflammation, lacrimation and photophobia
- Chronic inhalation leads to inflammation of the lungs and dental decay
- Sulphuric acid mists are carcinogenic to humans. Sulphuric acid or sulphuric acid solutions are not considered to be carcinogenic
- Sulphuric acid is not considered to be a developmental toxin

Environment

- Avoid release into the environment
- Inform Environment Agency of substantial release incidents

Prepared by J D Pritchard
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2011
Version 3

Contents

Sulphuric acid

General information

Key Points

Fire

- Non flammable under normal conditions
- Highly reactive
- Releases toxic and irritating fumes when heated to decomposition
- Do not use water on fuming acid
- Use fine water spray and liquid-tight chemical protective suits with breathing apparatus
- Gas-tight protective suits with breathing apparatus required for fuming acid

Health

- Exposure may occur following ingestion, inhalation, skin or eye exposure
- Corrosive
- Short-term inhalation may result in irritation of eyes and nose with sore throat, cough, chest tightness, headache and confusion
- Short-term ingestion results in burns to the mouth and throat
- Short-term skin exposure can result in irritation, swelling or burns
- Short-term eye exposure may cause swelling, watering and sensitivity to light
- Long-term inhalation leads to inflammation of the lungs and dental decay
- Sulphuric acid mists are carcinogenic to humans. Sulphuric acid or sulphuric acid solutions are not considered to be carcinogenic
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Background

Sulphuric acid is clear, colourless or brown oily liquid that is highly corrosive. Sulphuric acid is a very important chemical worldwide and over one million tonnes of sulphuric acid are made in the UK each year.

Sulphuric acid is made by burning sulphur. The sulphur dioxide given off is then reacted with a catalyst at high temperature to give sulphur trioxide. This can then be absorbed to give the acid. Depending on its intended use, it can be further diluted with water. This method of manufacture is called the Contact Process.

There are many uses for the acid including the manufacture of fertilisers, rubber, other acids, detergents, dyes, some medicines and in oil refining. Because it is so widely used in industry, exposure may occur in many work places. Burning fossil fuels also releases sulphur dioxide which can react with water in the air to form sulphuric acid. Sulphuric acid is also used to harvest potatoes; the acid damages the leaves killing the plant and making it easier to lift the potatoes from the ground.

At home the main sources of sulphuric acid are lead-acid car batteries and some solutions for unblocking drains. Sulphuric acid is not persistent in the environment, being quickly neutralised.

Strong solutions of sulphuric acid are highly corrosive and can cause skin burns on contact. The severity of the burn depends on the strength of the acid solution and how long you are exposed to it. Drinking a solution of sulphuric acid will burn the mouth, throat and stomach and can cause death. Burns to the eyes are dangerous and could cause blindness.

Breathing air with high levels of sulphuric acid can cause lung damage, shortness of breath, chest pain and cough, which may lead to death in severe cases. Breathing air contaminated with sulphuric acid over a long period of time can cause damage to teeth, throat and lungs.

Children exposed to sulphuric acid will have the similar effects as adults. However, children they may be more affected by an exposure due to their smaller size. Asthmatics may also be more sensitive to the irritant effects of sulphuric acid after breathing it in.

Sulphuric acid is unlikely to cause harm to the unborn child if the mother is exposed. This is because sulphuric acid causes toxicity at the point of contact only and rapidly breaks down on contact with body tissue.

Sulphuric acid or its solutions are not classified as carcinogens.

Frequently Asked Questions

What is sulphuric acid?

Sulphuric acid is a clear, colourless or brown, oily liquid that can be highly corrosive.

What is sulphuric acid used for?

Sulphuric acid is used in many industries. For example, it is used in the production of fertilisers, rubber, other acids, detergents, dyes, some pharmaceuticals and in oil refining.

How does sulphuric acid get into the environment?

Apart from industrial and agricultural processes, burning fossil fuels releases sulphur dioxide which can react with water in air to form sulphuric acid. This contributes to “acid-rain” which can cause environmental damage.

How could I be exposed to sulphuric acid?

At home, people may be exposed to sulphuric acid as it present in some household cleaning products.

If there is sulphuric acid in the environment will I have any adverse health effects?

The presence of sulphuric acid in the environment does not always lead to exposure. Clearly, in order for it to cause any adverse health effects you must come into contact with it. You may be exposed by breathing, eating, or drinking the substance or by skin contact. Following exposure to any chemical, the adverse health effects you may encounter depend on several factors, including the amount to which you are exposed (dose), the way you are exposed, the duration of exposure, the form of the chemical and if you were exposed to any other chemicals.

Strong solutions of sulphuric acid are highly corrosive and can cause burns to all parts of the body that they touch. Dilute solutions may cause irritation to the eyes and skin.

Can sulphuric acid cause cancer?

Sulphuric acid or its solutions are not classified as carcinogens. However, long term occupational exposure to mists containing mixtures of inorganic acid vapours (such as hydrochloric acid) that include sulphuric acid can cause an increased risk of cancer of the larynx.

Does sulphuric acid affect children or damage the unborn child?

If children breathe or ingest or touch sulphuric acid they will have similar effects as in adults such as burns to the hand or mouth for example.

Sulphuric acid is unlikely to cause harm to the unborn child if the mother is exposed. This is because sulphuric acid causes toxicity at the point of contact only and rapidly breaks down on contact with body tissue. Sulphuric acid is not known to damage the unborn child as it does not easily go from the mother to the child.

If sulphuric acid is used in car batteries, how should they be safely disposed of?

You should contact your local authority for advice on where to dispose of old car batteries; please do not dump them as they pose a risk to children and animals. They should be disposed of at a proper waste disposal site.

What should I do if I am exposed to sulphuric acid?

You should remove yourself from the source of exposure.

If you have got sulphuric acid on your skin, remove soiled clothing, wash the affected area with lukewarm water and soap for at least 10 – 15 minutes and seek medical advice.

If you have got sulphuric acid in your eyes, remove contact lenses, irrigate the affected eye with lukewarm water for at least 10 – 15 minutes and seek medical advice.

If you have inhaled or ingested sulphuric acid seek medical advice.

Sulphuric acid

Incident management

Key Points

Fire

- Non flammable under normal conditions
- Highly reactive
- Releases toxic and irritating fumes of oxides of sulphur when heated to decomposition
- Do not use water on fuming acid (anhydrous)
- In the event of a fire involving sulphuric acid, use fine water spray and liquid-tight protective clothing with breathing apparatus
- Gas-tight protective suits with breathing apparatus required for fuming acid

Health

- Exposure may occur following ingestion, inhalation, skin or ocular exposure
- Corrosive
- Inhalation causes irritation of the eyes and nose with sore throat, cough, chest tightness, headache, tachycardia and confusion
- Ingestion causes immediate burning of the mouth and throat, drooling, difficulty swallowing, abdominal pain, vomiting and haematemesis. Haemorrhagic or hypovolaemic shock and airway obstruction from laryngeal and/or epiglottic oedema are features of severe cases.
- Dermal exposure causes coagulation burns
- Ocular exposure causes pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia.

Environment

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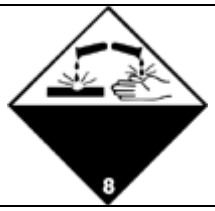
Hazard Identification

Standard (UK) Dangerous Goods Emergency Action Codes[a]

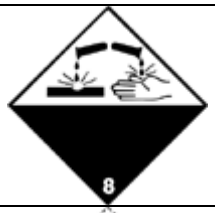
UN		**1830**	Sulphuric acid with more than 51% acid	
EAC		**2P**	Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Spillages and decontamination run-off may be washed to drains with large quantities of water. Substance can be violently or explosively reactive.	
APP		**-**		
Hazards	**Class**	**8**	Corrosive substance	
	Sub risks	**-**		
HIN		**80**	Corrosive or slightly corrosive material	

UN		**1832**	Sulphuric acid, spent	
EAC		**2W**	Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. 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

[a] Dangerous Goods Emergency Action Code List, HM Fire Service Inspectorate, Publications Section, The Stationery Office, 2009.

Standard (UK) Dangerous Goods Emergency Action Codes[a]

UN		**1831**	Sulphuric acid, fuming	
EAC		**4WE**	Use dry agent. Wear liquid-tight chemical protective clothing in combination with breathing apparatus*. Spillages and decontamination run-off should be prevented from entering drains and watercourses. 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		**2796**	Sulphuric acid with not more than 51% acid	
EAC		**2R**	Use fine water spray. Wear liquid-tight chemical protective clothing in combination with breathing apparatus. Spillages and decontamination run-off may be washed to drains with large quantities of water.	
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

* Liquid-tight chemical protective clothing (BS 8428) in combination with self-contained open circuit positive pressure compressed air 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.

[a] Dangerous Goods Emergency Action Code List, HM Fire Service Inspectorate, Publications Section, The Stationery Office, 2009.

***Gas-tight chemical protective clothing (BS EN 943 part 2) in combination with self-contained open circuit positive pressure compressed air breathing apparatus (BS EN 137).

Chemical Hazard Information and Packaging for Supply Classification[a]

Sulphuric acid …%

Classification	**C**	Corrosive	
Risk phrases	**R35**	Causes severe burns	
Safety phrases	**S(1/2)**	Keep locked up and out of the reach of children	
	S26	In case of contact with eyes rinse immediately with plenty of water and seek medical advice	
	S30	Never add water to this product	
	S45	In case of accident or if you fell unwell, seek medical advice immediately (show label where possible)	

Specific concentration limits

Concentration	Classification
C ≥ 15 %	C; R35
5 % ≤ C < 15 %	Xi; R36/38

[a] Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.2.
http://esis.jrc.ec.europa.eu/index.php?PGM=cla (accessed 11/2011)

*Globally Harmonised System of Classification and Labelling of Chemicals (GHS)[a]**

Sulphuric acid

Hazard Class and Category	Skin Corr. 1A	Skin corrosion, category 1A	
Hazard Statement	**H314**	Causes severe skin burns and eye damage	
Signal Words	DANGER		

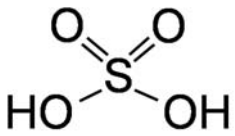
* Implemented in the EU on 20 January 2009.

Specific concentration limits and M factors

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

[a] Annex VI to Regulation (EC) No 1272/2008 on Classification, Labelling and Packaging of Substances and Mixtures- Table 3.1.
http://esis.jrc.ec.europa.eu/index.php?PGM=cla (accessed 11/2011)

Physicochemical Properties

CAS number	7664-93-9
Molecular weight	98
Empirical formula	H_2SO_4
Common synonyms	Sulfuric acid
State at room temperature	Liquid
Volatility	Non-volatile at 25 °C
Specific gravity	1.8 at 25 °C (water = 1)
Flammability	Non flammable, but may ignite other flammable materials
Lower explosive limit	Data not available
Upper explosive limit	Data not available
Water solubility	Miscible with water
Reactivity	Highly reactive. Anhydrous sulphuric acid reacts violently with water and organic materials. Concentrated sulphuric acid will oxidize, dehydrate, or sulfonate most organic compounds. It is capable of igniting finely divided combustible materials on contact. Sulphuric acid will corrode many metals by releasing hydrogen
Reaction or degradation products	Releases toxic and irritating fumes of oxides of sulphur when heated to decomposition
Odour	Acrid odour
Structure	

References[a,b,c]

[a] Sulphuric acid (HAZARDTEXT® Hazard Management). In: Klasco RK (Ed): TOMES® System. Thomson Micromedex, Greenwood Village, Colorado (accessed 02/2010).
[b] The Merck Index (14th Edition). Entry 8974: Sulfuric Acid, 2006.
[c] The Dictionary of Substances and their Effects. Ed. S Gangolli. Second Edition, Volume 6, 1999.

Threshold Toxicity Values

EXPOSURE VIA INHALATION / INGESTION		
ppm	**mg m^{-3}**	**SIGNS AND SYMPTOMS**
-	-	Data not available

Published Emergency Response Guidelines

Emergency Response Planning Guideline (ERPG) Values[(a)]

	Calculated value (ppm)	Listed value ($mg\ m^{-3}$)
ERPG-1*	0.5^	2
ERPG-2**	2.5	10
ERPG-3***	30	120

* Maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr 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 hr 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 hr without experiencing or developing life-threatening health effects.
^ Odour should be detectable near ERPG-1.

Interim Acute Exposure Guideline Levels (AEGLs)[(b)]

	$mg\ m^{-3}$				
	10 min	**30 min**	**60 min**	**4 hr**	**8 hr**
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

† The level of the chemical in air at or above which the general population could experience notable discomfort.
†† The 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.
††† The level of the chemical in air at or above which the general population could experience life-threatening health effects or death.

[a] American Industrial Hygiene Association (AIHA). 2010 Emergency Response Planning Guideline Values and Workplace Environmental Exposure Level Guides Handbook, Fairfax, VA
[b] U.S. Environmental Protection Agency. Acute Exposure Guideline Levels, http://www.epa.gov/oppt/aegl/pubs/chemlist.htm (accessed 02/2010).

Exposure Standards, Guidelines or Regulations

Occupational standards

WEL	LTEL (8 hour reference period): No guideline value specified
	STEL (15 min reference period): No guideline value specified

Public health guidelines

DRINKING WATER QUALITY GUIDELINE[a]	250 µg L^{-1} for sulphate anion
AIR QUALITY GUIDELINE	No guideline value specified
SOIL GUIDELINE VALUE AND HEALTH CRITERIA VALUES	No guideline values specified

WEL – Workplace exposure limit; LTEL - Long-term exposure limit; STEL – Short-term exposure limit

[a] Interim Guidance on the Water Supply (Water Quality) Regulations 2000 (England) and the Water Supply (Water Quality) Regulations 2001 (Wales) (accessed 01/2011). .

Health Effects

Major route of exposure[(a)]

- Toxic via inhalation, ingestion, dermal and ocular exposure..

Immediate signs or symptoms of acute exposure[(b-e)]

- Inhalation causes 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 36h to develop. Optic neuropathy has been reported following acute inhalation.
- 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, ARDS 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 exposure causes pain, blistering, ulceration and penetrating necrosis. Coagulation burns may develop which may be self-limiting and superficial with the destruction of the surface epithelium and submucosa.
- Ocular exposure causes pain, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia.

TOXBASE - http://www.toxbase.org (accessed 01/2011)
[a] TOXBASE: Sulphuric acid, 01/2005.
[b] TOXBASE: Corrosives - inhalation, 06/2010.
[c] TOXBASE: Corrosives - ingestion, 07/2010.
[d] TOXBASE: Skin decontamination - corrosives, 06/2010.
[e] TOXBASE: Chemicals splashed or sprayed into the eyes, 07/2007.

Decontamination and First Aid

Important Notes

- Secondary contamination may occur.
- Ambulance staff, paramedics and emergency department staff treating chemically-contaminated casualties should be equipped with the Department of Health approved, gas-tight (Respirex) decontamination suits based on EN466:1995, EN12941:1998 and prEN943-1:2001, where appropriate.
- Decontamination should be performed using local protocols in designated areas such as a decontamination cubicle with adequate ventilation.

Dermal exposure[a,b]

- Remove patient from exposure.
- The patient should remove all clothing and personal effects.
- Double-bag soiled clothing and place in a sealed container clearly labelled as a biohazard.
- Gently blot away any adherent liquid from the patient.
- Wash hair and all contaminated skin with copious amounts of water (preferably warm) and soap for at least 10-15 minutes. Decontaminate open wounds first and avoid contamination of unexposed skin.
- Pay special attention to skin folds, axillae, ears, fingernails, genital areas and feet.
- Burns totally more than 15% of body surface in adults (> 10 % in children) will require standard fluid resuscitation as for thermal burns.
- Cover affected area with a clean non-adherent dressing.

Ocular exposure[c]

- Remove patient from exposure.
- Remove contact lenses if necessary and immediately irrigate the affected eye thoroughly with water or 0.9% saline for at least 10-15 minutes.
- Patients with corneal damage or those whose symptoms do not resolve rapidly should be referred for urgent ophthalmological assessment.
-

Inhalation[d]

- Remove patient from exposure.
- Ensure a clear airway and adequate ventilation.
- Give oxygen to symptomatic patients.
- All patients with abnormal vital signs, chest pain, respiratory symptoms or hypoxia should have a 12 lead ECG performed.
- If the patient has clinical features of bronchospasm treat conventionally with nebulised bronchodilators and steroids.

TOXBASE – http://www.toxbase.org (accessed 01/2011)
[a] TOXBASE: Sulphuric Acid, 01/2005.
[b] TOXBASE: Skin decontamination – corrosives, 06/2010.
[c] TOXBASE: Chemicals splashed or sprayed into the eyes, 07/2007.
[d] TOXBASE: Corrosives – inhalation, 06/2010.

- Endotracheal intubation, or rarely, tracheostomy may be required for life threatening laryngeal oedema.
- Apply other supportive measures as indicated by the patient's clinical condition. .

Ingestion[(a)]

- 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. It is an indication for consideration of early intubation or tracheotomy.
- Do **NOT** attempt gastric lavage.
- Do **NOT** give neutralising chemicals as heat produced during neutralization reactions may increase injury.
- Monitor BP, pulse and oxygen saturation.
- Treat haemorrhagic or hypovolaemic shock by replacing lost fluids and blood intravenously.
- Apply other supportive measures as indicated by the patient's condition.

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TOXBASE - http://www.toxbase.org (accessed 01/2001)
[a] TOXBASE: Corrosives – ingestion, 07/2010.

Sulphuric acid

Toxicological overview

Key Points

Kinetics and metabolism

- A key toxicokinetic consideration of sulphuric acid inhalation is where is the respiratory tract the aerosols are deposited
- Once in the lung, sulphate from sulphuric acid is rapidly absorbed into the blood stream

Health effects of acute exposure

- The major routes of exposure are by ingestion, inhalation, dermal or ocular exposure
- Irritant and corrosive to all tissues with which it comes into contact
- Inhalation may cause burning or choking, sore throat, irritation of nose and eyes, cough and chest tightness. In severe cases pulmonary oedema may occur hours or days after exposure
- Ingestion can cause immediate burns to the mouth, throat, larynx, oesophagus and stomach, resulting in oedema, airway obstruction and difficulty in clearing bronchial secretions. Symptoms may include salivation, dysphagia, intense thirst, nausea, vomiting, haemorrhage, diarrhoea and abdominal pain. Shock, collapse, acute renal failure and death may arise
- Ocular or dermal exposure causes erythema, lacrimation, conjunctivitis, photophobia, or irritation, erythema or burns, respectively

Health effects of chronic exposure

- Chronic inhalation may lead to chemical pneumonitis, bronchitis, changes in lung function and dental decay
- Few data on the toxicity of sulphuric acid following chronic ingestion
- Limited mutagenicity data are available but it is predicted that it does not have mutagenic potential
- Inorganic acid mists containing sulphuric acid are carcinogenic to humans. Sulphuric acid or sulphuric acid solutions are not considered to be carcinogenic

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Toxicological Overview

Summary of Health Effects

Concentrated sulphuric acid is highly corrosive to all tissues with which it comes in contact.

Single, high exposures to sulphuric acid by inhalation, ingestion or dermal routes may be fatal.

There is sufficient evidence that occupational exposure to strong, inorganic–acid mists containing sulphuric acid is carcinogenic in humans [1]. Inhalation of sulphuric acid mists may cause an increase in upper respiratory tract neoplasms such as cancer of the larynx. This classification is for inorganic acid mists containing sulphuric acid only and does not apply to sulphuric acid or sulphuric acid solutions [2].

Severe lung damage (pulmonary oedema) may occur after a single short term exposure. Symptoms of which include coughing and shortness of breath and can be delayed until hours or days after the exposure. These symptoms are aggravated by physical exertion [3].

Sulphuric acid is considered not to be a developmental toxicant.

Its toxicity is due to effects at the site of initial contact, and systemic effects in mammals are not likely following exposure by any route [4].

Sulphuric acid is not considered as an allergen by skin contact in humans [5]. Occupational exposure to sulphuric acid may, however, result in dermatitis [3].

Kinetics and metabolism

Sulphuric acid is a direct irritant that results in adverse effects at the site of contact. aThe effects of sulphuric acid are a result of pH change rather than the liberation of sulphate ions [4].

The key toxicokinetic consideration following inhalation is where in the respiratory tract sulphuric acid aerosols deposit. Factors affecting this include environmental conditions, especially relative humidity (which affects aerosol size), and physiological factors such as breathing rate, depth of breathing, and type of breathing, e.g., mouth, nose, or oro-nasal. Once in the lung, the sulphate from sulphuric acid has been shown to be rapidly absorbed into the blood stream [4].

The sulphate anion becomes part of the pool of sulphate anions in the body, and is excreted in the urine. It is therefore unlikely to accumulate in the body [3].

Major routes of exposure

The main routes of exposure to sulphuric acid are via ingestion, inhalation, dermal or ocular exposure.

Domestically, exposure may occur from lead-acid batteries, preparations for unblocking drains or from entering areas of farmland treated with sulphuric acid before it has degraded.

Sulphuric acid in not persistent and is quickly neutralised in the environment. This means that the hazards associated with this chemical rapidly decrease from the time of application [4].

Health Effects of Acute / Single Exposure

Human Data

General toxicity

Sulphuric acid is corrosive to all tissues with which it comes in contact, and can cause systemic effects after severe exposures by inhalation, ingestion or topical application. The severity of injury depends on the concentration of the sulphuric acid solution and the duration of exposure [3].

Sulphuric acid produces superficial coagulation burns (which may be self-limiting) and destruction of surface epithelium and submucosa [6]. Sulphuric acid is a direct-acting toxicant and neurological effects other than subjective symptoms and reflex response to pain are not likely following exposure to sulphuric acid by any route [4].

Inhalation

The degree and severity of respiratory effects are influenced by factors such as the physical state and particle size of the aerosol, deposition site, concentration and humidity [4]. Asthmatics appear to be at particular risk from pulmonary effects [1]. Young children may also be at increased risk due to greater uptake on a mg/kg/body weight basis.

Sulphuric acid is not very volatile at 20°C [7] and so workplace exposures to harmful concentrations are primarily to mists or aerosols produced on spraying.

Sulphuric acid is corrosive and can cause severe irritation or corrosive damage if inhaled. Symptoms may include burning and choking sensations, sore throat [7], irritation of eyes and nose, cough, and chest tightness [6].

Dyspnoea and stridor due to laryngeal oedema may also follow exposure [6].

Severe lung damage may occur, with life-threatening accumulation of fluid (pulmonary oedema). The symptoms of pulmonary oedema include coughing and shortness of breath and can be delayed until hours or days after the exposure. These symptoms are aggravated by physical exertion [3].

Ingestion

Sulphuric acid is corrosive and will cause immediate burns on ingestion to the mouth, throat, oesophagus and the stomach (including antral ulceration and perforation). The larynx may also be burned causing oedema, airway obstruction and difficulty clearing bronchial secretions. In severe case extensive areas of the gastrointestinal tract may be involved [6].

Symptoms may include salivation, dysphagia (difficulty swallowing), intense thirst, nausea, vomiting, haemorrhage and haematemesis, diarrhoea and retro-sternal and abdominal pain [3, 6].

In addition, ingestion may result in metabolic acidosis, shock, collapse, hypotension, acute renal failure and disseminated intravascular coagulation (DIC) [6].

Small amounts of acid which may enter the lungs during ingestion or vomiting (aspiration) can cause serious lung injury and death [3].

Dermal / ocular exposure

Sulphuric acid and sulphuric acid mists are corrosive and can cause severe irritation with symptoms including erythema (redness) and pain. Other signs may be present, including corneal damage, blepharospasm, lacrimation, conjunctivitis, palpebral oedema and photophobia [6]. Severe deep burns to eyes may occur and cause permanent damage, including blindness [7].

Milder dermal exposures (generally to concentrations less than 10%) may occur without irritation [4]. Concentrated sulphuric acid can cause severe irritation and burns which may result in permanent scarring or, when extensive (>50%), death. In one case considered, a man was splashed over the face and body with a solution containing sulphuric acid, receiving second-degree burns over 60% of his body and third-degree burns over 20% of his body before dying 5 days later from the extensive burns and chemical damage to the respiratory tract [4].

High mist or aerosol concentrations may cause erythema, irritation and burns to the skin if contact is prolonged [3].

Delayed effects following an acute exposure

Pulmonary oedema with increasing breathlessness, wheeze, hypoxia and cyanosis may take up to 36h to develop [6]. This is aggravated by physical effort and so rest and medical observation are therefore essential [7].

In an industrial incident, a worker who experienced injury to the upper airways from sulphuric acid fumes was normal for most lung function tests at a 6-week follow-up [3]. In another industrial incident, a 40-year old worker who was accidentally sprayed in the face with sulphuric acid and had experienced acute respiratory symptoms had permanent pulmonary damage which was characterized by chronic cough, difficulty breathing, reduced respiratory performance, and bronchiectasis with fibrosis and emphysema developing within a 7-18 month period [4].

Health Effects of Chronic / Repeated Exposure

Human Data

General toxicity

Sulphuric acid is a direct irritant that results in adverse effects at the site of contact.

Sulphuric acid can be corrosive to all tissues with which it comes in contact, and can cause systemic effects after inhalation, ingestion or topical exposures. The severity of injury depends on the concentration of the sulphuric acid and the duration of exposure [3].

Inhalation

Inhalation of sulphuric acid mist will cause severe irritation of the lungs (chemical pneumonitis) and in severe cases may cause pulmonary oedema. Repeated exposure to lower concentrations of the mist may lead to damage to the lining of the throat in the region of the larynx [6].

The degree and severity of respiratory effects are influenced by factors such as the physical state and particle size of the aerosol, deposition site, concentration and humidity [4]. Asthmatics may be at particular risk from pulmonary effects [1, 4]. In addition, infants and young children may be at risk due to their increased exposure and uptake on a mg/kg/body weight basis.

Bronchitis and changes in lung function have been noted after long term exposure to sulphuric acid mists [4]. In one study of workers, a slight increase in bronchitis was noted after exposure to sulphuric acid aerosols at an average concentration of 1.4 mg m^{-3} for up to 40 years. There were no effects on lung function noted [4]. In another study of workers exposed for an average of 12.2 years, a small decrease in forced vital capacity (FVC) was observed in workers exposed to an average sulphuric acid aerosol concentration of 0.21 mg m^{-3} compared to workers exposed to an average concentration of 0.1 mg m^{-3}. No other significant changes in lung function tests were noted [4].

Sulphuric acid mists can attack tooth enamel leading to an increased risk of dental caries [7]. Exposures to high concentrations (up to 16 mg m^{-3}) cause dental erosion. Etching of teeth may occur after a few weeks exposure, progressing to erosion after a few months exposure [3].

Ingestion

There is little human data on the effects of chronic or repeated oral ingestion of sulphuric acid in humans.

Dermal / ocular exposure

High mist or aerosol concentrations may cause erythema, irritation and burns to the skin if contact is prolonged [3]. Repeated exposure to low concentrations of mists or aerosols can cause dermatitis [3]. Sulphuric acid is not considered as an allergen by skin contact in humans [5]. There is insufficient data on the effects in humans after chronic ocular exposure.

Genotoxicity

Only limited data are available to assess the mutagenicity of sulphuric acid.

Negative results were obtained in assays for gene mutation in bacteria using Salmonella typhimurium and Escherichia coli, both in the presence and absence of an exogenous metabolic activation system [5].

Positive results were reported in assays in mammalian cells to investigate clastogenicity. These were believed to be as a consequence of low pH, rather than any inherent mutagenicity. It is well established that such conditions may give artefactual positive results [6].

There were no experimental *in-vivo* data available. However, sulphuric acid will dissociate into hydrogen ions and sulphate ions which can be predicted to be without mutagenic potential.

Carcinogenicity

There is sufficient evidence that occupational exposure to strong-inorganic–acid mists containing sulphuric acid is carcinogenic [1]. Inhalation of sulphuric acid mists may cause an increase in upper respiratory tract cancers such as cancer of the larynx, resulting from chronic irritant effects on this tissue.

The IARC classification as a known human carcinogen is for inorganic acid mists containing sulphuric acid only and does not apply to sulphuric acid or sulphuric acid solutions [2].

Environmental concentrations of sulphuric acid are generally much lower than those found in occupational settings and are unlikely to result in respiratory tract cancers [4].

Reproductive and developmental toxicity

There are limited environmental data on the reproductive toxicity of sulphuric acid. In one study, no effects on the developing foetus were seen in rabbits or mice exposed by inhalation of sulphuric acid aerosols during gestation [4].

It is a point-of-contact toxicant, and it is unlikely that sulphuric acid would reach germ cells, cross the placenta, or be excreted into breast milk after exposure by any route (e.g., inhalation, oral, dermal, or ocular). On contact with tissues sulphuric acid dissociates into hydrogen and sulphate ions. Hydrogen ions are responsible for the toxic effects to tissue, which occur only at the point of contact with sulphuric acid [4].

Sulphuric acid is considered not to be a developmental toxicant.

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[5] Organisation for Economic Co-operation and Development (OECD) (2001). Screening Information Data Sets (SIDS), Initial Assessment Report for 11th SIAM.

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This document will be reviewed not later than 3 years or sooner if substantive evidence becomes available.