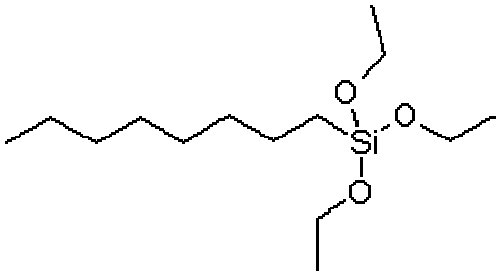
SIDS INITIAL ASSESSMENT PROFILE

CAS No.	2943-75-1
Chemical Name	Triethoxy(octyl)silane
Structural Formula	

SUMMARY CONCLUSIONS OF THE SIAR

Triethoxy(octyl)silane undergoes rapid hydrolysis (the half-life of 0.3 to 0.6 hours at a pH of 7 and 25°C), which occurs during testing; exposures to triethoxy(octyl)silane are likely to be transient depending on the test system, and observed intrinsic toxicity is likely due to a mixture of the parent molecule and the hydrolysis products ethanol and octylsilanetriol, and to a lesser degree any polymerization products. Based on the chemical structure of triethoxy(octyl)silane, the hydrolysis products, ethanol (CAS No. 64-17-5) and octylsilanetriol (CAS No. 31176-12-2) are expected, at a ratio of 3 moles ethanol to 1 mole octylsilanetriol. The water solubility of the octylsilanetriol cannot be measured because of the tendency to self-condense into highly cross-linked, high molecular weight polymers at concentrations greater than approximately 500 mg/L. It is known, however, that the octylsilanetriol and small condensation products will only precipitate out of water due to formation of larger, water insoluble polymeric resins. Data from the hydrolysis product ethanol have been presented and agreed upon at SIAM 19 (documents are available at http://www.inchem.org/documents/sids/sids/64175.pdf).

Physical-Chemical Properties

The EPISuite program (v 4.0) developed by the U.S. Environmental Protection Agency and Syracuse Research Corporation has been used for estimating some environmental fate parameters. This model has not been validated for chemicals that contain silanes in their molecular structure (although some measured data are included in the training data set); therefore, there is uncertainty associated with the calculated values and they should be used with caution whenever they are reported.

Triethoxy(octyl)silane is a clear, colorless liquid with a melting point of -46 °C, a boiling point of 257 °C at 1020 hPa and a measured vapour pressure of 0.63 hPa at 25 °C. The octanol-water partition coefficient (log K_{ow}) is >3.7 (measured) at 23 °C. Water solubility is < 0.13 mg/L at 22.8 °C (measured). The water solubility and log K_{ow} values may not be accurate because the chemical is hydrolytically unstable.

Human Health

No toxicokinetics data are available on the parent substance; however, rapid hydrolysis of triethoxy(octyl)silane is expected to produce 3 moles of ethanol for each mole of octylsilanetriol. The toxicokinetics data for octylsilanetriol are not available. Following any route of intake resulting in an elevated blood ethanol level, metabolism proceeds in three basic steps: ethanol is oxidized within the cytosol of hepatocytes to acetaldehyde, which is rapidly converted to acetate, which is released into the blood and oxidized by peripheral tissues to acetic acid and ultimately carbon dioxide, and water. The main pathway for ethanol metabolism proceeds via alcohol dehydrogenase. The rate of hepatic metabolism of ethanol is concentration independent except at very low or very high concentrations. The

kidneys and lungs excrete only 5 – 10 % of an absorbed dose of ethanol unchanged. The major route of excretion of ethanol is in the urine. Ethanol is excreted in the un-metabolized form in urine, exhaled air and sweat. Its metabolic products are also excreted by exhalation and in the urine.

The 4-hr inhalation LC_{50} value was greater than approximately 0.248 mg/L (the saturated vapor concentration) for vapor for male and female rats (similar to OECD TG 403). The substance caused hyperactivity in a single animal; there were no other clinical signs of toxicity. The dermal LD_{50} values were 6730 mg/kg bw for male and > 8000 mg/kg bw for female rabbits (similar to OECD TG 402). The substance caused irritation and necrosis at the site of contact, central nervous system (CNS) effects (limb paresis or paralysis) as the predominant clinical sign of toxicity, labored breathing, iritis, and weight loss with some emaciation. Findings at necropsy showed dark or bright red lungs and enlarged spleen. The oral LD_{50} values were 12,200 mg/kg bw for male and 11,500 mg/kg bw for female rats (11,800 mg/kg bw for combined sexes) (similar to OECD TG 401). The substance caused CNS effects as the predominant clinical sign of toxicity (sluggishness, aggressive behaviour, and unsteady gait with limb paresis or paralysis). Microscopic examination suggested effects on the renal system (nephritis, hydronephrosis, tubular dilation, renal mineralization, and hemorrhages of the urinary bladder). In a second study, the oral LD_{50} value was > 5110 mg/kg bw for male and female rats (OECD TG 401). The substance caused CNS effects (uncoordination, stilted gait, labored breathing, sunken sides and vocalization on handling) as the predominant clinical sign of toxicity; there were no gross necropsy findings in surviving animals. The gastro-intestinal tract was severely autolytic in the single female that died on day 7.

Triethoxy(octyl)silane was moderately irritating to the skin (test similar to OECD TG 404). Moderate erythema and moderate edema were observed in a skin irritation assay performed in rabbits. The effects were reversible by day 7. In a second study, triethoxy(octyl)silane was highly irritating to the skin (OECD TG 404). Moderate erythema and moderate-to-severe edema were observed in a skin irritation assay performed in rabbits. All skin effects were reversible by day 10. Triethoxy(octyl)silane was slightly irritating to eyes (similar to OECD TG 405). Transient iritis and minor-to-moderate conjunctival irritation with ocular discharge were observed in an eye irritation assay performed in rabbits. All effects were reversible by day 7. In a second study, triethoxy(octyl)silane was slightly irritating to eyes (OECD TG 405). Diffuse redness and slight swelling of the conjunctivae were observed in an eye irritation assay performed in rabbits. All effects were reversible by 48 hours.

No experimental data were available for skin sensitization in animals.

In a combined repeated-dose/reproductive/developmental toxicity screening test (OECD TG 422) triethoxy(octyl)silane was administered in dried (excess moisture content removed intentionally), deacidified peanut oil daily, seven days a week by oral gavage to 10 Sprague-Dawley rats/sex/group at 0, 100, 300 or 1000 mg/kg bw/day for 28 (males) or 29 (toxicity group females) days. Reproductive group females (10/group) were treated with the same dose levels for up to 45 days (prior to mating through post-partum day 4). Clinical signs included soiling of the head in 300 and 1000 mg/kg bw/day male and toxicity group females and 1000 mg/kg bw/day reproductive group females. Clinical observations consistent with neuromuscular toxicity (decreased activity, dragging of the hindlimbs and/or incoordinated gait) occurred only in the 1000 mg/kg bw/day reproductive group females, but were not observed in the males or toxicity group females. However, no changes were noted during Functional Observational Battery and Motor Activity evaluations in males and toxicity group females. Treatment-related decreases in group mean body weights and/or body weights gains occurred in all animals at 1000 mg/kg bw/day with associated decreases in food consumption (females). There was an increase in mean absolute and relative liver weights in males (relative: 11.7% and 17.3%) and toxicity group females (relative: 4.7% and 27.8%) at 1000 mg/kg bw/day. Histopathological findings were identified in the liver (dose-related centrilobular hypertrophy at 300 and 1000 mg/kg bw/day in toxicity and reproductive groups; not considered adverse as these changes are consistent with common adaptive changes that occur in the liver upon xenobiotic administration), bladder (diffuse epithelial hyperplasia in all animals at 1000 mg/kg bw/day) and kidneys, adrenal, thymus, spleen and brain, spinal cord, peripheral nerves and skeletal muscles (1000 mg/kg bw/day). CNS degeneration of white matter, predominantly the cerebellum and medulla, occurred in a large percentage of the toxicity and reproductive group females. In the brain, 40% and 80% of the 1000 mg/kg bw/day toxicity and reproductive group females exhibited white matter degeneration, respectively. Degeneration of the spinal cord occurred in 50% and 90% of the 1000 mg/kg bw/day toxicity and reproductive group females, respectively. The peripheral nerves (sciatic and tibial) also showed minimal to severe degeneration and demyelination in both 1000 mg/kg bw/day toxicity and reproductive group females, with less incidence and severity occurring in the toxicity group females. Based on the bladder epithelial hyperplasia in males and the neuromuscular findings in the toxicity and reproductive group females at 1000 mg/kg bw/day, the NOAEL for systemic toxicity was 300 mg/kg bw/day. In another study (similar to OECD TG 407), dietary administration of triethoxy(octyl)silane for 28

days to male and female Fisher 344 rats did not result in any treatment-related clinical signs or changes in food consumption, body and organ weights, hematology and clinical chemistry evaluations, or gross pathology and histopathology evaluations which were considered to reflect an adverse effect of the diet. The NOAELs were determined to be greater than 592.2 and 639.6 mg/kg bw/day (10,000 ppm) for male and female rats, respectively, the highest dose tested.

Triethoxy(octyl)silane did not induce gene mutations in bacterial cells (*Salmonella typhimurium* TA98, TA100, TA1535 and TA1537, and *Escherichia coli* WP2uvrA) *in vitro* (OECD TG 471 or similar to OECD TG 471) in two separate studies or induce chromosomal aberrations in Chinese hamster ovary cells (similar to OECD TG 473). Based on these results, triethoxy(octyl)silane is not considered to be genotoxic *in vitro*.

No data are available for the carcinogenicity of triethoxy(octyl)silane.

In the combined repeated-dose/reproductive/developmental toxicity screening test (OECD TG 422) mentioned above, triethoxy(octyl)silane was administered in dried, deacidified peanut oil daily, seven days a week by oral gavage to 10 rats/sex/group at 0, 100, 300 or 1000 mg/kg/day for 28 days in males and up to 45 consecutive days in females. Reproductive parameters evaluated included evidence of mating, pregnancy, duration of gestation, mean number of implantation sites, mean number of corpora lutea, mean mating and fertility indices and evaluation of loss of offspring (pre-implantation and post-natal loss). Changes in reproductive parameters were limited to the 1000 mg/kg bw/day group. Mating and fertility were unaffected by treatment. The mean duration of gestation was increased (5.6%) compared to controls ($p<0.01$). Of the seven dams that successfully initiated parturition, four of these dams exhibited dystocia (difficult/prolonged labor). Developmental parameters evaluated included total litter size, mean litter size, mean live litter size, mean litter weight, mean ratio of live births/litter size, sex ratio, pup viability, pup body weight and body weight gain. Changes in developmental parameters were limited to the 1000 mg/kg bw/day group. The mean number of live male and female pups/dam at first litter check (PND 0) in the 1000 mg/kg bw/day group was statistically decreased by 39.3% compared to controls. PND 0 mean litter weights, average pup body weights and body weight gains were similar to controls. By PND 4, several dams in the 1000 mg/kg bw/day group had been euthanized due to the severity of various clinical signs and/or difficulty during labor. Only four dams continued through PND 4. Of these litters, the total viable pups on PND 4 were decreased compared to controls, resulting in a 25.2% decrease in percent viability of pups/dam on PND 4 compared to controls. This significant decrease was due to a single dam that had a 14.3% post-natal loss of offspring. The remaining dams had no post-natal loss of pups between Days 0-4. PND 4 mean litter weights, average pup body weights and body weight gains in the 1000 mg/kg bw/day group were also decreased compared to control weights. External gross lesions were not observed for treated dams or pups. The reproductive effects only occurred at the 1000 mg/kg bw/day dose level in association with marked maternal toxicity. As such it is not possible to determine with confidence if the 1000 mg/kg bw/day dose level represents the NOAEL. Therefore, the reproductive toxicity NOAEL is considered to be > 300 mg/kg bw/day. The developmental effects only occurred at the 1000 mg/kg bw/day dose level in association with marked maternal toxicity. As such it is not possible to determine with confidence if the 1000 mg/kg bw/day dose level represents the NOAEL. Therefore, the developmental toxicity NOAEL is considered to be > 300 mg/kg bw/day.

Triethoxy(octyl)silane may present hazard for human health (skin irritation; repeated-dose toxicity-urinary tract; neuromuscular system-at high doses). Adequate screening-level data are available to characterize the human health hazard for the purposes of the OECD HPV Chemicals Programme.

Environment

The measured hydrolysis half-life for triethoxy(octyl)silane is 0.3-0.6 hours at 25 °C and pH 7. In the atmosphere, indirect photo-oxidation by reaction with hydroxyl radicals is predicted to occur with a half-life of 4.5 hours with an overall OH rate constant of 2.8×10^{-11} cm^3/molecule-sec. Triethoxy(octyl)silane is considered not readily biodegradable (5-6%, 28 d) following OECD TGs 301 B, 301 C and 301 D for ready biodegradability; based on the rapid hydrolysis of this material any potential for biodegradation is likely to be due to the hydrolysis product ethanol. The other hydrolysis products, octylsilanetriols and condensed octylsilanetriols are expected to be not readily biodegradable.

A level III fugacity model calculation with equal and continuous release to air, water and soil compartments suggests that triethoxy(octyl)silane will distribute mainly to the sediment (69.8%) and water (19.9%) compartments with minor distribution to the soil and air compartments (7.2 and 3%, respectively). However, triethoxy(octyl)silane is unlikely to be found in the environment, as this material is hydrolytically unstable. Henry's Law constant of 1.49×10^2 Pa-m^3/mole (1.47×10^{-3} atm-m^3/mole) suggests that volatilization from the water phase for triethoxy(octyl)silane is

expected to be high.

A dynamic 70-day study (OECD TG 305C) was conducted to evaluate the bioconcentration of ^{14}C-test substance by the common carp. A flow-through system was used to maintain a mean measured water concentration of 0.166 mg/L (high) or 0.0141 mg/L (low) for a 56-day exposure period. Test fish were then placed in clean water for a 14-day depuration period. Radioanalysis of the fish was performed throughout the exposure and depuration periods. BCFs in this study were estimated to be 1670 for the high treatment level and 1980 for the low treatment level with a geometric mean average of 1818. While the fish in this test significantly accumulated the test material from water, the majority of ^{14}C-test substance was cleared (depuration) within 14 days when the fish were placed in uncontaminated water. Results are based on total radioactivity (the test substance was radiolabelled on the octyl chain). The results represent the bioaccumulation of the parent compound and its hydrolysis/degradation products. Ethanol is not likely to bioaccumulate (calculated BCF=3.16).

Triethoxy(octyl)silane reacts to form ethanol and octylsilanetriol through hydrolysis. Furthermore, due to these properties, current estimation models are not capable of calculating physicochemical or environmental fate values with a known degree of accuracy. No information on the environmental fate of octylsilanetriol was found. However, based on studies on related monomeric silanols, it is expected that the adsorption of octylsilanetriol onto surfaces and condensation to disiloxanes in dilute aqueous solution may be important properties of this chemical. Octylsilanetriol is expected to partition primarily to soil and water due to its high water solubility and potential to bind to mineral surfaces. In water and air, octylsilanetriol may degrade photolytically. Slow biodegradation in water and soil might also occur.

Due to the rapid hydrolysis of triethoxy(octyl)silane in ecotoxicity studies, aquatic organisms are likely exposed to the parent and its hydrolysis products, ethanol, octylsilanetriol, and condensed octylsilanetriol materials. No toxicity data specifically relating to the silanol hydrolysis products are available.

The following acute toxicity test results have been determined for aquatic species:

Fish [*Oncorhynchus mykiss*]: 96 h LC_{50} > 0.055 mg/L (OECD TG 203; flow-through; measured; tested at the water solubility limit)
Invertebrate [*Daphnia magna*]: 48 h EC_{50} > 0.049 mg/L (OECD TG 202; flow-through; measured; tested at the water solubility limit)
Algae [*Pseudokirchneriella subcapitata*]: 72-hour E_yC_{50} , E_rC_{50} , E_bC_{50} > 0.13 mg/L (OECD TG 201; nominal; tested at the water solubility limit)
Algae [*Pseudokirchneriella subcapitata*] NOEC = 0.13 mg/L (nominal; tested at the water solubility limit)

Triethoxy(octyl)silane does not present an acute hazard for the environment based on its low hazard profile at the limit of water solubility. However, this chemical is not readily biodegradable. The parent chemical and/or some of its hydrolysis products have a moderate bioaccumulation potential. Adequate screening-level data are available to characterize the environmental hazard for the purposes of the OECD HPV Chemicals Programme.

Exposure

Triethoxy(octyl)silane was produced and/or imported in the United States at a volume between 454 and < 4,540 tonnes (1 million and < 10 million pounds) during 2005. This material is also imported into Europe (91 to 272 tonnes). The substance is used as a hydrophobation agent (building protection), manufacturing intermediate, water repellent, and pigment treatment. Percent use in final product <5 - 100% with no parent substance remaining after end use.

During manufacturing, occupational exposure through dermal and inhalation routes is possible, although worker exposures due to non-accidental releases are expected to be low, and are expected to occur only during transfer and sampling. These exposures are minimized by use of personal protective equipment (PPE) and engineering controls. PPE includes hard hat, glasses, chemical and fire resistant clothes, safety shoes, chemical resistant gloves, and respirator. Use of engineering controls includes pressure and temperature controls; location ventilation; closed sample loops, kettle house ventilation and local vent drops. The industrial consumer may use the substance in open applications to walls (building water-proofing) and closed systems with proper materials of construction. Engineering controls include ventilation systems, automatic feed systems with interlocks, grounded equipment, and splash guards at appropriate locations.

There are no consumer uses of the substance. There are no intentional releases to the environment. The reactive nature of this material destroys the parent material in water, thus limiting environmental exposure to triethoxy(octyl)silane.