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Safety Guide

for

Handling
Chemicals and other
Hazardous Materials

CONTINENTAL OIL COMPANY

This booklet covers precautionary measures for the handling of chemicals and the other hazardous materials most commonly used in our operations. There are many hazardous materials not included in this booklet because their use is restricted to laboratories or isolated locations.

First aid measures are given for the treatment of minor injuries and/or exposures. If there is any doubt regarding the seriousness of employee's injury or exposure, the employee should have medical treatment at once.

Prepared by
Safety and Health Divisions
Industrial Relations Department
Continental Oil Company

ACETONE

Maximum Allowable Concentration in Air: 500 parts per million.

Explosive Limits: From 2.5 to 12.8 per cent by volume in air.

Hazardous Properties: It is narcotic and markedly stimulating to the respiratory centers, very flammable and constitutes a dangerous fire hazard, and is an irritant to the eyes and mucous membranes of the respiratory tract. Prolonged inhalation can cause irritation of mucous membranes of the eyes and respiratory tract. It can cause headaches, fainting, and, in much larger concentrations, a state of stupor. Prolonged exposure to the vapor irritates the skin. It is said to cause an onset of a state of stupor at a faster rate than methyl alcohol but is supposed to be less toxic. In higher concentrations it is more toxic for brief exposures than chloroform and is only slightly less toxic than benzene. It can cause a granulation of the eyelids, dislike of light, excess tears, and corneal burns.

Treatment and Antidotes: One suffering from toxic effects of this material should immediately be removed to fresh air and should copiously wash skin or eyes with water. If contact symptoms are severe, call a physician.

Storage and Handling: It is quite volatile and very flammable, and it should be stored in a cool place away from constant sources of ignition. Personnel exposed to high concentrations of

this material should wear air-line respirators or twin-cartridge chemical gas masks of a variety approved for this material. Good general ventilation should be the rule when it is being used. If it is found to cause irritation to the eyes in the concentration being used, chemical goggles should be worn.

Only electrical equipment of the explosion-proof type (Group D) should be in use where acetone is being used or stored. Vapor forms explosive mixtures with air at all temperatures down to 3°F.

Fires of acetone can be extinguished best by water-spray or by carbon dioxide, carbon tetrachloride, or dry chemical.

Also Called: Dimethyl ketone, ketone propane, and propanone.

Formula: CH_3COCH_3

Description: Colorless liquid; fragrant mint-like odor.

ALUMINUM CHLORIDE

Hazardous Properties: This material has been known to cause allergic symptoms of various types in humans.

Storage and Handling: Exposed personnel who are sensitive to it should wear protective clothing, if necessary, to avoid bodily contact.

Formula: $AlCl_3$

Description: Yellowish-white granular crystals.

AMMONIA, ANHYDROUS

Maximum Allowable Concentration in Air: 100 parts per million.

Explosive Limits: 16 to 25 per cent by volume in air.

Hazardous Properties: Fire and explosion hazards are present but are considered small. It is irritating to the eyes, skin, and mucous membranes of the nose. It acts principally on the upper respiratory tract, where it exerts an alkaline caustic action and it elicits immediate violent respiratory reflexes such as coughing and arrest of respiration. It affects the eyes immediately. Inhalation causes acute inflammation of the respiratory organs, cough edema of the lungs, chronic bronchial catarrh, secretion of saliva, and retention of urine. Concentrations of the order of 5,000 to 10,000 parts per million are deadly for exposures of a few minutes. Concentrations of 2,500 to 4,500 parts per million are dangerous for exposures of 30 to 60 minutes. The maximum concentration that can be tolerated for 60 minutes is 300 parts per million. The maximum concentration that can be tolerated for several hours without serious disturbances is 100 parts per million. The least detectable odor is about 53 parts per million, and the smallest concentration which will cause immediate irritation of the eyes is 698 parts per million. The least concentration which causes coughing is 1,720 parts per million. The gas is very dangerous to the eyes, as is the liquid. Symptoms of intoxication are irritation and swelling

of the eyelids, burning of the throat, coughing, pulmonary edema, irritation of the skin, especially if it is moist, labored breathing, and respiratory failure. Faulty refrigeration systems occasionally give rise to high concentrations of ammonia in industrial applications. Others liable to intoxication from this material are coke oven and textile workers, calcium carbide workers, dye makers, tannery workers, and those employed in the munitions, explosives, glue, lacquer, fertilizers, artificial ice, artificial silk, and many other industries.

Treatment and Antidotes: If liquid ammonia is spilled upon the clothing, all clothing should be removed immediately and the body thoroughly drenched with water. If the eyes are injured by ammonia, they should be washed immediately and abundantly with water; and this may be followed by the introduction of a saturated solution of boric acid. If pain is severe, use local anesthetic, such as 0.5 per cent solutions of pontocaine hydrochloride. Thereafter the application of olive oil or some similar oil is desirable. Continuous warm boric compresses to the eyes may be of value. The usual treatment of corneal ulcers should be instituted, and an ophthalmologist should be called at once. Respiratory and circulatory measures should be taken if the concentration of fumes has been severe and the respiration affected. Inhalations of from 5 to 7 per cent carbon dioxide in oxygen should be given. If pulmonary edema ensues, the use of oxygen by means of a tent or intranasal apparatus is advised.

Storage and handling: Cylinders should be stored away from heat and sunlight. They should never be dropped. Connections to these cylinders should be tight. Caution should be observed when opening containers, and a gas mask should be worn. Storage should be in fire-resistant structures away from chlorine, bromine, iodine, and mineral acids. Water is an effective fire-extinguishing agent.

Also Called: Liquid ammonia.

Formula: NH_3

Description: Colorless gas, extremely pungent odor, liquefied by compression.

BENZENE

Maximum Allowable Concentration in Air: 100 parts per million.

Explosive Limits: 1.5 to 8.0 per cent by volume in air.

Hazardous Properties: The results of inhalation of toxic quantities of the vapor are both acute and chronic, depending upon the concentration of the vapor and the length of the exposure. Acute poisoning results from the inhalation of vapors above 3,000 parts per million for even short periods of time, such as a matter of minutes. The effects are rapid. Symptoms are a cramping of the leg muscles, dizziness, excitement, breathlessness, and the sensation of pressure on the lower central part of the forehead. In advanced cases of acute poisoning, the patient becomes confused, hysterical, laughs, shouts, curses, sings, and becomes very obstinate. Chronic poisoning results from daily exposure to unsafe concentrations over prolonged periods, such as weeks or months. Its use can cause an irritation of the skin due to the defatting effect.

The liquid is highly volatile and flammable and introduces a potential fire hazard wherever it is stored, handled, or used. At ordinary temperatures a vapor is evolved which when mixed with air forms explosive mixtures within certain limits. This material is a dangerous fire and explosion hazard.

Treatment and Antidotes: If benzene is spilled upon the person, clothing

should be immediately removed so as to avoid skin contact. If it enters the eyes, they should be flushed thoroughly for at least 15 minutes with clean warm water. Medical attention must be secured at once. In case of unusual exposure to the vapor, for first aid the patient should be removed to fresh air and, if possible, collapse should be prevented by having him lie down without a pillow, where he should be kept quiet and warm but not hot. If necessary, the patient should be restrained to prevent too much motion.

Storage and Handling: This material is extremely flammable, and the vapor is very toxic. Keep it away from heat, sparks, and open flame by storing in a cool place. Containers should be kept sealed and plainly labeled. It should be handled only with adequate ventilation. Personnel should be cautioned to prevent prolonged or repeated contact with the skin, since it can be absorbed through the skin and cause the toxic symptoms noted above.

To fight fires of this material, foam, carbon dioxide, carbon tetrachloride, and dry chemical may be used to advantage. Avoid use of water.

Also Called: Benzol, phenyl hydride, and coal naphtha.

Formula: C_6H_6

Description: Clear colorless liquid.

CALCIUM CHLORIDE

Hazardous Properties: If this material comes in contact with the eyes, it will cause excessive tears and irritation of the eyes.

Treatment and Antidotes: Eyes so exposed should be washed with plenty of warm water, and the irritation will stop. If it is severe, consult a physician.

Storage and Handling: Personnel exposed to this material in the form of a fine dust should wear chemical safety goggles.

Formula: $CaCl_2$

Description: Cubic colorless, deliquescent crystals.

CALCIUM OXIDE

Hazardous Properties: Calcium oxide is very caustic and can cause skin rash. The fine dust is irritating to the eyes, mucous membranes, and upper respiratory tract. Its chief toxic action is due to the fact that it is a strong caustic, and it may be regarded primarily as an irritant. In addition, when water is added to quantities of it, a great deal of heat is evolved. This may, under certain conditions, cause burns or start fires. Calcium oxide is used as a component of many industrial processes. It is an example of an irritant dust that can cause lung damage by extension of the inflammation of the mucous membranes. It is a very common cause of dermatitis and particularly offensive to the eyes. In the form of lime, it can cause lesions of the surface of the eyelids, abundant tears, immediate opacities in a few minutes, corneal ulcers, and watery inflammation of the eye.

Treatment and Antidotes: This material should immediately be removed from skin contact with large quantities of water. If the eyes are involved, they should immediately be washed with plenty of warm water and a physician consulted. Large amounts on the body can cause serious burns. These should be attended to immediately.

Storage and Handling: Personnel who must be exposed to this material should primarily take care of their eyes by wearing chemical safety goggles. Respiratory protection is indicated. If the concentration of this dust is high

enough, protective clothing should be worn to avoid skin contact.

Also Called: Unslaked lime, quicklime, burnt lime, and calx.

Formula: CaO

Description: Cubic colorless crystals.

CARBON DIOXIDE

Maximum Allowable Concentration in Air: 5,000 parts per million.

Hazardous Properties: Gaseous carbon dioxide is the regulator of the breathing function in the body. An increase in the percentage of CO_2 breathed results in an increased rate of breathing. High concentrations, however, paralyze the respiratory center and cause asphyxiation and death. Concentrations in some atmospheres are sufficient to cause symptoms in man, or even unconsciousness and death. Carbon dioxide gas is a heavy vapor; therefore it can collect in manholes, mine floors, shipholds, wells, brewery vats, garbage dumps, etc. It does not tend to diffuse away readily. High concentrations in such places can remain for considerable lengths of time. Five thousand to 10,000 parts per million in normal air causes a slight and unnoticeable increase in the ventilation of the lungs. Twenty thousands parts per million will increase the lung ventilation by 50 per cent, whereas 30,000 parts per million will increase it about 100 per cent. Fifty thousand parts per million causes about 300 per cent increase in lung ventilation. Breathing then becomes laborious, and 100,000 parts per million can be endured only for a few minutes. One hundred twenty thousand to 150,000 parts per million causes quick loss of consciousness. Death may take place after exposure of several hours to 250,000 parts per million. Liquid carbon dioxide can exist only at low temperatures or at normal temperatures and high pressures; therefore CO_2 is extremely

dangerous when confined. Containers of it should not be dropped. Solid carbon dioxide is extremely cold; indeed it can cause burns when in contact with any part of the body. It is used as a refrigerant and is sometimes called "Dry Ice."

Intoxication from carbon dioxide causes excitement, headache, vertigo, dyspnea, drowsiness, weakness, dizziness, and muscular weakness. Following the initial excitement, high concentrations may result in coma or even death. It can cause visual disturbances in high concentrations.

Treatment and Antidotes: If a person is overcome by high concentration of carbon dioxide vapor, he should immediately be removed to fresh air. Carbon dioxide causes only temporary disability due to exposure, and the symptoms are always of short duration. If breathing has stopped, institute artificial respiration and, if necessary, give oxygen. Call a physician.

Storage and Handling: When it is stored as liquid or as gas under pressure, it should be kept in a cool place. The containers should never be dropped. Solid carbon dioxide can be readily stored; however, when personnel must enter such areas, they should be protected by the use of positive pressure or self-contained air-line respirators. Personnel handling solid carbon dioxide should have complete body protection from the freezing cold. If there is any danger of carbon dioxide collecting in an area where personnel must work, this area should be tested before they are allowed to enter.

Because of the high pressure under which it exists, liquid carbon dioxide can cause container fragments to fly as if from an explosion if the containers are dropped and broken. Do not store where they may be exposed to high temperatures.

Also Called: Carbonic acid, carbonic anhydride, and "dry ice."

Formula: CO_2

Description: Colorless, odorless gas; colorless liquid, white snow-like solid.

CARBON TETRACHLORIDE

Maximum Allowable Concentration in Air: 100 parts per million. It would, however, be much safer to use 50 parts per million or, as many large industrial plants are doing, aim at 25 parts per million.

Hazardous Properties: Carbon tetrachloride is potentially toxic by inhalation, prolonged or repeated contact of the liquid with the skin or the mucous membranes, or by ingestion. When used properly, however, it is relatively safe, though it can have an irritating effect. It produces tears, burning, and other symptoms of inflammation of the eyes; and if taken internally, it causes gastrointestinal inflammation, nausea, vomiting, diarrhea, and bloody stools. After a short time general symptoms of toxicity appear as a result of damage to the liver, kidneys, heart, adrenal glands, and nervous system. Ingestion of more than 3 to 4 cubic centimeters may cause death.

Carbon tetrachloride is widely used as a solvent to clean machinery and to remove greases and oil from all sorts of apparatus. Clothing saturated with it should be removed immediately and the body subjected to a warm shower with plenty of soap. After prolonged or repeated contact with the skin, it can cause a dermatitis and possibly a hypersensitivity to itself. In such a case, the skin becomes rough, red, and dry due to the removal of the skin oils. Skin in this condition cracks easily and then becomes susceptible to infection. Carbon tetrachloride is dangerous to the eyes

as vapor or liquid. It is particularly dangerous to alcoholics, exceedingly fleshy individuals, and undernourished persons or those with pulmonary, liver, or kidney diseases, stomach ulcers, or hypertension. It is also dangerous to individuals having a sensitivity to carbon tetrachloride or even to many common hydrocarbons.

Regardless of the mode of entry into the body, the first symptoms to look for, if overexposure to this material is suspected, are headache, mental confusion, depression, fatigue, loss of appetite, nausea, vomiting, loss of co-ordination and sense of balance, as well as visual disturbances. Such poisoning is frequently insidious, and the onset of the toxic symptoms noted may be delayed for periods of from 2 to 8 days or longer.

Treatment and Antidotes: Personnel suspected of having been overexposed to this material should be removed to fresh air immediately and a physician summoned. If there is any spillage on the person, his contaminated clothing should be removed at once. If breathing has stopped, artificial respiration should be started. In any event, the patient should be kept quiet and comfortably warm but not hot. If the material has been swallowed, the patient should be made to vomit by drinking a full glass of mustard water, lukewarm water with salt, or soapy water. NOTE: Alcohol, fats, oils, or epinephrine should not be administered. If some carbon tetrachloride has been spilled into the eyes, they should be irrigated with large amounts of warm water for 15 minutes.

Storage and Handling: Store in a cool ventilated area and label properly so that personnel will use caution in handling. Many persons have inadvertently poisoned themselves with this material because they did not know its identity or toxic properties. Do not store or use near sources of open flame or high temperature which causes formation of toxic decomposition products.

When carbon tetrachloride is being used in any quantity, avoid contaminating the atmosphere. If possible, good general ventilation should be provided. Uncovered pails or other containers should never be used. Ventilation should be provided, particularly at floor level as well as in the usual locations. Pits, depressions, totally enclosed basements, etc., should be avoided because the vapors are heavy and will sink and stay in such places. Prolonged or repeated inhalation of the vapor should be avoided as well as prolonged or repeated skin contact. It should never be taken internally.

When carbon tetrachloride is in use, frequent checks of the atmospheric concentration should be taken. Personnel who must be exposed to it should take adequate safety precautions. Gas-type, or at least chemical-type, safety goggles are recommended. If a high concentration is suspected, a positive-pressure, or a self-contained source of air, type gas mask should be used. The air-line type respirator is also recommended. Anyone who must enter tanks or other enclosed areas where the material has been stored should do so only if he has a life line and harness connection and an attendant

constantly in charge to pull him to safety should he begin to lose consciousness.

Another effect of this material in the air is to reduce the oxygen content; therefore care must be taken to avoid such oxygen deficiency. Personnel who must use rags wet with carbon tetrachloride should wear gloves to prevent dermatitis and other skin effects.

Also Called: Tetrachloromethane and perchloromethane.

Formula: CCl_4

Description: Colorless liquid, peculiar odor.

CHLORINE

Maximum Allowable Concentration in Air: 0.35 to 2 parts per million.

Hazardous Properties: Liquid chlorine is very dangerous to the eyes, as is chlorine gas. It can cause excess tears and degrees of irritation to the eyes. High concentrations can cause pneumonitis and excess accumulation of fluid in the lungs. In concentrations of 1,000 parts per million, it is invariably and rapidly fatal; therefore lung irritation is one of the most serious effects of chlorine. The least concentration with detectable odor is 3.5 parts per million. The least concentration necessary to cause throat irritation is 15 parts per million and to cause coughing is 30 parts per million; therefore the strong odor of chlorine acts as a warning mechanism. There are fewer fatalities due to chlorine poisoning in industry, where it is widely used, than to nitrogen dioxide, which is more subtle. Further symptoms due to the inhalation of chlorine are respiratory reflexes, causing coughing, smarting of the eyes, and general feeling of discomfort in the chest, a hoarse cough, nausea, and vomiting. The face may become red and bloated because of congestion in the veins or gray due to failing circulation.

Treatment and Antidotes: A patient who has been severely gassed should be removed from the toxic area promptly. All constricting clothing about the neck should be loosened. He should be kept quiet in a reclining position and should be wrapped with warm blankets while hot water bottles are applied if needed.

Oxygen should be administered in all cases. It is considered best not to wait for cyanosis to set in, since the administration of oxygen will often prevent cyanosis and relieve the pain of deep respiratory effort. Olive oil for the eyes may be effective. Codeine phosphate or sulfate for cough, or spraying of the nose and throat with a soothing solution at times, is useful; but for this latter use, products containing oil should be avoided because of the danger of developing an oil pneumonia. Furthermore, such patients should be reassured regarding any permanent effects to the lungs; thus a neurosis may be avoided and malingering prevented by the emphatic statement of existing statistics and knowledge regarding these cases.

Storage and Handling: Containers of this material under pressure should be stored carefully in a cool place away from acute fire hazards and should be plainly labeled. These containers should never be dropped, because they may break and allow large volumes of chlorine to escape. This gas is heavy and will cling to the ground. It will cause a great deal of damage to personnel near its point of release. Personnel who must be exposed to chlorine must have protective equipment. Protection for the respiratory tract is also necessary, and an approved respirator is recommended. If the concentration is quite high, protective clothing should be worn to avoid contact with the skin. Areas where this material is stored should be plainly marked, and personnel should be cautioned to avoid careless handling.

Formula: Cl_2

Description: Greenish-yellow gas, liquid, or rhombic crystals.

FURFURAL

Explosive Limits: 2.1 per cent by volume in air is lower limit of flammability.

Hazardous Properties: The liquid is dangerous to the eyes and is also a moderate fire hazard. The vapor is irritant to mucous membranes and is a central nervous system poison; however its low volatility reduces its toxic effect. In industry there is a tendency to minimize the danger of acute effects resulting from exposure to it. This is true, particularly, because of its low volatility. Nothing much is known concerning the possibility of chronic effects, such as nervous disturbances, following prolonged or severe exposure to this material.

Storage and Handling: It should be stored in a cool well-ventilated place away from areas of acute fire hazard. Personnel who must be exposed to this material should wear protection for their eyes. To fight fires of this material, water (fog or spray), foam, carbon dioxide, carbon tetrachloride, and dry chemical may be used.

Also Called: 2-furancarbonal, 2-furaldehyde, fural, and furale.

Formula: C_4H_3OCHO

Description: Colorless yellow liquid; almond odor.

HYDROCHLORIC ACID

Maximum Allowable Concentration in Air: 5 to 10 parts per million.

Hazardous Properties: This material is very corrosive and poisonous. It is very dangerous to the eyes. It can cause conjunctivitis, abnormal accumulation of fluids in the eyes, and inflammation of the edge of the eyelids. It has an irritating effect on the nose and throat, although the degree of irritation is generally transient, except in cases of prolonged or repeated exposures. The lower concentrations of this material are apparently harmless, although it is possible that they promote tooth decay. It has also been found that concentrations up to 16 parts per million to 23 parts per million do exist in industry and that workers can develop apparent immunity to these concentrations.

The highly acid material neutralizes the alkali of the tissues and can cause death as a result of abnormal accumulation of fluids or spasm of the larynx and inflammation of the upper respiratory system. Concentrations of the order of 1,500 to 2,000 parts per million are lethal for human beings over an exposure of only a few minutes. The maximum concentration which can be tolerated for several hours is 10 to 50 parts per million. Repeated oral administration of dilute hydrogen chloride to dogs has produced acute and chronic gastritis and has caused ulcers of the opening from the stomach into the intestine. Toxic doses, on the other hand, lower the alkaline reserve of the blood.

Mists of hydrochloric acid caused by pickling of heated metal can cause nosebleeds, bleeding of the gums, ulceration of the nasal and oral mucosa, and render the skin of the face so tender that shaving can become painful. Exposure of the face to gaseous hydrochloric acid escaping from leaks in apparatus has caused severe burns. Contact with concentrated solutions of hydrogen chloride in cleaning metal can give rise to small burns and ulceration of the hands. When this material is ingested, its most pronounced effect is at the point of contact with the mouth or throat. From the industrial standpoint, the greatest hazard of this material is its irritant effect on the eyes, nose, and upper respiratory tract and the fact that in contact with metals it can evolve hydrogen gas, which is a fire and explosion hazard.

Treatment and Antidotes: In case of contact, immediately flush skin or eyes with plenty of water and remove all contaminated clothing. If this material has been swallowed, drink a teaspoonful or more of magnesia, chalk whiting, or small pieces of soap softened in water, milk, or egg white. In the event of severe exposure to the vapors of this material, remove patient immediately to fresh air. If possible, give oxygen or, if necessary, artificial respiration. Call a physician at once. If this material comes in contact with the eyes, they should be flushed for at least 15 minutes with warm water. A physician should be consulted immediately.

Storage and Handling: Wherever this material is used, ventilation should

be provided. If the ventilation is effective enough, personal protective equipment will not be necessary. When personnel are exposed to and expected to handle large quantities of hydrochloric acid, they should wear personal protective equipment. Recommended are chemical safety goggles for the eyes, protective clothing to avoid skin contact, and a respirator to avoid inhaling the fumes.

This material should be stored in a cool, ventilated place away from areas of acute fire hazard, away from oxidizing agents such as nitric acid and chlorates, and out of the direct rays of the sun. Containers should be kept closed and plainly labeled. Fires involving hydrochloric acid can be fought with water. The acid can be stored in glass or rubber-lined containers. Spills may be flushed with water or neutralized by such alkalies as soda ash or slaked lime.

Also Called: Muriatic acid, chlorohydric acid, and hydrogen chloride.

Formula: HCl

Description: Colorless gas or colorless fuming liquid; strongly corrosive. Soluble in water.

HYDROFLUORIC ACID

Maximum Allowable Concentration in Air: 3 parts per million.

Hazardous Properties: This material is a corrosive liquid and poisonous. Small amounts in the eye can cause intense irritation of the eyelids, tears, and slow ulceration of the eye. Large amounts in the eye cause immediate blindness. The vapor or liquid material is very dangerous when in contact with the eyes, skin, or any part of the body, or if ingested orally. On the skin it can cause medically serious and very painful burns. It has a sharp, penetrating odor which ordinarily prevents the inhalation of toxic quantities. Fifty parts per million of this material or more is considered to be fatal in an exposure of from 30 to 60 minutes. Burns caused by 20 per cent or weaker solutions do not become noticeable for some hours. Burns by solutions of over 20 to about 60 per cent are detected almost at once and from 61 to 100 per cent are felt as soon as they occur. The material is extremely irritating to the respiratory tract, where it causes inflammation and congestion of the lungs. If swallowed, it causes severe irritation to the esophagus and stomach. It is not considered a source of chronic poisoning. In contact with metals, this material is corrosive and evolves hydrogen gas, which is an explosive hazard.

Treatment and Antidotes: When this material comes in contact with the skin or any part of the body, the use of a drenching shower immediately is important.

Personnel should be taught to use safety equipment when working with hydrofluoric acid. If a person is overcome from exposure, remove him at once from the contaminated area or, if acid has come in contact with his body, give him a drenching shower as quickly as possible. Remove contaminated clothing and get medical assistance. Compresses of ice, alcohol, or magnesium sulfate should be applied to the part affected, or, if possible, it should be dipped into such a solution for at least 30 minutes.

Storage and Handling: Wherever this material is used, good safety equipment should be at hand. Bubbler fountains for the eyes and drenching showers to wash the material away from the person as quickly as possible are recommended. Clothing which has been exposed to this material should be washed before reuse, and clothing which is used daily by workers with this material should be washed each day before reissue. Personnel who must work with this material should wear long gauntlet type gloves made of a resistant material, such as neoprene or rubber. They should wear rubber shoes or boots and chemical safety goggles with transparent plastic face shields to protect the eyes, face, and surrounding area from splashes and should use air-line respirators to avoid inhalation.

Hydrofluoric acid should be stored in lead carboys or in containers made of ceresin wax or gutta percha in a cool place away from areas of acute fire hazard and out of the direct rays of the sun. It should be stored in a ventilated and

isolated area. Containers of this material should be kept closed and plainly labeled, and personnel should be cautioned against careless handling and consequent injury to containers.

Also Called: Hydrogen fluoride and fluorhydric acid.

Formula: HF

Description: Clear, colorless, fuming corrosive liquid or gas. Soluble in water.

HYDROGEN SULFIDE

Maximum Allowable Concentration in Air: 20 parts per million.

Explosive Limits: 4.3 to 46 per cent by volume in air.

Hazardous Properties: This material is dangerously poisonous, highly flammable, and corrosive to eye and respiratory tissues. It attacks many metals, forming sulfides. It can cause subacute flashes of light, contracting of the pupil of the eyes, sharp pains, morbid dislike of light, and inflammation and ulceration of the cornea, as well as acute paralysis of the pupil of the eye. It is a dangerous fire hazard; and in the presence of air or oxygen, it can easily form explosive mixtures. Furthermore, it is dangerously reactive with strong or fuming nitric acid and powerful oxidizing agents.

It is considered an irritant to the eyes and respiratory tract, and increasing concentrations become more and more harmful until high concentrations can cause almost immediate death. When this material burns in air or oxygen, it forms the very toxic sulfur dioxide. Hydrogen sulfide has a very characteristic smell, and even low concentrations are easily recognized thereby; but this is only true when it is first encountered. It is not reliable as a warning signal because higher concentrations, which have a sweetish odor, also have a paralyzing effect on the nerves of smell and, when inhaled, may cause death. In addition, low concentrations, upon prolonged or repeated exposures, will tire the sense of smell to the point

where exposed personnel may fail to detect its presence.

Treatment and Antidotes: For first aid to personnel who may have been exposed to this material, carry patient to fresh air. If he has stopped breathing, apply artificial respiration at once. Keep him warm and call a physician.

Storage and Handling: Store in a cool ventilated place away from areas of acute fire hazard, oxidizing agents, or open flames so that static electricity will not accumulate on the container. It is important that all electrical equipment in the immediate vicinity should be so constructed that there will be no sparks from it when in operation. In addition, it is important that none of this equipment should heat up to a point where it may cause hydrogen sulfide to ignite (500°F.).

Personnel who must be exposed should have protection for the eyes, such as chemical safety goggles of the unperforated type. Respiratory equipment should be available also, that is, self-contained air supply or air-line respirators equipped with full face pieces. Where there is no deficiency of oxygen, a special type of gas mask may be worn where the concentration is not above 20,000 parts per million. There is an industrially approved canister type of gas mask which may be used for short exposures to this material. Personnel should be cautioned to avoid repeated or prolonged inhalation of anything which smells like hydrogen sulfide. If a hydrogen sulfide odor is noticeable, all flames and hot surfaces in that area

should be well ventilated. Containers of this material should be kept closed and plainly labeled. It is usually shipped in steel cylinders.

Also Called: Sulfuretted hydrogen.

Formula: H_2S

Description: Colorless, flammable gas; offensive odor, sweetish taste. Soluble in water.

A

MERCURY

Maximum Allowable Concentration in Air: 0.1 mg/cu. meter.

Hazardous Properties: Acute mercury poisoning results in damage to the kidneys, whereas chronic mercury poisoning damages the nervous system. This damage is very serious and may be permanently disabling. Typical symptoms of chronic mercury poisoning or its effects on the nervous system are: tremor of the extremities, mental disturbances, and soreness of the gums. Similar symptoms are often found in acute and subacute poisoning. This disease is often termed "hatters' shakes," which is a throwback to the time when mercury compounds were widely used in making felt hats. Workers in this industry often developed this chronic mercurialism, characterized by tremors of the extremities. Acute mercurialism is often fatal.

Some of the ways in which mercury can become a hazard are as follows: It is one of the very few metals which is liquid at room temperature, and this unique property finds numerous industrial applications. Incidentally, at room temperature mercury vapor, when at equilibrium with the supply of mercury, is nearly 200 times the allowable concentration indicated above. It must be remembered that it is not necessary to heat mercury to drive off sufficient vapor to contaminate the surrounding atmosphere. Mercury is often made a part of instruments and other apparatus, and in this work much of it can be spilled on work benches and floors. It can get into corners and crevices and remain

there, giving off dangerous vapor.

Furthermore, where mercury is used, as in mercury boilers and stills, hazards may occur from leaks in such systems. This is very dangerous, and frequent checks of the possible contamination of the air in such a neighborhood should be made. It should be remembered that mercury can be absorbed either through the respiratory tract following the inhalation of the vapor or finely divided dust, or through the skin, as well as through the alimentary tract. It can most easily be absorbed through the skin when it is applied in a finely divided condition or when the skin is exposed to volatile compounds or organic compounds of mercury.

Treatment and Antidotes: When personnel who may have been exposed to mercury show any of the characteristic symptoms of chronic mercury poisoning, they should immediately get medical advice. The most prominent symptoms of chronic mercury poisoning are the psychic disturbance known as erythism (a peculiar form of timidity), tremor (most characteristic symptom but seldom the first to appear), pallor, and stomatitis, which is revealed by salivation and tenderness of the gums. If acute mercury poisoning is suspected, get medical advice at once. The poison should be removed from the stomach as quickly as possible by means of a gastric lavage containing one teaspoonful of sodium bicarbonate in water. If it is an attempted suicide, it may be necessary to restrain the patient. The patient should drink or be given a quart of milk containing two raw eggs and be made to evacuate it. Remove the cream from top of the bottle before using the milk, because fats

dissolve mercury salts more quickly and aid in the absorption of it into the body. Those in attendance on the patient should be advised to administer milk and eggs; and after the arrival of a physician, the patient can be removed to a hospital. The stomach should again be washed out with a pint of water containing 3 tablespoons of charcoal with 20 grams of magnesium sulfate. A good suggestion is intravenous injections of sodium bicarbonate, which increases the blood chlorides and in turn diminishes the nitrogen retention, thereby improving the general condition. After the stomach has been thoroughly washed out, morphine may be given and then orange juice daily. Milk and eggs should be given as soon as the vomiting has been controlled. Colonic flushing with 8 grains of calcium sulfide should be continued until there is no further test for mercury.

Storage and Handling: Mercury and its compounds should be stored in a cool, well-ventilated place away from areas of acute fire hazard. Containers should be kept closed and plainly labeled. Personnel should be cautioned repeatedly concerning the careless handling of these materials. Wherever mercury is used, there should be good ventilation, both of a general nature and at floor level. This is necessary because mercury vapors are heavy and tend to sink to the floor. Frequent medical checkups are the rule, and periodic urine analysis for mercury should be made on those who work with mercury. In addition, any areas in which mercury is used should be frequently checked for atmospheric contamination.

It should be plainly understood by personnel who work with mercury that there should be no storage or eating of lunches in the immediate area, and no smoking. It is very important to keep clean. Frequent washing of the hands and face and a shower after work are important requisites. Personnel should continually change clothing upon starting work and should then, after taking a shower, change into fresh clothes.

It is not considered good practice to work with or use mercury on a floor which is at all absorbent. The floors of rooms in which mercury is used should be made of smooth material which can be wet down and kept scrupulously clean. Mercury which gets into cracks and crevices will remain there and give off toxic vapor for a long time. When mercury is wet at room temperature, it will not give off vapor. This is a good thing to keep in mind if an area has been contaminated with mercury on the floor and there has not yet been time to clean it up. Another way of reducing the mercury hazard is to sprinkle calcium sulfide liberally onto the area where mercury has fallen so that it can react and form the innocuous mercury sulfide.

Mercury or mercury salts and compounds and mixtures containing mercury should never be heated in the open. In the laboratory they should be heated under a fume-hood. In a factory or plant, if such materials must be heated, this should be done where there is a good natural draft or exhaust ventilation.

All volatile organic mercury compounds should be stored in an isolated

area which is also ventilated. It should never be stored in buildings where office personnel or others have to work all day. Containers of mercury and mercury salts should be plainly labeled. Mercury vapor does not give any warning of its presence. It has no odor, although some individuals may feel a metallic taste in the mouth when it is present. This is a very unreliable method for detecting it. A better one is an instrument such as the General Electric mercury vapor detector which can detect down to 1/100 of the presently accepted toxic limit.

Caution: Mercury in the liquid state can be accidentally taken home in pockets, cuffs of trousers, and other crevices in the clothing. Once deposited on the rugs and floors at home, it will be a continual source of possible chronic mercurialism unless discovered and removed. It is even important to change shoes when leaving an area which is contaminated with mercury. It should be made a rule that whenever a man who is working with mercury has to leave the room, he should wash his hands and change his clothing.

Any materials which have been treated with mercury or contain mercury in any form should be so labeled very plainly so that special precautions can be taken in those places. All soluble compounds of mercury are poisonous. Other combinations of mercury are toxic because when they are heated they will give off the highly toxic mercury vapor. All volatile organic compounds of mercury are very poisonous because the high volatility means that greater concentrations of mercury can be inhaled into the body or

can penetrate the skin. Personnel who must be exposed for even brief periods of time to high or unknown concentrations of mercury vapor should wear protective equipment. Recommended are protective clothing to avoid skin contact and a respirator to avoid getting it into the lungs.

Formula: Hg

Description: Silvery liquid, metallic element.

A

METHYL ALCOHOL

Maximum Allowable Concentration in Air: 200 parts per million.

Explosive Limits: 6.0 to 36.5 per cent by volume in air.

Hazardous Properties: A flammable liquid and a dangerous fire hazard. Though not dangerously reactive, it is toxic. Ingestion or absorption of methanol causes central nervous system damage, particularly of the optic nerve. It causes degenerative damage to the kidneys, liver, heart, and other organs, which go on regardless of its portal of entry into the body. Symptoms of intoxication by methanol may be delayed from 9 to 36 hours, during which time an individual may continue to carry on his usual work, when suddenly an onset of weakness, headache, nausea, vomiting, abdominal pain, dimness of vision, and even a state of unconsciousness may develop. After a long continued coma, death, from failure of respiration, may occur. Blindness has occurred in a large percentage of cases of severe poisoning from this material. It affects both eyes, may set in within a few hours, or may be delayed for several days due to injury of the optic nerve and retina. In many cases it is permanent. Workers who use this material may complain of local irritation of the eyes, skin, and respiratory tract even when exposed to low concentrations.

Inhalation of excessive amounts of this material will result in acute poisoning within a short time. One thousand

parts per million can cause slight symptoms of poisoning. Five thousand parts per million can cause stupor and sleepiness, whereas 50,000 parts per million will cause profound and probably fatal state of stupor in from one to two hours. The symptoms are irritation, headache, sensation of heat, fatigue, and drowsiness. If the worker is not immediately removed from high concentrations, serious poisoning can occur.

Repeated subacute exposures, too, can cause acute poisoning, because methanol may accumulate in the system. Exposure to methanol can cause skin rash, particularly after prolonged or repeated contact with the skin. It causes the skin to become rough, red, and dry due to the removal of the natural skin oils. The skin then cracks easily and is readily susceptible to infection.

When methanol splashes into the eyes, it causes tears and burning due to its irritant effect. Dilation of pupils which no longer react to light, follicular hypertrophy, edema, and degeneration of the ganglion cells and optic neuritis can be caused by this material.

Treatment and Antidotes: For first aid to a patient who has been exposed to this material, speed is of great importance. Immediately remove him to fresh air, remove contaminated clothing, and wash the body with soap and warm water. If this material has been swallowed, the stomach must be emptied as quickly as possible. If breathing has stopped, start artificial respiration. Keep the patient quiet, comfortably warm, but not hot. Call a physician. If the eyes are

involved, they should be washed immediately and abundantly with water for a minimum of 15 minutes. For any of the chronic symptoms of exposure to this material, get medical advice.

Storage and Handling: This material should be stored in a cool place away from areas of acute fire hazard and open flame. Containers should be kept closed and plainly labeled. It should be stored in a ventilated area so that small leaks cannot build up enough concentration of vapor to cause explosions or the intoxication of individuals who enter such an area. Storage tanks of this material should be electrically grounded to prevent the accumulation of dangerous amounts of static electricity. Drums should be stored out of the direct rays of the sun and with the plugs upward. To put out fires of this material, dry chemical, carbon dioxide, or large quantities of water may be used effectively.

Personnel who are exposed to it should wear chemical safety goggles and a full face shield for protection of the face and eyes; and if the concentration of the vapor is high or unknown, a respirator should be worn to avoid excessive inhalation. Furthermore, protective clothing is advisable to avoid skin contact. Areas where this material is in use should be provided with deluge type of showers so that this material can quickly be rinsed from the body if spillage occurs. Bubbler type of eye washing equipment should also be installed, available for treatment of cases where it is splashed into the eyes.

A

Blankets should be provided in such areas in which to wrap patients to keep them warm in event of intoxication.

Also Called: Methanol.

Formula: CH_3OH

OLEIC ACID

Hazardous Properties: A combustible liquid and a moderate fire hazard. It is susceptible to spontaneous heating.

Storage and Handling: Store in a cool place, away from areas of acute fire hazard, open flame, and powerful oxidizing agents. To fight fires of this material, use water (fog or spray), foam, carbon dioxide, or dry chemicals.

Also Called: Red oil.

Formula: $C_{17}H_{33}COOH$

PHENOL

Hazardous Properties: Phenol is a hazard to health. Its vapors, which are produced either from the solid material or from solutions, are flammable, and it can be quite dangerous when involved in a fire. The liquid or solutions are very corrosive to the skin, and it is readily absorbed through the skin and mucous membranes, either when broken or intact. It can be absorbed into the body through the gastrointestinal tract or through the lungs. After absorption, the toxic effects of phenol are exerted primarily upon the central nervous system; but following sufficient exposure, there can also be an abnormal accumulation of fluids in the lungs, kidneys, liver, pancreas, and spleen. Exposure to toxic amounts usually results in death within a few hours.

It can have systemic effects also. The symptoms of absorption which may develop rapidly are profound muscular weakness, headache, dizziness, dimness of vision, ringing of the ears, irregular and rapid respiration, weak pulse, and difficult breathing, followed occasionally by mental confusion, muscular twitching, loss of consciousness, and, in rare cases, death from respiratory failure. If phenol enters the stomach there is also nausea, with or without vomiting, and severe abdominal pain.

The corrosive action of phenol occurs when it comes in contact with any body tissue, and it can cause serious burns or death unless it is promptly and thoroughly removed. Individual susceptibility to

intoxication by phenol varies widely with the individuals involved. Contact with it causes no immediate sensation, but after a few moments there is pricking and intense burning, followed by its local-anesthetic effect. The affected tissues show white discoloration, wrinkling, and softening initially. Then they become red, then brown or black. The final symptoms are those of gangrene.

Absorption of phenol following extensive burns may produce the general symptoms of toxicity given above. Its local effect is a skin rash which can come from prolonged or repeated contact with low concentrations of phenol in any form. Furthermore, even the application of phenol to skin lesions for medical purposes, as has been practiced in some cases, may result in extensive gangrene of the area, occasionally necessitating amputation of an extremity. Upon contact with the eyes, it causes burns and destruction of the tissues. Upon inhalation it causes enlargement of the pupils. Both the liquid and solid forms of this material are particularly dangerous to the eyes.

Treatment and Antidotes: Immediately call for medical assistance. If breathing has stopped, institute artificial respiration. Act quickly! If this material has spilled upon the skin or mucous membranes, remove all contaminated clothing and wash the contaminated areas with abundant quantities of warm water and soap. Continue this washing until all odor of phenol has disappeared. If available, use freely either alcohol or glycerine to help remove the material from skin contact.

Keep the patient warm but not hot. Do not apply salves or ointments for at least 24 hours following injury, since this sort of material may aid absorption into the body. If the eyes are involved, they should be washed promptly with abundant quantities of water for at least 15 minutes. A bubbler-type drinking fountain or eye-wash fountain may be used for the initial emergency washing. Use water at room temperature if at all possible to minimize the pain and discomfort of the exposure.

If phenol has been taken internally, since as little as 9 cubic centimeters can cause death, it is important to get medical aid. It is a violent poison, and there is no satisfactory antidote. It is of critical importance that large quantities of liquid, such as salt water, weak sodium bicarbonate solution, milk, or gruel be administered, followed by a soothing substance such as raw egg white or cornstarch paste. These should be swallowed by the patient to cause vomiting.

Storage and Handling: Personnel exposed to this material should use adequate safety equipment. Recommended are gas-tight safety goggles and positive pressure hose masks or air-line respirators to avoid excessive inhalation. Personnel who must enter areas where the concentration is either high or unknown should take particular care to avoid intoxication from this material. Recommended for such exposure are a life-harness and air-line respirator, gas-tight chemical safety goggles, and protective clothing to avoid skin contact. Under certain conditions

industrial gas masks may be used. The U. S. Bureau of Mines can recommend rules necessary to follow under such circumstances.

The protective clothing should consist of rubber gloves, rubber aprons, boots or shoes, and possibly other impermeable articles of clothing. Water (fog or spray) is an effective fire-fighting agent in fires involving phenol. Effective also are carbon dioxide, dry chemical, and carbon tetrachloride-base extinguishers.

In case phenol is spilled, only properly protected personnel should remain in the area. Then the spilled material should be immediately attended to. Do not leave spills unattended. Flush immediately with large quantities of water until all traces of the odor have disappeared. The area should be freely ventilated to remove vapors. Then a 5 per cent solution of caustic soda may be used as a neutralizing agent; however this must be used carefully because it too can be corrosive and cause burns to the skin and eyes.

Containers of phenol should be stored in a cool, but not too cold, place. It should be a ventilated area away from acute fire hazards and powerful oxidizing agents. Containers should be kept closed and plainly labeled. Do not store in the direct light of the sun. Phenol should never be stored with or near food.

Also Called: Carbolic acid, phenic acid, and phenylic acid.

Formula: C_6H_5OH

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Description: White crystalline mass which turns pink or red if not perfectly pure. Very soluble in ether, soluble in alcohol and in water. Burning taste. Distinctive odor.

PROPANE

Explosive Limits: 2.4 to 9.5 per cent by volume in air.

Hazardous Properties: A flammable gas and a dangerous fire hazard. In high enough concentrations it can cause the pupils to become narrowed and inactive. This material is not considered a poisonous gas. It does have an anesthetic action, but it does not appear to produce injury even in concentrations as high as 50,000 parts per million for exposures of up to 2 hours. The greatest risk from this material is its fire and explosion hazard.

Treatment and Antidotes: Personnel overcome by this material should immediately be removed to fresh air. If breathing has stopped, institute artificial respiration at once. The symptoms should disappear rapidly.

Storage and Handling: Store in a cool, isolated, ventilated area away from acute fire hazards and open flame. It should not be stored near powerful oxidizing agents. Containers should be kept closed and plainly labeled.

Also Called: Dimethylmethane.

Formula: $CH_3CH_2CH_3$

Description: Colorless gas.

Hazardous Properties: This material, both solid and in solution, has a markedly corrosive action upon all body tissues of the body. The symptoms of irritation from this material are frequently evident immediately. Its corrosive action on tissue causes burns and frequently deep ulceration, with ultimate scarring. Prolonged contact with dilute solutions has a destructive effect upon tissue. Mists, vapors, and dusts of this compound cause many small burns, and contact with the eyes, either in the solid or solution form, rapidly causes severe damage to the delicate tissue. Ingestion either in the solid or solution form causes very serious damage to the mucous membranes or other tissues with which contact is made. It can cause perforation and scarring. Inhalation of the dust or concentrated mist can cause damage to the upper respiratory tract and to lung tissue, depending upon the severity of the exposure; thus effects of inhalation may vary from mild irritation of the mucous membranes to a severe pneumonitis. It can cause an irritant dermatitis.

Treatment and Antidotes: Speed in removing this caustic from contact with the skin of one who has come in contact with it is important to avoid injury. Persons so injured should be referred to a physician. Remove all contaminated clothing at once and, if possible, give patient a shower under deluge type of shower using plenty of water. If the eyes are involved, they should be irrigated at once with plenty of warm water for 15 minutes. Call a physician.

usually shipped in iron drums.

Also Called: Caustic soda, sodium hydrate, lye, and white caustic.

Formula: NaOH

Description: White pieces, lumps, or sticks.

STEARIC ACID

Hazardous Properties: A flammable material and moderate fire hazard. It is susceptible to spontaneous heating.

Storage and Handling: Store it in a cool, well-ventilated area, away from open flame, areas of acute fire hazard, and powerful oxidizing agents. To fight fires of this material, water (fog or spray), carbon dioxide, carbon tetrachloride, or foam can be used to advantage.

Formula: $CH_3(CH_2)_{16}COOH$

SULFUR DIOXIDE

A

Maximum Allowable Concentration in Air: 10 parts per million.

Hazardous Properties: This material is dangerous to the eyes, as it causes irritation and inflammation of the eye. It has a suffocating odor and is a corrosive and poisonous material. In moist air or fogs, this gas combines with water to form sulfurous acid but is only very slowly oxidized to sulfuric acid. Concentrations of 6 to 12 parts per million cause immediate irritation to the nose and throat, while 0.3 to 1 part per million can be detected by the average individual possibly by taste rather than by the sense of smell. Three parts per million has an easily noticeable odor, and 20 parts per million is the least amount which is irritating to the eyes. Ten thousand parts per million is irritant to moist areas of the skin within a few minutes of exposure.

This material chiefly affects the upper respiratory tract and the bronchi. It may cause swelling of the lungs or glottis and can produce respiratory paralysis. It may cause the extension of the duration of colds, but no significant change in their incidence will be noticed. Concentrations of less than 1 part per million are believed to be injurious to plant foliage.

This material is so irritating that it provides its own warning of toxic concentrations. Four hundred to 500 parts per million is immediately dangerous to life. Excessive exposure to high

enough concentrations of this material can be fatal. Its toxicity is comparable to hydrogen chloride; however less than fatal concentrations can be borne for fair periods of time with no apparent permanent damage.

Treatment and Antidotes: Personnel who have shown toxic symptoms when exposed to this material should immediately be removed to fresh air. If the eyes are involved, they should be irrigated with copious quantities of warm water. If the symptoms persist, call a physician.

Storage and Handling: Store in a cool, isolated area, away from acute fire hazard and in a detached building. Containers of this material should be kept closed, plainly labeled, and carefully stored to avoid mechanical injury. Personnel should be cautioned regarding its use. Personnel who must work with this material should use adequate protective equipment. If the concentrations are likely to be high or are known, the recommended protection is a respirator to avoid excessive inhalation, protective clothing to avoid skin contact, and chemical safety goggles for protection of the eyes. These should be of the gas-tight variety.

Also Called: Sulfurous acid anhydride.

Formula: SO_2

Description: Colorless gas or liquid.

SULFURIC ACID

Maximum Allowable Concentration in Air: 1 part per million for fumes or mist.

Hazardous Properties: This material is a very corrosive liquid. It is highly corrosive to most metals, dangerously reactive, and a strong oxidizing agent which will react with water and organic materials with the evolution of heat. Contact with the body results in rapid destruction of tissue, causing severe burns. This acid is not flammable; but in high concentrations it may give rise to ignition by contact with combustible materials. When it attacks metals, a highly flammable gas, hydrogen, is generated; hence the acid is considered a dangerous fire hazard.

No systemic effects due to continual ingestion of small amounts of this material have been noted. There are systemic effects secondary to tissue damage caused by contact with it; however repeated contact with dilute solutions can cause a skin rash, and repeated or prolonged inhalation of a mist of sulfuric acid can cause an inflammation of the upper respiratory tract leading to chronic bronchitis. Sensitivity to sulfuric acid or mists or vapors varies with individuals. Normally, 0.125 to 0.50 part per million may be mildly annoying, and 1.5 to 2.5 parts per million can be definitely unpleasant. Ten to 20 parts per million is unbearable. Workers exposed to low concentrated vapor or mists from hot acid or oleum can cause rapid loss of consciousness with serious

damage to lung tissue. In concentrated form it acts as a powerful caustic to the skin destroying the outer layer of skin and penetrating to some distance into the skin and subcutaneous tissues, in which it causes destruction of the tissues. This causes great pain; and if much of the skin is involved, it is accompanied by shock, collapse, and symptoms similar to those seen in severe burns. It owes its action upon living tissues to its neutralization of proteins, since most living tissue is neutral or slightly alkaline in reaction and cannot exist in an acid medium. The fumes or mists of this material cause an ineffective strangling cough and irritation of the mucous membranes of the eyes and upper respiratory tract. Severe exposure may cause a chemical pneumonitis. Erosion of the teeth due to exposure to strong acid fumes has been recognized in industry.

Treatment and Antidotes: Speed in removing this material from contact with the body is of primary importance. Start first aid at once. In all cases of contact in any form, delay can result in serious injuries. All persons injured should be referred to a physician; however immediately give prolonged applications of running water to wash the material off the person. Remove contaminated clothing. Subject patient to a deluge type of shower if this is available. Do not attempt to neutralize the acid in contact with the skin until all areas of contact have been thoroughly irrigated with running water. Then applications of mild alkaline solutions may be in order. Shock symptoms will often be

noted in cases of severe or extensive burns. In such a case, put patient on his back and keep him warm, but not hot, until physician arrives. Do not apply oils or ointments to burned areas without instructions from a physician. If eyes are involved, they should immediately be irrigated with abundant quantities of warm water for at least 15 minutes.

If the material has been taken internally, it causes burns of the mucous membrane of the throat, esophagus, and stomach. Do not attempt to induce vomiting in patients who have swallowed strong solutions of sulfuric acid. Do not give anything to an unconscious patient by mouth. If he is conscious, encourage him to wash out his mouth with abundant amounts of water and have him drink milk, if it is available, mixed with whites of eggs. If this is not available, have him drink as much water as possible. Get medical help.

Storage and Handling: Personnel should be cautioned to avoid skin contact with this material. Keep it away from the eyes and clothing. In case of contact, start first aid immediately. Where this material has been spilled, the spill should be attended to at once. Ventilate the area and flush with large quantities of water. Then use bicarbonate of soda to neutralize the last remaining traces of this material. Do not pour sulfuric acid directly down a drain, as it can contaminate sewage and water supplies and corrode pipes on the way down. First neutralize it and remember that it takes 200 pounds of soda ash to neutralize 13 gallons of sulfuric acid.

Do not add water to a container of this material, because this causes a very violent reaction and the amount of heat evolved is enough to cause the mixture to boil and spatter strong acid on personnel in the vicinity. Do not store containers in direct sunlight. Store them in a cool, ventilated area. Never empty carboys by means of pressure. If no water is available to flush away spills, cover such contaminated areas with dry sand, ashes, or gravel. Neutralize if possible with soda ash or lime. Do not use combustibles such as cloth, sawdust, or other organic materials to mop up such spills.

Personnel who work with this material should have the following equipment: a brimmed felt or treated fiber hat, rubber gloves, rubber hightop safety-toe shoes or boots with tops covered by the trousers, woolen outer clothing which fits snugly at the neck and wrists, a rubber apron, and a rubber acid suit. For tank car or unloading points, water in ample quantities should be available at once; and deluge-type showers should be available and bubblers for washing and irrigating the eyes. Personnel should wear gas-tight chemical safety goggles; and when entering an area in which this material is stored, a rescue harness and life-line should be supplied with an outside attendant to maintain constant observation for rescue work. Recommended also are positive-pressure hose masks or air-line respirators, or self-contained air or oxygen supply gas masks.

When sulfuric acid is involved in a fire, it is very dangerous and can evolve toxic fumes. It should be stored in an area which is isolated from saltpeter, metallic powders, carbides, picrates, fulminates, chlorates, and other combustible materials. Fires involving it should be smothered with sand, ashes, or rock dust; but avoid the use of water. This material is usually shipped in carboys, iron drums, glass bottles, and tank cars.

Also Called: Oil of vitriol and dipping acid.

Formula: H_2SO_4

Description: Colorless oily liquid. Soluble in water.

TETRAETHYL LEAD

Hazardous Properties: This material is a powerful poison and a solvent for fatty materials. It has some solvent action on rubber as well. The fact that it is a solvent of fatty tissue makes it an industrial hazard, because it can cause intoxication not only by inhalation but also by absorption through the skin. It decomposes when exposed to sunlight or allowed to evaporate but forms triethyl lead, which is also a poisonous compound, as one of its decomposition products. This liquid lead compound, when handled in undiluted form or concentrated solutions as when it is manufactured or in the plants where it is mixed with gasoline, may cause lead exposure intoxication by coming in contact with the skin. Any open receptacle which contains these liquids in high concentration or any container, article of clothing, or any other object which is not kept clean, particularly in contact with this material, may subject personnel to serious lead exposure.

Storage and Handling: Where it is in use, good general ventilation should be provided. Good housekeeping should be insisted upon. It is necessary to keep clean all surfaces which may be exposed to the vapors or liquid form of this material so that these surfaces cannot in turn intoxicate personnel exposed to them. People exposed to high or unknown concentrations should take particular precautions. Recommended are an air-line or self-contained oxygen or air-supply type of respirator to avoid inhalation exposure, chemical safety goggles of the gas-tight variety for protection of the

eyes, and good protective clothing to avoid skin contact with it. This is important. Personnel who may come in contact with pure or concentrated solutions of this liquid should be cautioned to avoid repeated or prolonged inhalation of the fumes or vapors and to avoid all but very short skin exposures to the liquid, the solution, or its vapors.

Formula: $Pb(C_2H_5)_4$

Description: Colorless oily liquid.

TOLUENE

Maximum Allowable Concentration in Air: 200 parts per million.

Explosive Limits: 1.3 to 6.8 per cent by volume in air.

Hazardous Properties: It is a flammable liquid and a dangerous fire hazard. Its vapors form flammable mixtures with air at all temperatures to 40°F. It is also toxic. It can cause corneal burns, cornea opaque, keratoconus, and extensive death of tissue. Industrial exposure and intoxication from this material are related chiefly to inhalation of its vapor, which causes a progressive, depressant action upon the central nervous system. It affects the bone marrow as well. In addition to its narcotic action, it is a pronounced irritant to mucous surfaces. This material is very similar in its toxic effects to benzene, although it is somewhat more powerful as a narcotic and its acute toxicity is somewhat greater. Animals have been found to be severely affected but alive after 18 daily exposures to 1,250 parts per million. Fatalities occurred after only a few daily exposures for 4 hours per day to 4,000 parts per million concentrations. The warning properties of this material are good only upon entering an area where it is being used; however fatigue of the smelling organ sets in very rapidly, and the irritant effects are not distinct enough to be depended upon.

Storage and Handling: Store in a cool, ventilated area away from acute fire hazards, open flame, and powerful oxidizing agents. Personnel exposed to high or

unknown concentrations should wear respirators to avoid excessive inhalation, chemical safety goggles of the gas tight variety for protection of the eyes, and possibly protective clothing, when the exposure is severe, to avoid excessive skin contact. Containers of this material should be kept closed at all times and plainly labeled. To fight fires of this material, foam, carbon dioxide, carbon tetrachloride, or dry chemical can be used.

Also Called: Methylbenzene, phenylmethane, and toluol.

Formula: $C_6H_5CH_3$

Hazardous Properties: This material is a moderately flammable, toxic liquid. The ortho isomer is considered more toxic than the others. This material is a poison if ingested orally, the lethal dose being of the order of 1 gram per kilogram of body weight. Two grams or less can cause a moderate degree of paralysis. The literature contains a report of intoxication to personnel exposed to 0.1 part per million concentrations. Its action is persistent and cumulative. It can also cause serious damage to the nervous system. There are many reports of its toxicity in the literature. Symptoms of intoxication are gastrointestinal disturbances, followed by a period free from symptoms. Then muscle soreness and paralysis of the extremities become evident. Severe cases of poisoning due to this material leave their victims bedridden. It is stated that in humans slow but complete recovery usually occurs. It can be absorbed through the skin as well as through the respiratory tract in the form of vapor. There was recovery among all the workers affected in a time lapse from 1 to 3 years. This material has occasionally been used to adulterate ginger extract in the making of beverages.

Treatment and Antidotes: When this material has been ingested or when it is believed that personnel have been exposed to toxic quantities of it in the vapor or liquid form, call a physician at once.

Storage and Handling: Store in a cool place away from areas of acute fire hazard and open flame. Personnel who must be exposed to this material should take precautions in its use. It is recommended that personnel be cautioned to avoid prolonged or repeated skin contact with it and that those exposed to the vapors should wear a respirator to avoid excessive inhalation and protective clothing to avoid skin contact with the vapors. Chemical safety goggles are recommended for protection of the eyes. It is commonly shipped in steel drums. To fight fires of this material, water (fog or spray), foam, carbon dioxide, carbon tetrachloride, or dry chemical can be used.

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