Sulfuric Acid

1 Nonproprietary Names

BP: Sulphuric acid
PhEur: Acidum sulfuricum
USPNF: Sulfuric acid

2 Synonyms

E513; hydrogen sulfate; oil of vitriol.

3 Chemical Name and CAS Registry Number

Sulfuric acid [7664-93-9].

4 Empirical Formula

H_2SO_4

Molecular Weight

98.08

5 Structural Formula

H_2SO_4

6 Functional Category

Acidifying agent..

7 Applications in Pharmaceutical Formulation or Technology

Sulfuric acid is used as an acidifying agent in a variety of pharmaceutical and food preparations. It may also be used to prepare dilute sulfuric acid, which, in addition to its use as an excipient, has some therapeutic use for the treatment of gastric hypoacidity, as an astringent in diarrhea, or to stimulate appetite. Sulfuric acid has been used in parenteral, oral, topical, and ophthalmic pharmaceutical formulations.

8 Description

Sulfuric acid occurs as a clear, colorless, odorless, oily liquid. It is very corrosive and has a great affinity for water.

The USPNF 20 specifies that sulfuric acid contains not less than 95% and not more than 98%, by weight, of H_2SO_4; the remainder is water. *See also* Section 9.

9 Pharmacopeial Specifications

See Table I.

Table I: Pharmacopeial specifications for sulfuric acid.

Test	PhEur 2002	USPNF 20
Identification	+	+
Residue on ignition	—	⩽0.005%
Chloride	⩽50 ppm	⩽0.005%
Arsenic	⩽1 ppm	⩽1 ppm
Heavy metals	⩽5 ppm	⩽5 ppm
Weight per mL	≈1.84	—
Iron	⩽25 ppm	—
Nitrate	+	—
Reducing substances	—	+
Assay (of H_2SO_4)	95.0–100.5%	95.0–98.0%

10 Typical Properties

Boiling point:
≈290°C for H_2SO_4 (95%–98% w/w)
330°C for H_2SO_4 (100% w/w)
Density: ≈1.84 g/cm^3 at 20°C
Dissociation constant:
$pK_{a1} = -3.00$
$pK_{a2} = 1.99$
Freezing point:
10°C for H_2SO_4 (100% w/w)
3°C for H_2SO_4 (98% w/w)
−32°C for H_2SO_4 (93% w/w)
Solubility: miscible with ethanol and water.
Vapor density: 3.4 (air = 1.0)
Vapor pressure: <0.3 mmHg at 20°C

11 Stability and Storage Conditions

Sulfuric acid is stable but very corrosive and hygroscopic. It will draw moisture from the atmosphere. Sulfuric acid should be stored in a tightly closed container in an explosion proof area. Containers should be stored out of direct sunlight and away from heat. Avoid heat and moisture. Isolate from incompatible materials. *See also* Section 12.

12 Incompatibilities

Avoid storage in close proximity to water, most common metals, organic materials, strong reducing agents, combustible materials, strong bases, carbonates, sulfides, cyanides, strong oxidizing agents, and carbides.

Sulfuric acid is a powerful oxidizer and may ignite or explode on contact with many materials.

It can react violently with the evolution of a large amount of heat. Oxides of sulfur and hydrogen can be generated during reactions.

Great care must be exercised when mixing with other liquids.

13 Method of Manufacture

Sulfuric acid may be prepared industrially by either the contact process or the chamber process.[1,2]

Contact Process

$2SO_2 + O_2 \rightarrow 2SO_3$

$SO_3 + H_2O \rightarrow H_2SO_4$

Chamber Process

$2NO + O_2 \rightarrow 2NO_2$

$NO_2 + SO_2 + H_2O \rightarrow H_2SO_4 + NO$

14 Safety

Sulfuric acid is widely used in a variety of pharmaceutical formulations. Although concentrated sulfuric acid is very corrosive, it is normally used well diluted in formulations. Concentrated sulfuric acid will react violently with water and much heat is generated. When diluting sulfuric acid, the acid should always be added to the other liquid with great caution.

The concentrated solution is extremely corrosive and can cause severe damage or necrosis on contact with the eyes and skin. Ingestion may cause severe injury or death. Inhalation of concentrated vapors can cause serious lung damage.

LD_{50} (rat, oral): 2.14 g/kg[3]

15 Handling Precautions

Caution should be exercised when handling sulfuric acid and suitable protection against inhalation and spillage should be made. Respiratory protection may not be required where adequate ventilation exists. Eye protection (safety goggles and face shield), rubber gloves, and apron are recommended, depending on the circumstances and quantity of sulfuric acid handled. Do not dilute spills of concentrated acid with water since an exothermic reaction will occur. Spills should be neutralized with soda ash or lime. Splashes on the skin and eyes should be treated by immediate and prolonged washing with large amounts of water followed by the application of sodium bicarbonate and medical attention should be sought.

Fumes can cause irritation or permanent damage to the eyes, nose, and respiratory system; prolonged exposure to fumes may damage the lungs.

In the UK, the long-term exposure limit (8-hour TWA) for sulfuric acid is 1 mg/m^3.[4]

16 Regulatory Acceptance

GRAS listed. Accepted for use as a food additive in Europe. Included in the FDA Inactive Ingredients Guide (IM, IV, and IP injections, inhalation solutions, irrigation solutions, ophthalmic solutions and suspensions, oral solutions, and topical emulsions and creams). Included in nonparenteral and parenteral solutions licensed in Europe.

17 Related Substances

Dilute sulfuric acid; fuming sulfuric acid.

Dilute sulfuric acid

Density: 1.062–1.072 g/cm^3

Comments: prepared by adding 104 g of sulfuric acid to 896 g of purified water with constant stirring and cooling. Dilute sulfuric acid contains between 9.5% and 10.5% w/w of H_2SO_4.

Fuming sulfuric acid

Synonyms: oleum.

Comments: fuming sulfuric acid consists of H_2SO_4 with free sulfur trioxide (SO_3). It is prepared by adding sulfur trioxide to sulfuric acid. Available in grades containing up to about 80% free SO_3.

Fuming sulfuric acid is a colorless or slightly colored, viscous liquid that emits choking fumes of sulfur trioxide. It is extremely corrosive and should be handled with great care and stored in tightly closed glass-stoppered bottles.

18 Comments

The EINECS number for sulfuric acid is 231-639-5.

19 Specific References

1 Druecker WW, West JR. *The Manufacture of Sulfuric Acid*. New York: Reinhold, 1959: 515.

2 Nickless G, ed. *Inorganic Sulphur Chemistry*. New York: Elsevier, 1968: 535–561.

3 Lewis RJ, ed. *Sax's Dangerous Properties of Industrial Materials*, 10th edn. New York: Wiley, 2000: 3330–3331.

4 Health and Safety Executive. *EH40/2002: Occupational Exposure Limits 2002*. Sudbury: Health and Safety Executive, 2002.

20 General References

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21 Author

GE Amidon.

22 Date of Revision

14 June 2002.