

MATERIAL SAFETY DATA SHEET

SECTION 1. PRODUCT IDENTIFICATION

PRODUCT NAME: Silane

CHEMICAL NAME: Hydride **FORMULA:** SiH₄

SYNONYMS: Silicon Tetrahydride; Monosilane; Silicane

MANUFACTURER: Air Products and Chemicals, Inc.

ADDRESS: 7201 Hamilton Boulevard

Allentown, PA 18195-1501

PRODUCT INFORMATION: (800) 752-1597

MSDS NUMBER: 1052 **REVISION:** 4

REVIEW DATE: October 1998 **REVISION DATE:** October 1998

SECTION 2. COMPOSITION / INFORMATION ON INGREDIENTS

Silane is sold as a pure product (> 99%).

CAS NUMBER: 7803-62-5

EXPOSURE LIMITS:

OSHA: None established **ACGIH:** TLV = 5 ppm **NIOSH:** REL = 5 ppm

SECTION 3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

PYROPHORIC GAS! Silane is a colorless, air-reactive gas, with a choking effect. This gas usually ignites upon contact with air, releasing a dense white cloud of amorphous silicon dioxide. The primary health hazard associated with Silane is the potential for severe thermal burns from contact with flames resulting from the spontaneous ignition of this gas. Depending on the severity of the burns, such exposures can be fatal. Flame or high temperature impinging on a localized area of the cylinder of this product can cause the cylinder to burst without activating the cylinder's relief devices. If Silane is released at high pressure or high flow velocity, a delayed detonation may occur. Silane releases which have not spontaneously ignited must be considered extremely dangerous, and should not be approached. Emergency responders must have personal protective equipment and fire protection appropriate for the situation to which they are responding. Do not attempt to extinguish fire without stopping the flow of the gas.

EMERGENCY TELEPHONE NUMBERS

(800) 523-9374 Continental U.S., Canada, and Puerto Rico

1. 481-7711 Other locations

ACUTE POTENTIAL HEALTH EFFECTS:

ROUTES OF EXPOSURE:

EYE CONTACT: Silane can be irritating to eyes. Decomposition of Silane will result in the production of amorphous silicon dioxide. Eye contact with particulates of amorphous silicon dioxide may be irritating.

INGESTION: Ingestion of Silane is not a likely route of industrial exposure.

INHALATION: Inhalation of high concentrations of this gas can result in headache, nausea, dizziness, and irritation of the upper respiratory tract. Silane can be irritating to the mucous membranes and the respiratory system. Severe Silane over-exposures via inhalation may result in pulmonary edema and adverse kidney effects. Decomposition of Silane will result in the production of amorphous silicon dioxide. Though inhalation of amorphous silicon dioxide can be irritating to the nose and throat, such exposure does not present the potential for adverse health effects that exist with inhalation of crystalline silicon dioxide. Overexposure to high concentrations may result in thermal burns due to the pyrophoric nature of the gas.

SKIN CONTACT: Silane can be irritating to the skin. Decomposition of Silane will result in the production of amorphous silicon dioxide. Skin contact with particulates of amorphous silicon dioxide may be irritating.

POTENTIAL HEALTH EFFECTS OF REPEATED EXPOSURE:

ROUTE OF ENTRY: None

TARGET ORGANS: Not applicable

SYMPTOMS: There are currently no known adverse health effects associated with chronic exposure to Silane.

MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE: Skin conditions and respiratory disorders may be aggravated by exposures to Silane and its decomposition products.

CARCINOGENICITY: Silane is not found on the FEDERAL OSHA Z LIST, NTP, CAL/OSHA, or IARC Carcinogenicity lists.

SECTION 4. FIRST AID MEASURES

THERMAL BURNS: In the event personnel are burned as a result of a Silane release, trained personnel should provide first aid treatment. Get medical attention immediately.

EYE CONTACT: Immediately begin decontamination with running water, open victim's eyes while under gently running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes. Victim must seek immediate medical attention from an ophthalmologist.

INGESTION: Ingestion of Silane is not a likely route of exposure.

INHALATION: Remove victim(s) to fresh air, as quickly as possible. Trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation, if necessary.

SKIN CONTACT: Flush area with copious amounts of water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek medical attention if irritation persists, or if there are other adverse health effects.

NOTES TO PHYSICIANS: Administer oxygen, if necessary and treat symptoms. Be observant for initial signs of pulmonary edema.

SECTION 5. FIRE FIGHTING MEASURES

FLASH POINT: AUTOIGNITION: FLAMMABLE RANGE:

Not applicable Unknown (LEL): 1.4% (UEL): 96.0%

FIRE EXTINGUISHING MEDIA: Extinguish Silane fires by shutting-off the source of the gas. Use a fine water spray or fog to reduce combustion products formed in air. Do not use halocarbon-type fire extinguishing agents. Cool fire-exposed cylinders with water spray, from the maximum distance possible.

SPECIAL FIRE-FIGHTING PROCEDURES: Evacuate all personnel from area. If possible without risk, shut off source of gas, then fight fire according to types of materials burning. Use a fine water spray or fog to reduce combustion products formed in air. Water may not be effective in actually extinguishing a fire involving Silane. Do not use halocarbon-type fire extinguishing agents. Stop the leak or discharge, if possible. Do not attempt to extinguish fire without stopping the flow of the gas. This will avoid possible accumulation and reignition of a flammable gas mixture. For small releases, if it is not possible to stop the leak, and it does not endanger personnel, let the fire burn itself out. Keep adjacent cylinders cool by spraying with large amounts of water until the fire burns itself out. Large fires should be fought from a distance with an unmanned hose holder or monitor nozzles. Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment, including fire resistant clothing. If necessary, decontaminate fire-response equipment with soap and water solution.

UNUSUAL FIRE AND EXPLOSION HAZARDS: PYROPHORIC GAS! This product is a colorless, air-reactive gas. This gas usually ignites upon contact with air, releasing a dense white cloud of amorphous silicon dioxide. **If Silane is released at high pressure or high flow velocity, a delayed detonation may occur. Silane releases which have not spontaneously ignited must be considered extremely dangerous, and should not be approached.**

Most cylinders are designed to vent contents when exposed to elevated temperatures. Pressure in a cylinder can build-up due to heat and it may rupture if pressure relief devices should fail to function.

HAZARDOUS COMBUSTION PRODUCTS: Combustion products include oxides of silicon.

SECTION 6. ACCIDENTAL RELEASE MEASURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED: Evacuate immediate area. Silane is a pyrophoric gas and can ignite spontaneously upon contact with air, releasing a dense white cloud of amorphous silicon dioxide. Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Normally, a release of Silane will result in a fire. If Silane is released at high pressure or high flow velocity, a delayed detonation may occur. Silane releases which have not spontaneously ignited must be considered extremely dangerous, and should not be approached. Shut off source of leak, if possible. Isolate any leaking cylinder. If this does not stop the release (or if it is not possible to reach the valve), allow the gas to release in-place or remove it to a safe area and allow the gas to be released there.

If leak is from container, pressure relief device or its valve, contact your supplier. If leak is in user's system, close cylinder valve, safely vent pressure and purge with inert gas before attempting repairs. Protection of all personnel and the area must be maintained. All responders must be adequately protected from exposure. Monitor the surrounding area for Silane level. The level of Silane must be at acceptable levels (see Section 2, Composition / Information on Ingredients) before personnel can be allowed in the area without Self-contained breathing apparatus. Combustible vapor levels must be below 0.14%, which is 10% of the LEL of Silane, prior to entry. Attempt to close the main source valve prior to entering the area.

SECTION 7. HANDLING AND STORAGE

STORAGE: Store cylinders in a well-ventilated, secure area, protected from the weather. Cylinders should be stored up-right with valve outlet seals and valve protection caps in place. Storage should be away from heavily traveled areas and emergency exits. There should be no sources of ignition. All electrical equipment should be explosion-proof in the storage areas. Storage areas must meet National Electrical Codes for Class 1 hazardous areas. Flammable storage areas should be separated from oxygen and other oxidizers by a minimum distance of 20 ft. or by a barrier of non-combustible material at least 5 ft. high, having a fire resistance rating of at least 1/2 hour. Post "No Smoking or Open Flames" signs in the storage and use areas. Do not allow storage temperature to exceed 125 ° F (52 ° C). Full and empty cylinders should be segregated. Use a first-in, first-out inventory system to prevent full containers from being stored for long periods of time. Consideration should be taken to install leak detection and alarm equipment for storage areas.

HANDLING: Non-sparking tools should be used. Do not attempt to repair, adjust, or in any other way modify the cylinders containing Silane. If there is a malfunction, or another type of operational problem, contact nearest distributor immediately. Working alone with Silane should be avoided when possible. All work operations should be monitored in such a way that emergency personnel can be immediately contacted in the event of a release.

The Silane dispensing area should be monitored with the use of hydride monitors to detect leaks and releases and a UV/IR monitor to detect fires. Both monitors should be interlocked (fail safe) to shut off the flow of Silane upon detection. Monitoring systems should be equipped with a source of back-up or emergency power. A remote emergency shutdown device must be present to shut off Silane at the source. The use of packed valves on systems containing silane should not be permitted. Only valves such as packless diaphragm or bellows-type should be used. An excess flow valve or excess-flow switch should be installed on all dispensing systems to shut off flow in the case of a downstream line rupture. This shut off valve should be located as close to the source as possible.

Do not drag, roll, slide or drop cylinder. Use a suitable hand truck designed for cylinder movement. Never attempt to lift a cylinder by its cap. Secure cylinders at all times while in use. Use a pressure-reducing regulator and separate control valve to safely discharge product from cylinder. Use a check valve to prevent reverse flow into cylinder. Never apply flame or localized heat directly to any part of the cylinder. Once cylinder has been connected to properly purged and inerted process, open cylinder valve slowly and carefully. If user experiences any difficulty operating cylinder valve, discontinue use and contact supplier. Never insert an object (e.g., wrench, screwdriver, etc.) into valve cap openings. Doing so may damage valve, causing a leak to occur. Use an adjustable strap-wrench to remove over-tight or rusted caps. All piped systems and associated equipment must be grounded. Electrical equipment should be non-sparking or explosion-proof.

SPECIAL PRECAUTIONS: Avoid temperatures of less than -170 ° F (-112 ° C), due to the possibility of sucking-back air, which may form explosive mixtures within the system. Do not use Silane in conjunction with heavy-metal halides or free halogens, with which Silane will react violently. Care should be taken that all handling systems are purged free of halogens that might exist from degreasing agents, or chlorinated hydrocarbons. Evacuate and thoroughly pressure-check all systems for leaks at pressures two to three times the anticipated working pressure, preferably with

helium. In addition, regular leak-testing should be instituted and performed. Use an alternate vacuum and inert gas purge cycles of the system to purge all air out of the system after it has been leak-tested or opened for any reason. Before disconnecting any system that has Silane in it, thoroughly purge the system of Silane with an inert gas.

Any portion of a system that is dead-ended or allows "pocketing" of Silane should be treated with vacuum-purge cycles. Venting should be to an area designed for Silane disposal, preferably by burning. Concentrations, even in the low percentage range, are dangerous and should not be exposed to air. Silane can also be vented by diluting with an inert gas to prevent ignition upon discharge to the atmosphere.

Always store and handle compressed gas cylinders in accordance with Compressed Gas Association, Inc. (telephone 703-412-0900) pamphlet CGA P-1, *Safe Handling of Compressed Gases in Containers*. Local regulations may require specific equipment for storage and use.

SECTION 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

ENGINEERING CONTROLS:

VENTILATION: Silane detectors should be installed in or near areas where this product is being used or stored. Provide adequate natural or explosion-proof ventilation to prevent accumulation of gas concentrations and adequate to ensure Silane does not reach its lower flammability limit of 1.4%. If appropriate, install automatic monitoring equipment to detect the presence of explosive air-gas mixtures and the level of oxygen.

RESPIRATORY PROTECTION: High concentration that can cause rapid suffocation are within the flammable range and must not be entered.

Emergency Use: Escape-type SCBA should be used.

EYE PROTECTION: Splash goggles or safety glasses with side shields and a faceshield. Ensure eyewash/safety shower stations are available near areas where this product is used.

SKIN PROTECTION: Work gloves are recommended when handling cylinders. Use fire-resistant gloves and clothing in emergency situations. Use double gloves for spill response.

OTHER PROTECTIVE EQUIPMENT: Use body protection appropriate for task. Static-resistant clothing is recommended. Safety shoes are recommended when handling cylinders.

SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE, ODOR AND STATE: Colorless gas, with a choking effect.

MOLECULAR WEIGHT: 32.12

BOILING POINT (at 1 atm): -169.0 ° F (-111.7 ° C)

SPECIFIC GRAVITY (also called vapor density) (air = 1): 1.2

FREEZING/MELTING POINT: -301.0 °F (-185.0 °C)

VAPOR PRESSURE (At 70 ° F (21.1 ° C): Not applicable.

GAS DENSITY (At 70 ° F (21.1 ° C) and 1 atm): 0.084 lb/ft³

SOLUBILITY IN WATER: Negligible

SECTION 10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Pyrophoric. Ignites spontaneously on exposure to air.

CONDITIONS TO AVOID: Cylinders should not be exposed to temperatures in excess of 125° F (52°C).

INCOMPATIBILITY (Materials to Avoid): Air, halogens, other oxidizers, and moisture.

REACTIVITY:

A) HAZARDOUS DECOMPOSITION PRODUCTS: Not applicable

B) HAZARDOUS POLYMERIZATION: Will not occur

SECTION 11. TOXICOLOGICAL INFORMATION

LC₅₀ (Inhalation): Rat LC₅₀: 9600 ppm/4 hours

LD₅₀ (Oral): No data currently available.

LD₅₀ (Dermal): No data currently available.

SKIN CORROSIVITY: Silane is not corrosive to the skin. When in contact with water, Silane may form silicic acid, which is corrosive to the skin.

CARCINOGENICITY: Currently, Silane has not been found to be carcinogenic.

ADDITIONAL NOTES: Studies in mice showed that exposure to 10,000 ppm for 1 hour or exposure to ■ 2500 ppm for 4 hours resulted in adverse kidney effects. Mice exposed to 1000 ppm, 6 hours/day, 5 days/week for 2 to 4 weeks only exhibited mild respiratory tract irritation. Silane has been shown to cause mutations in bacteria.

SECTION 12. ECOLOGICAL INFORMATION

AQUATIC TOXICITY: Currently, no aquatic toxicity data are available for Silane.

MOBILITY: Due to the pyrophoric nature of Silane in air, it will ignite before it can enter the soil.

PERSISTENCE AND BIODEGRADABILITY: Silane will not persist in the environment, as it will ignite and decompose on contact with air.

POTENTIAL TO BIOACCUMULATE: Silane will not bioaccumulate.

REMARKS: Silane is not a Class I or Class II ozone depleting chemical (40 CFR Part 82).

SECTION 13. DISPOSAL CONSIDERATIONS

UNUSED PRODUCT / EMPTY CONTAINER: Return container and unused product to supplier. Do not attempt to dispose of residual or unused quantities.

DISPOSAL INFORMATION: Residual product in the system may be burned if suitable burning unit (flair incinerator) is available on-site. This shall be done in accordance with Federal, State and local regulations. Wastes containing this material may be classified by EPA as a hazardous waste by characteristic (such as Ignitability, Corrosivity, Toxicity, Reactivity). Waste streams must be characterized by the user to meet Federal, State and local requirements.

SECTION 14. TRANSPORT INFORMATION

DOT PROPER SHIPPING NAME: Silane, Compressed

HAZARD CLASS NUMBER and DESCRIPTION: 2.1 (Flammable Gas)

UN IDENTIFICATION NUMBER: UN2203

DOT SHIPPING LABEL(S) REQUIRED: Flammable Gas

PLACARD (When required): Flammable Gas

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure upright position in a well-ventilated truck. Never transport in passenger compartment of a vehicle. Ensure cylinder valve is properly closed, valve outlet cap has been reinstalled, and valve protection cap is secured before shipping cylinder.

CAUTION: Compressed gas cylinders shall not be refilled except by qualified producers of compressed gases. Shipment of a compressed gas cylinder which has not been filled by the owner or with the owner's written consent is a violation of Federal law (49 CFR 173.301).

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SECTION 15. REGULATORY INFORMATION

U.S. FEDERAL REGULATIONS

EPA - ENVIRONMENTAL PROTECTION AGENCY:

CERCLA: Comprehensive Environmental Response, Compensation, and Liability Act of 1990

(40 CFR Parts 117 and 302).

Reportable Quantity (RQ): Not applicable

SARA TITLE III: Superfund Amendment and Reauthorization Act

SECTIONS 302/304: Emergency Planning and Notification (40 CFR Part 355)

Extremely Hazardous Substances: Silane is not listed.

Threshold Planning Quantity (TPQ): Not applicable

Reportable Quantity (RQ): Not applicable

SECTIONS 311/312: Hazardous Chemical Reporting (40 CFR Part 370)

IMMEDIATE HEALTH: Yes PRESSURE: Yes

DELAYED HEALTH: No REACTIVITY: Yes

FIRE: Yes

SECTION 313: Toxic Chemical Release Reporting (40 CFR 372)

Releases of Silane do not require reporting under Section 313.

CLEAN AIR ACT:

SECTION 112 (r): Risk Management Programs for Chemical Accidental Release

(40 CFR Part 68)

Silane is listed as a regulated substance under Section 112 (r).

Threshold Planning Quantity (TPQ): 10,000 lbs (4,553 kg)

TSCA: Toxic Substances Control Act

Silane is listed on the TSCA Inventory.

OSHA - OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR Part 1910.119: Process Safety Management of Highly Hazardous Chemicals.

Silane is not listed in Appendix A as a highly hazardous chemical.

Threshold Planning Quantity (TPQ): Under this regulation, however, any process that involves a flammable gas on-site, in one location, in quantities of 10,000 lb. (4,553 kg) or greater is covered under this regulation unless it is used as a fuel.

STATE REGULATIONS:

CALIFORNIA:

Proposition 65: Silane is not a listed substance which the State of California requires warning under this statute.

SECTION 16. OTHER INFORMATION

NFPA RATINGS: HMIS RATINGS:

HEALTH: = 1 HEALTH: = 1

FLAMMABILITY = 4 FLAMMABILITY: = 4

REACTIVITY: = 3 REACTIVITY: = 3

SPECIAL: None