Industrial Chemical Toxicology

Overview

There are tens of thousands of different industrial chemicals manufactured, stored and transported throughout the U.S. and the rest of the world. Each substance has different toxicological properties and physical characteristics. Some industrial chemicals can pose significant health hazards (carcinogens, non-cancer causative agents, reproductive hazards, corrosives or agents that affect the lungs or blood, etc). Some pose no intrinsic health hazards but nonetheless pose physical hazards (flammable, combustible, explosive or reactive).

Each chemical has different toxicological properties and characteristics[a]

The time that such agents persist in the environment following release depends on many variables. These include the quantity released, the method of release and the state of the chemical (gaseous, liquid or solid), chemical stability and permeability, weather conditions (wind speed, rain, temperature), ability to persist in different mediums (air, soil, water) and other factors.[1]

All of these factors must be taken into account in an objective toxicological exposure assessment. Adverse health effects from toxic industrial chemicals vary widely. Some chemicals are highly toxic and may rapidly affect exposed individuals, whereas others may cause reproductive damage or induce carcinogenic reactions that may not appear for many years. Information related to how some chemicals affect humans and symptoms of exposure can sometimes be found in material safety data sheets (MSDS) or chemical information cards. OSHA (the U.S. Occupational Safety & Health Administration) provides specific guidelines for disclosures of adverse health effects with respect to exposures as well as "best practices" for treating exposure victims.[2]

Only an objective toxicological exposure assessment can accurately quantify potential health impacts with respect to industrial chemicals. The following partial list represents common industrial chemicals and contaminants with which *TCAS* has gained extensive experience over a period of more than 28 years. *TCAS* has regularly performed toxicological assessments, produced written reports and/or provided expert testimony with respect to exposure, adverse health effects and/or demonstrating or refuting causation subsequent to being retained by defendants, plaintiffs, prosecutors, state attorney generals, public defenders' offices and U.S. Attorneys' offices. Please contact our office for information concerning any industrial chemical not included herein.

Click on any substance to view the corresponding entry.

Acids | Corrosives | Solvents | Trichloroethlyene | Vinyl Chloride

Click to view other types of hazardous substances.

Environmental Hazards | Hydrocarbons | Compounds & Metals | Pesticides | Dioxins | Hazardous Substances Index

Acids

Show all results for "Acids"

Acids[b]

Acids are perhaps the most common of all industrial chemicals and are also essential components for normal body functions in humans and animals. Acids can generally be grouped into two classes: "strong" and "weak." Due to the extraordinarily broad scope of acidic compounds, there are few general rules with respect to the impacts of ingesting, inhaling or coming into contact with acids. Whereas strong acids and some concentrated weak acids are corrosive, there are exceptions (such as carboranes and boric acid). Additionally, some substances containing acid have intrinsically hazardous properties that may be quite different than those of the acid component alone. For example, in a *TCAS* case study involving phosphoric acid, Dr. Sawyer demonstrated that the plaintiff's exposure to a cleaning product did not contribute to her injury and thus refuted causation in this particular matter. Thus, in any exposure scenario involving acids, each substance must be assessed according to its concentration, chemical form and specific properties.

NIOSH (the National Institute for Occupational Safety and Health) publishes detailed information on permissible exposure limits, chemical characteristics, physical properties and health hazards for acids.[3] NIOSH also provides recommendations for medical surveillance, respiratory protection, personal protection and sanitation practices for specific acids governed by Federal occupational safety and health regulations. Additionally, the MSDS (Material Safety Data Sheet) published by manufacturers provides information regarding acute and chronic health effects, including hazard identification, methods for treating exposure, physical and chemical properties, stability, reactivity and toxicological data (if available). *TCAS* has performed toxicological assessments in cases involving acids in both individual and industrial matters. Please contact our office for additional information.

Corrosives

Show all results for "Corrosives"

Symbol for corrosives[c]

Corrosives attack and chemically damage exposed body tissues. Although many corrosive substances are acidic (see "Acids" above), some corrosives are classified as bases or caustic alkalis. These include such substances as ammonium hydroxide, potassium hydroxide (caustic potash), sodium hydroxide (caustic soda) and others. Many common non-acidic cleaning products have corrosive properties and a wide range of substances in common use exhibit corrosive characteristics. For example, glutaraldehyde (used as a disinfectant and sterilizing agent in medical and dental settings) is harmful if inhaled or swallowed, can be irritating to the respiratory tract, eyes and skin, may cause permanent eye injury and can cause severe allergic skin reactions.[4] Similarly, lye (sodium hydroxide, also known as caustic soda) is an inorganic, highly caustic metallic base and alkali salt of sodium. It can cause severe burns in all tissues that come in contact with it. Low-level inhalation as dusts, mists or aerosols can cause irritation of the nose, throat, and respiratory system. Higher levels may cause permanent damage.

Corrosives can be toxic by all routes of exposure (dermal, inhalation and ingestion). Tissue damage may occur rapidly or very slowly depending on concentration and chemistry. Depending on the precise chemistry and concentration, acute symptoms can range from mild irritation to immediate destruction of body tissues. Chronic exposure to corrosive substances can cause a wide range of adverse health effects, including scarring, respiratory ulceration and nervous system damage. In some cases corrosives (such as sodium hydroxide) have been reported to be indirect causative agents of more serious diseases (such as cancer) resulting from tissue destruction and scar formation.[5] *TCAS* has in-depth experience in interpreting laboratory test results and assessing toxicological issues for a wide range of corrosives. Please contact our office for additional information.

Solvents

Show all results for "Solvents"

Solvents[d]

Organic and chemical solvents are primarily used as cleaning agents but have many other uses as well. Common solvents include tetrachloroethylene in dry cleaning, toluene and turpentine in paint thinners, acetone, methyl acetate and ethyl acetate in nail polish removers, hexane and petrol ether as cleaning agents, citrus terpenes in detergents, ethanol in perfumes, etc. These are just a few of the thousands of different types of solvents used in both industrial applications and consumer products.

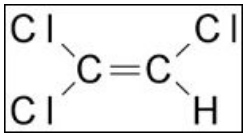
Health hazards associated with solvent exposure include cancer, nervous system toxicity, reproductive damage, liver and kidney damage, respiratory impairment and dermatitis.[6] Organic solvents can be especially problematic as many have been classified as carcinogens and/or causative factors in non-cancer health effects. Organic solvents recognized as carcinogens include benzene, carbon tetrachloride and trichloroethylene (TCE). Toluene, tetrachloroethylene, and n-hexane are classified as neurotoxins; 2-ethoxyethanol, 2-methoxyethanol and methyl chloride are associated with reproductive disorders. Additionally, different classes of chemicals can be used as organic solvents, including aliphatic hydrocarbons, aromatic hydrocarbons, amines, esters, ethers, ketones, and nitrated or chlorinated hydrocarbons.[7] All of these solvents have specific toxicological impacts and their documented adverse health effects must be precisely quantified when conducting a toxicological exposure assessment based on dose, exposure intervals, routes of exposure and other investigative factors.

Solvents are not merely hazardous as toxic agents in isolated exposure cases. Persistent groundwater contamination from solvents is a significant problem in the U.S. and a number of Superfund sites continue to be engaged in long-term remediation efforts. For example, the Lockwood groundwater plume in Billings, Montana has been a significant source of toxic contamination for many decades (it was not until 1986 that municipal personnel discovered benzene and chlorinated solvents in their water supply). The primary source of contamination was from a company that used industrial solvents and steam to clean tanker truck trailers, discharging wastewater to a septic system and drain field. This wastewater eventually collected into a plume of contamination in the groundwater.[8]

Producing an objective toxicological assessment of widespread solvent contamination can involve assessing health risks to an entire community. In the case of groundwater contamination, hydrological data may be required to accurately assess the behavior, migration, transport and fate of underground contamination. By collecting the necessary laboratory data, compiling the available human studies, performing the required dose calculations and strictly applying the prevailing peer-reviewed and regulatory assessment methodologies, the expert toxicologist can provide scientifically-credible opinions with respect to adverse health risks, site remediation, the potential need for medical monitoring and other pertinent toxicological issues. Please contact our office for additional information.

Trichloroethlyene (TCE)

Show all results for "Trichloroethlyene"



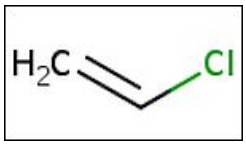
Chemical structure of Trichloroethlyene[e]

TCE *(1,1,2-trichloroethylene)* is a colorless, transparent liquid used as a degreaser, paint stripper, adhesive solvent and additive in paints and varnishes as well as in the manufacture of other chemicals. TCE has been a long-standing historical contaminant of groundwater in many residential areas. Following U.S. EPA (2005b) "Guidelines for Carcinogen Risk Assessment," TCE is characterized as *"carcinogenic to humans"* by all routes of exposure. This conclusion is based on convincing evidence of a causal association between TCE exposure in humans and kidney cancer.[9] TCE exposure can also augment the toxicity of other chemicals through exposure to some of TCE's metabolites. This means that the expert toxicologist must also consider the cumulative effects of TCE along with other environmental contaminants.[10]

Our Toxic Exposures page illustrates the various pathways used to calculate cumulative TCE dosage in a toxicological exposure assessment. Additionally, *TCAS* was recently retained to conduct a formal toxicological analysis in a well-publicized case involving a lawsuit filed against a manufacturing company for allegedly contaminating the local water supply with TCE. This trichloroethylene case study illustrates how exposure evidence, historical factors, a well-constructed residential questionnaire and a toxicological risk assessment can significantly impact an outcome in toxic tort litigation. Please contact our office for additional information.

Vinyl Chloride

Show all results for "Vinyl Chloride"



Chemical structure of vinyl chloride[f]

Vinyl chloride (also known as chloroethene, chloroethylene, ethylene monochloride or monochloroethylene) is a colorless gas with a mild, sweet odor. It can exist in liquid form under high pressure or at low temperatures. The majority of vinyl chloride produced in the U.S. is used to make PVC (polyvinyl chloride), from which many different plastic and vinyl products are made including pipes, wire, packaging materials, etc. Some vinyl chloride is used in furniture and automobile upholstery, wall coverings, housewares and automotive parts. In the past vinyl chloride was used as a refrigerant.[11]

Vinyl chloride is carcinogenic and U.S. EPA has classified vinyl chloride as a "Group 1 Known Human Carcinogen." Acute (short-term) exposure symptoms include dizziness, drowsiness, and headaches. Chronic (long-term) exposure through inhalation and oral exposure can result in liver damage. Cancer is a major concern from exposure via inhalation, as vinyl chloride exposure has been shown to increase the risk of hepatic anglosarcoma, a rare form of liver cancer in humans.[12]

Although the majority of vinyl chloride exposures tend to be occupational in nature, there have been numerous cases of vinyl chloride contamination in groundwater. *TCAS* recently conducted a health risk assessment of a plume of groundwater contaminated with vinyl chloride and TCE. Other cases of vinyl chloride contamination continue to be uncovered in the U.S., such as the 2015 Marion County vinyl chloride groundwater plume in Indianapolis, Indiana.[13] Such contamination can impact large numbers of residents who depend on groundwater as their primary drinking water source. *TCAS* has been retained in numerous cases involving vinyl chloride contamination including large-scale releases from chemical facilities, refineries and other sources. Please contact our office for additional information.

Notes and References

1. U.S. Occupational Safety & Health Administration, "Toxic Industrial Chemicals (TICs) Guide," September, 2014.
2. U.S. Occupational Safety & Health Administration, "Best Practices for Hospital-Based First Receivers of Victims," January, 2005.
3. National Institute for Occupational Safety and Health, Occupational Health Guidelines for Chemical Hazards," Publication Number 81-123, June, 2014.
4. National Institute for Occupational Safety and Health, Glutaraldehyde - Occupational Hazards in Hospitals," Publication Number 2001-115, June, 2014.
5. ATSDR, Division of Toxicology and Environmental Medicine, ToxFAQs for Sodium Hydroxide (NaOH)," April, 2002
6. U.S. Occupational Safety & Health Administration, "Solvents," 2016.
7. Centers for Disease Control and Prevention, "Organic Solvents," December, 2013.
8. U.S. Environmental Protection Agency, "Lockwood Solvent Ground Water Plume," April, 2016.
9. U.S. Environmental Protection Agency, "Trichloroethylene (CASRN 79-01-6), Evidence for Human Carcinogenicity," IRIS, September, 2007.
10. U.S. Environmental Protection Agency, "Health Assessment Document for Trichloroethylene Synthesis and Characterization," August, 2010.
11. ATSDR, Division of Toxicology and Environmental Medicine, "Toxicological Profile for Vinyl Chloride," July, 2006.
12. U.S. Environmental Protection Agency, "Vinyl Chloride," February, 2016.
13. U.S. Environmental Protection Agency, "West Vermont Drinking Water Contamination, Indianapolis, IN," April, 2016.

Images

a. Montage of public domain thumbnail images: USGS, USDA Hazardous Waste Operations, U.S. Department of Veterans Affairs, Keith Beard, Pawel Jagielski, Nino Satria
b. Acids, USGS, Geochemical Sediment Analysis Procedures
c. Corrosives, USDA, Hazardous Waste Operations and Emergency Response
d. Solvents, U.S. Department of Veterans Affairs, "Industrial Solvents
e. National Institute of Environmental Health Sciences, "Trichloroethlyene"
f. Toxnet, "Vinyl Chloride"

A Message from Dr. William R. Sawyer
Chief Toxicologist, *TCAS, LLC*

"Toxicological findings involving industrial chemicals must be based on compelling weight-of-evidence. Careful application of generally-accepted methods and multiple peer-reviewed studies are both essential to demonstrate or refute causation."

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