

Safety Data Sheet

Picric acid

Division of Safety
National Institutes
of Health



WARNING!

THIS COMPOUND IS MODERATELY TOXIC AND MUTAGENIC. IT IS READILY ABSORBED THROUGH THE RESPIRATORY AND INTESTINAL TRACTS. IT MAY CAUSE SEVERE IRRITATION OF TISSUES (SKIN, EYES, MUCOUS MEMBRANES, AND LUNGS) AND INDUCE SENSITIVITY. AVOID FORMATION AND BREATHING OF AEROSOLS.

LABORATORY OPERATIONS SHOULD BE CONDUCTED IN A FUME HOOD, GLOVE BOX, OR VENTILATED CABINET.

AVOID SKIN CONTACT: IF EXPOSED, WASH WITH SOAP AND WARM WATER. AVOID WASHING WITH SOLVENTS. AVOID RUBBING OF SKIN OR INCREASING ITS TEMPERATURE.

PICRIC ACID IS FLAMMABLE AND EXPLOSIVE. KEEP AWAY FROM SPARKS AND OPEN FLAMES. IN CASE OF FIRE, USE CARBON DIOXIDE OR DRY CHEMICAL EXTINGUISHER.

FOR EYE EXPOSURE, IRRIGATE IMMEDIATELY WITH LARGE AMOUNTS OF WATER. FOR INGESTION, INDUCE VOMITING. DRINK MILK OR WATER. REFER FOR GASTRIC LAVAGE. FOR INHALATION, REMOVE VICTIM PROMPTLY TO CLEAN AIR. ADMINISTER RESCUE BREATHING IF NECESSARY. REFER TO PHYSICIAN.

IN CASE OF LABORATORY SPILL, WEAR PROTECTIVE CLOTHING DURING CLEANUP. AVOID SKIN CONTACT OR BREATHING OF AEROSOLS. USE HOT WATER TO DISSOLVE COMPOUND. USE ABSORBENT PAPER TO MOP UP SPILL. WASH DOWN AREA WITH SOAP AND WATER. DISPOSE OF WASTE SOLUTIONS AND MATERIALS APPROPRIATELY.

A. Background

Picric acid is an odorless, almost colorless to pale yellow crystal-line solid with an intensely bitter taste. It is explosive upon rapid heating or by percussion. Its acute toxicity in animals

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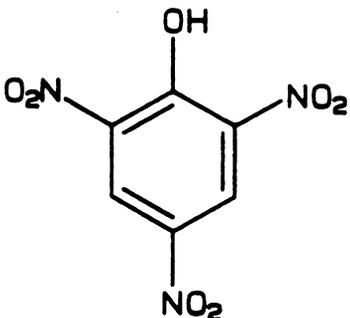
Prepared by the Environmental
Control and Research Program

is moderately low. Skin exposure to aerosols results in dermatitis with erythema, and often allergic reactions. Ingestion or percutaneous absorption can produce nausea, vomiting, diarrhea, and convulsions. Picric acid is used in explosives manufacture, corrosion inhibition, metal etching, as a textile mordant, as a laboratory reagent (detection of alkaloids, creatinine determination), and as an intermediate in the synthesis of dyes and medicinal.

The recommended threshold limit value (skin) is 0.1 mg/m^3 (ACGIH, 1987). Picric acid is classified as a DOT Class A Explosive for purposes of shipping, storage, and disposal.

Chemical and Physical Data

1. Chemical Abstract No.: 88-89-1.
2. Synonyms: Carbazotic acid; 2-hydroxy-1,3,5-trinitrobenzene; melinite; nitroxanthic acid; picronitric acid; 2,4,6-trinitrophenol.
3. Chemical formula: $\text{C}_6\text{H}_3\text{N}_3\text{O}_7$
Molecular weight: 229.11
4. Density: 1.763
5. Absorption spectroscopy: Picric acid shows an ultraviolet absorption maximum at 350 nm ($\epsilon_{\text{max}} = 6,740$) in methanol solution. Complete infrared, proton NMR, and ultraviolet spectra are shown in the respective Sadtler Handbooks (Simons, 1978a, 1978b, 1979).
6. Volatility: Vapor pressure measurements, and Clausius-Clapeyron constants for sublimation in the range of 40.9-132.9°C have been tabulated (Cundall et al., 1978). Vapor pressure at room temperature is much less than 1 mm Hg.
7. Solubility: The water solubility of picric acid in the temperature range 0-30°C has been tabulated (Densham and Ravald, 1958). One gram dissolves in 78 ml water at 25°C, 15 ml boiling water, 12 ml ethanol, 10 ml benzene, 35 ml chloroform, 65 ml ether. Solubility in carbon disulfide and carbon tetrachloride is low.
8. Description: Pale yellow or (after several recrystallizations) almost colorless crystals whose form is solvent-dependent: leaves from water, prisms from ether, plates from ethanol. Odorless, with intensely bitter taste.



9. Melting point: 122-123°C; boiling point indeterminate; explodes above 300°C.
10. Stability: Picric acid for use as a laboratory reagent is usually sold containing 10-15% water and in this state is relatively stable. However, dry picric acid may explode on initiation by friction, shock, or sudden heating. In the presence of alkali, ammonium ion, and particularly of heavy metals it forms salts which are much more sensitive to detonation than the free acid, and which can act as initiators. Prolonged exposure to ultraviolet light under nitrogen results in decomposition (Jaekel, 1957).
11. Chemical reactivity: The phenol group of picric acid is strongly ionized in aqueous solution, making picric acid a strong acid with $pK_a = 0.402$ (Pearce and Simkins, 1968). As mentioned above, it forms salts with metal ions. Several reducing agents convert it to picramic acid (2-amino-4,6 dinitrophenol). Treatment with chlorine or chlorates at elevated temperatures results in formation of the highly toxic chloropicrin (CCl_3NO_2) and chloranil (tetrachloro-1,4-quinone). It also forms picrates with organic bases, and addition compounds with benzene and other aromatic hydrocarbons.
12. Flash point: 150°C (closed cup).
13. Autoignition temperature: Approximately 300°C.
14. Explosion temperature: Temperature required to cause explosion in 5 sec: 322°C; in 1 sec: 360°C (Henkin and McGill, 1952).
15. Flammable limits in air: No data.

Fire, Explosion, and Reactivity Hazard Data^A

1. Use water as fire extinguishant. Fire-fighting personnel should wear air-supplied respirators with full-face masks. Do not attempt to extinguish massive fires involving picric acid.
2. Picric acid is incompatible with copper, lead, zinc, other metals, and ammonia with which it forms shock-sensitive salts (initiators of explosion). Contact with plaster or concrete may result in formation of the shock-sensitive calcium salt.
3. Other incompatibilities include sudden heat (explodes above 300°C).

Information in this and the following Section is in part based on the following sources: NFPA, 1968; DHHS, 1981; NRC, 1983.

4. Hazardous decomposition products which may be evolved under conditions of fire include nitrogen oxides, carbon monoxide, and chloropicrin.
5. Do not expose to sparks or open flames. Use non-spark tools and equipment.

Operational Procedures

The NIH Guidelines for the Laboratory Use of Chemical Carcinogens describe operational practices to be followed when potentially carcinogenic chemicals are used in NIH laboratories. The NIH Guidelines should be consulted to identify the proper use conditions required and specific controls to be implemented during normal and complex operations or manipulations involving picric acid.

It should be emphasized that this data sheet and the NIH Guidelines are intended as starting points for the implementation of good laboratory practices when using this compound. The practices and procedures described in the following sections pertain to the National Institutes of Health and may not be universally applicable to other institutions. Administrators and/or researchers at other institutions should modify the following items as needed to reflect their individual management system and current occupational and environmental regulations.

Laboratory operations should be carried out in a fume hood or glove box. Personnel should wear laboratory coats, rubber aprons, face shields, and gloves (while there are no specific data on picric acid, neoprene gloves are superior to other gloves tested for permeability to trinitrotoluene [NRC, 1981, p. 159]). Protective clothing should be changed immediately after suspected contamination.

1. Chemical inactivation: No validated method reported.
2. Decontamination: Turn off equipment that could be affected by picric acid or the materials used for cleanup. Do not sweep or brush large spills of solid picric acid except under the supervision of an explosives expert. If there is any uncertainty regarding the procedures to be followed for decontamination, call the NIH Fire Department (dial 116) for assistance. For small amounts of spilled picric acid solutions use absorbent paper to mop up. Wipe off surfaces with hot water, then wash with copious quantities of water. Glassware should be rinsed (in a hood) with hot water, followed by soap and water. Animal cages should be washed with water.
3. Disposal: Large quantities of picric acid should be disposed of only by explosives experts. No waste streams containing picric acid shall be disposed of in sinks or general refuse. Surplus picric acid or chemical waste streams contaminated with picric acid shall be handled as hazardous chemical waste and disposed of in accordance with the NIH chemical waste disposal system.

Nonchemical waste (e.g., animal carcasses and bedding) containing picric acid shall be handled and packaged for incineration in accordance with the NIH medical-pathological waste disposal system. Potentially infectious waste (e.g., tissue cultures) containing picric acid shall be packaged for incineration, as above. Burnable waste (e.g., absorbent bench top liners) minimally contaminated with picric acid shall be handled as potentially infectious waste and packaged for incineration, as above. Absorbent materials (e.g., associated with spill cleanup) grossly contaminated shall be handled in accordance with the chemical waste disposal system. Radioactive waste containing picric acid shall be handled in accordance with the NIH radioactive waste disposal system.

4. Storage: Storage of dry picric acid should be avoided because of its explosive nature. Store picric acid reagent (containing 10-15% water) in dark-colored, tightly closed containers under refrigeration. Avoid exposure to light. Store working quantities of picric acid solutions in an explosion-safe refrigerator in the work area. Do not store in ampoules since these could explode.

The usual laboratory reagent plastic-capped containers of picric acid, containing 10-15% water, are safe to store in a cool place. Special precautions are required if material in such containers appears to have dried out after repeated opening over a long time, particularly around the mouth of the container. Detailed disposal instructions in this situation, as well as for disposal of metal-capped containers (particularly hazardous), are described on p. 103, NRC (1983).

Monitoring and Measurement Procedures Including Direct Field Measurements and Sampling for Subsequent Laboratory Analysis

1. Sampling: Air sampling of particulate picric acid is accomplished with a mixed cellulose ester membrane filter as described in the official NIOSH procedure (NIOSH, 1978). The filter material is extracted with 70% aqueous methanol for analysis. This procedure is also applicable to monitoring of personal exposure.
2. Analysis: The official NIOSH procedure (NIOSH, 1978) employs high performance liquid chromatography with a variable UV detector at 360 nm, using filter extracts as described above. Overall average recovery is 99%, and the detection limit is estimated to be at least 10 ng/ml. Possible interferences may be compounds with the same retention time as picric acid. The overall method is applicable only to particulate material and does not apply where there may be a significant vapor concentration. An older method is based on colorimetry of the picric

acid-2,2-dipyridyl iron (II) chelate, made selective for picric acid by extraction of the complex into nitrobenzene at pH 2.5 (Hayashi et al., 1965). Purity of picric acid samples has been determined by paper chromatography (Colman, 1962).

Biological Effects (Animal and Human)

Absorption: Picric acid is absorbed by inhalation and ingestion of dust. While it produces profound topical effects upon exposure of skin and eyes, it probably is not absorbed by these routes to product systemic intoxication.

Distribution: No data.

Metabolism and excretion: There are hardly any data in the literature concerning this, and those which have been quoted (von Oettingen, 1949) stem from investigations carried out around 1900. It is assumed that there may be some reduction in the liver to picramic acid. Rabbits and dogs excrete picric acid mostly unchanged.

Toxic effects: The acute toxicity of picric acid appears to be low. While the literature contains no data on LD50s, the LDLo (lowest reported dose to produce lethal effects) for several mammalian species is of the order of 60-200 mg/kg. It is stated (Stokinger, 1971) that "one or two grams in man causes severe poisoning," which would be in line with the quoted figures for other mammalian species.

Chronic effects of picric acid (usually as the result of exposures to high concentrations of dust) have been reviewed by Arena (1979). Systemic effects are those of acute gastroenteritis, with abdominal pain, nausea, yellow-colored vomitus, and diarrhea. There is often acute nephritis. The urine is red (probably due to hemolytic action) and sparse, sometimes leading to anuria. There may also be liver and central nervous system involvement. Topical effects are found notably on skin and eyes. Picric acid is a potent skin sensitizer and produces dermatitis with erythema and vesicular eruptions, and ultimate desquamation. The skin and hair may be stained yellow. Eye effects include irritation (often aggravated by sensitization) and conjunctivitis. After high doses the cornea and aqueous humor may be yellow, causing "yellow vision."

Carcinogenic effects: None have been reported.

Mutagenic and teratogenic effects: Picric acid has been reported to be mutagenic in E. coli (Dean, 1978) and in some Ames test strains (Gocke et al., 1981).

Emergency Treatment

1. Skin and eye exposure: For skin exposure, remove contaminated clothing and wash skin with soap and water. Skin should not be rinsed with organic solvents. Avoid rubbing of skin or increasing its temperature. For eye exposure, irrigate immediately with copious quantities of running water for at least 15 minutes. Obtain ophthalmological evaluation.
2. Ingestion: Drink plenty of water or milk. Induce vomiting. Refer for gastric lavage.
3. Inhalation: Remove victim promptly to clean air. Administer rescue breathing if necessary.
4. Refer to physician at once. Consider treatment for pulmonary irritation.

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