DOSSIER

ON

ANTIMONY AND ANTIMONY COMPOUNDS

By

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March 7, 1978

Contract No. NSF-C-ENV77-15417

Prepared for

TSCA Interagency Testing Committee
Washington, DC

FOREWORD

This document has been prepared for the Toxic Substances Control Act (TSCA) Interagency Testing Committee by its technical contractor, Clement Associates, Inc. The Committee is charged with the responsibility for making recommendations to the Administrator of the Environmental Protection Agency (EPA) regarding chemical substances which should be given priority by EPA for testing to determine adverse effects on man or the environment.

The dossiers in this document were originally drafted by Clement and were reviewed in detail by the Committee, which in certain instances added additional information. Conclusions presented in the dossiers about specific studies were made by Clement scientists and were reviewed by the Committee. The information in the dossiers thus reflects the collective knowledge and judgment of the Committee and its technical contractor. It has been used as the primary basis for the designation of the chemicals involved for priority testing in the Committee's Initial Report to the Administrator, Environmental Protection Agency (Federal Register 42, 55026, October 12, 1977).

The dossiers were designed to provide the Committee with information on the chemicals' physical and chemical properties, exposure characteristics, and biological properties in sufficient detail to support an informed judgment on whether the substances could be given priority for testing. The dossiers are not comprehensive critical reviews. Such reviews could not be performed with the constraints imposed upon the Committee (and, therefore, the contractor) by the statutory deadlines of TSCA.

Faced with the task of preparing dossiers which could be quickly assembled and yet contain sufficient information for the Committee's purposes, Clement proceeded along the following lines.

Literature searches were conducted using the National Library of Medicine's TOXLINE and the Environmental Mutagen Information Center (EMIC) automated data banks. Each reference on a list of sources of general information (see General References - Appendix A) was reviewed. Further references and information were obtained from monographs, criteria documents, reviews, and reports available from government agency files and trade association libraries. Information received in response to the Committee's July 1977 Federal Register notice requesting information on certain substances was reviewed. Clement scientists relied upon their own knowledge of the literature to augment the data sources.

In general, secondary sources were consulted first in preparing the dossiers. When an article was judged to contain information of

major significance or to require a critical review, the primary source was consulted. Except when specifically noted otherwise, the information cited in these dossiers was derived from the primary sources.

ANTIMONY AND ANTIMONY COMPOUNDS

(ANTIMONY, ANTIMONY (III) CHLORIDE, ANTIMONY TRIOXIDE, ANTIMONY TRISULFIDE)

PART I

GENERAL INFORMATION

ANTIMONY

1.1 Identification

CAS No.: 007440360
NIOSH No.: CC40250

1.2 Synonyms and Trade Names

Antimony Black; antimony, regulus; C.I. 77050; stibium (G16)

1.3 Chemical Formula and Atomic Weight

Sb At. wt. 121.75 (G22)

1.4 Chemical and Physical Properties

1.4.1 Description: Silver-white solid metal, hexagonal crystals (G21,G22)

1.4.2 Boiling Point: 1,750°C (G22)

1.4.3 Melting Point: 630.74°C (G22)

1.4.4 Absorption Spectrometry:

No information found in sources searched

1.4.5 Solubility: Insoluble in water; soluble in hot concentrated H_2SO_4 and aqua regia (G22)

1.4.6 Octanol/Water Partition Coefficient:

No information found in sources searched

1.5 Production and Use

1.5.1 Production: 1° Antimony (recovered from ore)--24.0 million lb
2° Antimony (recovered from antimony-bearing scrap)--42.0 million lb (G32)

1.5.2 Use: Hardening alloy for lead, especially in storage batteries and cable sheaths; bearing metal; type metal; solder; collapsible tubes and foil; sheet and pipe; semiconductor technology (99.999% grade); pyrotechnics, bullets, blackening iron, coating metals (G21,G23)

1.6 Exposure Estimates

1.6.1 Release Rate: No information found in sources searched

1.6.2 NOHS Occupational Exposure:

Rank: 139
Estimated no. of persons exposed: 1,351,000*

*rough estimate (G28)

1.7 Manufacturers:

Alloychem, Inc.
Belmont Metals, Inc.
Copalco International Ltd.
Gehning, Inc.
ICC Industries
ICC Metals Co.
Indussa Corp.
Kawecki Berylco Industries, Inc.
A. D. MacKay, Inc.
Monson Chemicals, Inc.
Morgan Chemicals, Inc.
Pesses Co.
United Mineral & Chemical Corp.

(G37)

ANTIMONY (III) CHLORIDE

1.1 Identification

CAS No.: 010025919
NIOSH No.: CC49000

1.2 Synonyms and Trade Names

Antimony butter; antimony trichloride; caustic antimony; antimonous chloride; C.I. 77056; butter of antimony

(G16,G21)

1.3 Chemical Formula and Molecular Weight

$SbCl_3$ Mol. wt. 228.11 (G22)

1.4 Chemical and Physical Properties

1.4.1 Description: Colorless, rhombic, deliquescent (G22)

1.4.2 Boiling Point: 283°C (G22)

1.4.3 Melting Point: 73.4°C (G22)

1.4.4 Absorption Spectrometry:

No information found in sources searched

1.4.5 Solubility: Insoluble in pyridine, quinoline, and other organic bases; soluble in cold water (601.6 g/100 cc at o°C); soluble in all proportions in hot water (80°C); soluble in absolute alcohol, HCl, tartaric acid, $CHCl_3$ (about 22%), acetone, CS_2, dioxane, benzene, ether, CCl_4 (G22,G23)

Octanol/Water Partition Coefficient:

No information found in sources searched

1.5 Production and Use

1.5.1 Production:

No information found in sources searched

1.5.2 Use: In the manufacture of antimony salts; in bronzing irons; as a mordant; manufacturing lakes; as a chlorinating agent and catalyst in organic synthesis; reagent for chloral, aromatic hydrocarbons, and Vitamin A; for molecular weight determinations; in chemical microscopy for the identification of drugs (forms adducts and addition compounds) (G21,G23)

1.6 Exposure Estimates

1.6.1 Release Rate:

No information found in sources searched

1.6.2 NOHS Occupational Exposure:

Rank: 876
Estimated no. of persons exposed: 142,000*

*rough estimate (G29)

1.7 Manufacturers:

American Hoechst Corp.
Chemical Dynamics Corp.
Conray Chemicals, Inc.
EM Laboratories, Inc.
Great Western Inorganics
McGean Chemical Co., Inc. (G37)
Stauffer Chemical Co.
(G37)

ANTIMONY TRIOXIDE

1.1 Identification CAS No.: 001309644
NIOSH No.:

1.2 Synonyms and Trade Names

Nat. Valentinite, Nat. Senarmontite; diantimony trioxide; flowers of antimony; Exitelite; Weisspiessglanz; antimony white; antimony oxide

(G22,G23)

1.3 Chemical Formula and Molecular Weight

Sb_2O_3 (or Sb_4O_6) Mol. wt. 291.50 (G22)

1.4 Chemical and Physical Properties

1.4.1 Description: Nat. Senarmontite: white, cubic crystals
Nat. Valentinite: colorless, rhombic crystals

(G22)

1.4.2 Boiling Point:

Nat. Senarmontite: sublimes at 1,550°C
Nat. Valentinite: 1,550°C

(G22)

1.4.3 Melting Point: 656°C (G22)

1.4.4 Absorption Spectrometry:

No information found in sources searched

1.4.5 Solubility:

Nat. Senarmontite: Very slightly soluble in cold water; slightly soluble in hot water; soluble in KOH, HCl (3%), tartaric acid (0.03 g/100 cc at 20°C), and acetic acid

Nat. Valentinite: Very slightly soluble in cold water; slightly soluble in hot water; soluble in KOH, HCl, tartaric acid, and acetic acid

(G22)

1.4.6 Octanol/Water Partition Coefficient:

No information found in sources searched

1.5 Production and Use

1.5.1 Production: No information found in sources searched

1.5.2 Use: In the manufacture of tartar emetic; as paint pigments; in enamels and glasses; as mordants; in flameproofing canvas textiles, paper, and plastics (chiefly polyvinyl chloride); ceramic opacifier; as a catalyst; as an intermediate; in staining iron and copper; in phosphors; as a glass decolorizer

(G21,G23)

	No. of products containing antimony trioxide	No. of antimony trioxide products in category / Total no. of products in category X 10
Paints, varnishes, shellac, rust preventatives, etc.	1	0.009%
Flame retardant chemicals	45	7.6%

The 46 products surveyed contained an average of 14.7% antimony trioxide.

(G27)

1.6 Exposure Estimates

1.6.1 Release Rate:

No information found in sources searched

1.6.2 NOHS Occupational Exposure:

Rank: 1173
Estimated no. of persons exposed: 89,000*

*rough estimate (G29)

1.7 Manufacturers:

Agrimet, Inc.
Allied Chemical Corp.
Alloychem, Inc.
Alpha International Chemical, Inc.
American Hoechst Corp.
American International Chemical Inc.
Asher-Moore Co.
Chemetron Corp.
Cometals, Inc.
Conray Chemicals, Inc.
Derby & Co., Inc.

East Falls Corp.
EM Laboratories, Inc.
Great Western Inorganics
Harshaw Chemical Co.
Hetako Chemical Corp.
Helm Houston Chemical Corp.
Holtrachem, Inc.
ICC Industries
ICD Chemicals., Inc.
IMC Chemical Group, Inc.
Indussa Corp.
Keyser International Inc.
Kingsley & Keith Chemical Corp.
Kock Chemical Co.
Kraft Chemical Co.
M & T Chemicals, Inc.
A. D. Mackay, Inc.
McGean Chemical co., Inc.
McKesson Chemical Co.
Monson Chemicals, Inc.
NL Industries, Inc.
Nyacol Inc.
Orlex Chemicals Corp.
Park Trading Co.
Philipp Brothers Chemicals, Inc.
Pyramid Chemical Sales Co.
Revelli Chemicals, Inc.
Samincorp Inc.
Shepard Chemical Industries, Inc.
Sylvan Chemical Corp.
T. R. American Inc.
Robert I. Webber Co., Inc.
Wellman, Inc.

(G37)

ANTIMONY TRISULFIDE

1.1 Identification — CAS No.: 001345046; NIOSH No.: CC94500

1.2 Synonyms and Trade Names

Antimonous sulfide; antimony glance; antimony orange; antimony sulfide, solid; C.I. 77060; C.I. Pigment Red 107; crimson antimony; needle antimony; nat. stibnite; black antimony

(G16,G21,G22)

1.3 Chemical Formula and Molecular Weight

Sb_2S_3 Mol. wt. 339.69 (G22)

1.4 Chemical and Physical Properties

1.4.1 Description: Occurs in nature as black crystalline stibnite; is orange-red when precipitated from solutions of salts of antimony

(G21)

1.4.2 Boiling Point: ~1,150°C (G22)

1.4.3 Melting Point: 550°C (G22)

1.4.4 Absorption Spectrometry:

No information found in sources searched

1.4.5 Solubility: Insoluble in acetic acid; soluble in cold water (0.000175 g/100 cc at 18°C), alcohol, NH_4SH, K_2S, HCl, and solutions of the fixed alkali hydroxides

(G22, G23)

1.4.6 Octanol/Water Partition Coefficient:

No information found in sources searched

1.5 Production and Use

1.5.1 Production: No information found in sources searched

1.5.2 Use: In pyrotechnics (Bengal fires); in the manufacture of ruby glass, matches, explosives, paint pigments (vermillion or yellow), antimony salts, and camouflage paints (reflects IR radiation in same way as green vegetation)

(G21,G23)

1.6 Exposure Estimates

1.6.1 Release Rate: No information found in sources searched

1.6.2 NOHS Occupational Exposure:

Rank: 176
Estimated no. of persons exposed: 1,221,000*

*rough estimate (G29)

1.7 Manufacturers

Barium and Chemicals, Inc.
EM Laboratories, Inc.
General Metallic Oxides Co.
Hummel Chemical Co., Inc.
Indussa Corp.
A. D. Mackay, Inc.
McGean Chemical Co., Inc.
Philipp Brothers Chemicals, Inc.
(G37)

ANTIMONY AND ANTIMONY COMPOUNDS

PART II

BIOLOGICAL PROPERTIES

General Information on Toxicity

Antimony poisoning closely parallels arsenic poisoning, except that vomiting from antimony may be more prominent, perhaps because antimony compounds are less readily absorbed than arsenicals. Temporary ECG changes in humans and severe cardiac damage in animals have been reported. Trivalent antimony compounds are reportedly much more lethal than pentavalent derivatives (G26). The distribution of antimony after intravenous or intramuscular administration is variable and cannot be explained solely by valence. The trivalent forms generally concentrate in red blood cells, while the pentavalent compounds are found in the plasma. Acute antimony poisoning results in vomiting, watery diarrhea, collapse, irregular respiration, and lowered temperature. In fatal cases, death occurs within a few hours after ingestion (G33). Trivalent antimony is highly reactive towards thiol groups in enzymes (G10).

ANTIMONY

2.1 Bioaccumulation

Because of its extremely low solubility in water or any other solvent, antimony metal is unlikely to bioaccumulate. Salts of antimony are known to bioaccumulate. The oxides are rather insoluble in water, so perhaps no appreciable bioaccumulation would occur in a reasonably short time.

Bertine and Goldberg (1) showed bioaccumulation of antimony

in the dissolved, ionic state by measuring concentrations in both sea water and the flesh of invertebrates. They found the concentration of antimony to be 500 times greater in shrimp than it was in the water.

Evidence that inhaled antimony can be stored in the bones of mice with a retention time of several weeks was also found (2).

2.2 Impurities and Environmental Degradation or Conversion Products

Antimony itself is very stable in the environment. It will tarnish in moist air but not in dry air. Antimony oxide at high temperatures, e.g., in soldering, may release toxic fumes (G4) If used in storage batteries, the highly toxic stibine may be released (G23). Environmental effects from these sources are expected to be minimal. Since the trivalent antimony compounds (e.g., tartar emetic), are many more times toxic than the pentavalent analogs (G8), the oxidation of trivalent antimony compounds to the pentavalent state will reduce toxicity and vice versa. Antimony and its compounds, as inorganics, are persistent. They are often associated with lead and arsenic (G4), which may add to their toxicity.

2.3 Acute Toxicity

The NIOSH Registry of Toxic Effects of Chemical Substances (G16) reported the acute toxicity of antimony as follows:

	Dosage	Species	Route
LD50	100 mg/kg	Rat	Oral
LDLo	100 mg/kg	"	Intraperitoneal
"	150 mg/kg	Guinea Pig	"

Antimony fumes have been described as toxic (G21). In industry, the reported effects of antimony include upper respiratory tract irritation, pneumonitis, dizziness, diarrhea, vomiting, and dermatitis (G33). Headache, nausea, thirst, pains in the limbs, and a feeling of exhaustion are symptoms that occurred in workers exposed to antimony fumes (3).

The ACGIH TLV-TWA for antimony in air is 500 $\mu g/m^3$ (G11).

2.4 Other Toxic Effects

Cardiac effects, including death from atrial fibrillation in a few cases, liver toxicity characterized by jaundice and fatty degeneration, pulmonary congestion and edema, and papular skin eruptions have been reported (G33). Occupational poisoning by antimony is difficult to establish since traces of arsenic may be present. Antimony miners have been reported to develop silicosis.

Low hemoglobin levels and lower levels of total and reduced glutathione were noted in workers who were in contact with antimony (4).

An unusual finding in rats given antimony at 5 ppm in drinking water, from weaning until death, was that nonfasting serum glucose levels were lower than fasting levels (5). Also, serum cholesterol was found to be abnormal, and antimony accumulated in soft tissue.

2.5 Carcinogenicity

No reports were found of evidence suggesting that antimony or its oxide is carcinogenic in workers or experimental animals. One lifetime feeding study in mice was reported (5). No tumors

were induced but the dose administered was only 5 ppm in drinking water.

2.6 Mutagenicity

No information was found in the sources searched.

2.7 Teratogenicity

Soluble salts of antimony at fairly low doses have been tested for teratogenicity in two species, sheep (6) and chicks (7). In both, results were negative.

2.8 Metabolic Information

No information was found in the sources searched.

2.9 Ecological Effects

Antimony is one of the elements classified by Wood (8) as "very toxic and relatively accessible" in the environment. Although not specifically discussed by Wood, it has the capacity to undergo natural cycling in the environment. It is known to accumulate in marine organisms (9).

The National Academy of Sciences Committee on Water Quality Criteria concluded in 1973 that "there are insufficient data available at this time to recommend a level (of antimony) that would present minimal risk of deleterious effects" (10). On the basis of scanty data on toxicity, this Committee suggested that concentrations of antimony equal to or exceeding 0.2 mg/liter would constitute a hazard in the marine environment.

ANTIMONY (III) CHLORIDE

2.1 Bioaccumulation

See Antimony, 2.1.

2.2 Impurities and Environmental Degradation or Conversion Products

See Antimony, 2.2.

2.3 Acute Toxicity

The NIOSH Registry of Toxic Effects of Chemical Substances (G16) reported the acute toxicity of antimony (III) chloride as follows:

	Dosage	Species	Route
TCLo*	73 mg/kg	Human	Inhalation
TCLo	73 mg/m^3	"	"
LD50	675 mg/kg	Rat	Oral
"	574 mg/kg	Guinea Pig	"

*Pulmonary and gastrointestinal effects

The primary acute systemic effects of exposure were reported to be usually caused by breathing of the released hydrogen chloride gas. (Note: Antimony trichloride reacts with moisture to form hydrogen chloride gas and in the presence of larger quantities of water to form hydrochloric acid and antimony oxychloride. The acidic nature of these compounds is the cause of injury.) Mild exposure may cause only irritation of the nose, throat, and air passages. Skin exposure to dry antimony trichloride reportedly may result in deep chemical burns with blister formation. Burns may also appear in the nose if the dry powder is inhaled. Strong solutions cause burning of the skin and possibly redness.

and swelling. Eye contact may cause severe burns (G5).

The ACGIH TLV-TWA for antimony (III) chloride in air is 500 $\mu g\ Sb/m^3$ (G11).

2.4 Other Toxic Effects

The trivalent forms of antimony generally concentrate in red blood cells. They accumulate in the liver and are slowly excreted principally in the feces. In experimental animals, significantly high concentrations have been found in the thyroid after administration of trivalent compounds (G33).

Repeated skin contact with powder or solutions may result in dermatitis of the primary irritant type (G5).

Repeated inhalation of powder or mists of solutions may cause chronic nasal irritation with the development of ulcers on the nasal septum (G5).

Studies of rats that inhaled trivalent antimony (antimony trichloride) indicate that antimony is greatly localized in the red blood cells. However, no red blood cell localization occurred in two rabbits and one dog exposed by intratracheal administration (11).

2.5 Carcinogenicity

No information was found in the sources searched.

2.6 Mutagenicity

No information was found in the sources searched.

2.7 Teratogenicity

See Antimony, 2.7.

2.8 Metabolic Information

No information was found in the sources searched.

2.9 Ecological Effects

See Antimony, 2.9.

ANTIMONY TRIOXIDE

2.1 Bioaccumulation

See Antimony, 2.1.

2.2 Impurities and Environmental Degradation or Conversion Products

See Antimony, 2.2.

2.3 Acute Toxicity

No information was found in the sources searched.

2.4 Other Toxic Effects

When antimony trioxide at 100 mg/kg was added to the daily diet of mice, it was reported to be highly toxic, causing early death (12).

Serotonin, adrenaline, and noradrenaline levels and monoamine oxidase activity were periodically determined in the adrenal glands of rats injected subcutaneously with this compound (165 mg Sb/kg, five times weekly for several months). The adrenocortical functions were reported to be initially stimulated but later were restored to normal or were somewhat depressed.

Development of habituation was reported to apparently involve inhibition of the hypophyseal-adrenal system and depletion of catechol amine reserves (13).

Antimony trioxide administered to rats subcutaneously at 165 mg Sb/kg, five times a week, for 3 months, or to swine in smaller doses was reported to have produced a biphasic effect on biogenic amine metabolism in cardiac muscle, brain, and liver. It was said to have activated monamine oxidase and reduced the serotonin tissue level; both later reverted to normal. Noradrenaline tissue level was reduced and did not re-

vert (14).

Catarrhal penumonia in rats was attributed to antimony oxide dust. In the presence of 10% silica, it induced fibrous pneumonia with sclerosis (15).

2.5 Carcinogenicity

See Antimony, 2.5.

2.6 Mutagenicity

No information was found in the sources searched.

2.7 Teratogenicity

See Antimony, 2.7.

2.8 Metabolic Information

No information was found in the sources searched.

2.9 Ecological Effects

See Antimony, 2.9.

ANTIMONY TRISULFIDE

2.1 Bioaccumulation

See Antimony, 2.1.

2.2 Impurities and Environmental Degradation or Conversion Products

See Antimony, 2.2.

2.3 Acute Toxicity

The NIOSH Registry of Toxic Effects of Chemical Substances (G16) reported the acute toxicity of antimony trisulfide as follows:

	Dosage	Species	Route
TCLo (gastrointestinal effects)	580 $\mu g/m^3$/35 wk	Human	Inhalation
TCLo (blood effects)	580 $\mu g/m^3$/35 wk	"	"
LDLo	1,000 mg/kg	Rat	Intraperitoneal

The ACGIH TLV-TWA for antimony trisulfide in air is 500 μg (Sb)/m^3 (G11).

2.4 Other Toxic Effects

No information was found in the sources searched.

2.5 Carcinogenicity

No information was found in the sources searched.

2.6 Mutagenicity

No information was found in the sources searched.

2.7 Teratogenicity

See Antimony, 2.7.

2.8 Metabolic Information

No information was found in the sources searched.

2.9 Ecological Effects

See Antimony, 2.9.

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APPENDIX A

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APPENDIX B

KEY TO ABBREVIATIONS

TCLo - Lowest published toxic concentration
- the concentration of a substance in air which has been reported to produce any toxic effect in animals or humans over any given exposure time.

TDLo - Lowest published toxic dose
- the lowest dose of a substance introduced by any route other than inhalation over any given period of time that has been reported to produce any toxic effect in animals or humans.

LCLo - Lowest published lethal concentration
- the lowest concentration of a substance, other than an LC50, in air that has been reported to have caused death in humans or animals over any given exposure time.

LDLo - Lowest published lethal dose
- the lowest dose of a substance other than LD50 introduced by any route other than inhalation over any given period of time that has been reported to have caused death in humans or animals.

LC50 - Median lethal concentration
- the concentration of a test material that kills 50 per cent of an experimental animal population within a given time period.

LD50 - Median lethal dose
- the dose of a test material, introduced by any route other than inhalation, that kills 50 percent of an experimental animal population within a given time period.

LT50 - Median Lethal Response Time
-Statistical estimate of the time from dosage to the death of 50 percent of the organisms in the population subjected to a toxicant under specified conditions.

TLm - Median tolerance limit
- the concentration of a test material at which 50 per cent of an experimental animal population are able to survive for a specified time period.

TLV® - Threshold limit value
- the airborne concentration of a substance to which nearly all workers may be repeatedly exposed day after day without adverse effect.

TLV®-TWA - Threshold limit value - time weighted average
- the time-weighted average concentration of a substance for an 8-hour workday or 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

TLV®-STEL- Threshold limit value - short term exposure limit-
- the maximal concentration of a substance to which workers can be exposed for up to 15 minutes without suffering acute or chronic toxic effects. No more than four excursions per day are permitted. There must be at least 60 minutes between exposure periods. The daily TLV-TWA must not be exceeded.

BOD - Biochemical oxygen demand
- a measure of the presence of organic materials which will be oxidized biologically in bodies of water.

NOHS Occupational Exposure:

- Rank
  - an ordering of the approximately 7000 hazards occurring in the workplace from most common to least common

- Estimated number of persons exposed
  - includes full- and part-time workers. For hazards ranked 1 through 200, the figure projected to national statistics by NIOSH is given; for the remaining hazards the number of people exposed given in the survey was multiplied by a fixed number to give a rough estimate of national exposure. The fixed number used, --30--, is derived from the statistical sampling technique used in this survey.

i - insoluble

ss - slightly soluble

s - soluble

vs - very soluble

∞ - soluble in all proportions

bz - benzene

chl - chloroform

eth	- ether
peth	- petroleum ether
ace	- acetone
lig	- ligroin
alc	- alcohol
CCl_4	- carbon tetrachloride
dil. alk.	- dilute alkalis
CS_2	- carbon disulfide
os	- organic solvents
oos	- ordinary organic solvents