TROJAN UV™

FACTSHEET
1,4-DIOXANE

Environmental Contaminant Treatment

Update on Emerging Contaminants: 1,4-Dioxane

1,4-Dioxane is a semi-volatile, colorless liquid with a mild ethereal odor, also known as diethylene dioxide, dioxane, or p-dioxane. It is miscible with water, oils and most chlorinated solvents. It is also flammable and, during storage, may form explosive peroxides.

SOURCES OF 1,4-DIOXANE

1,4-Dioxane is primarily used as a stabilizer in chlorinated solvents. At one time, approximately 90% of the 1,4-dioxane produced went into the production of 1,1,1-trichloroethane (TCA). This application has now been phased out due to TCA's destructive effects on atmospheric ozone. Industries or processes in which 1,4-dioxane is used, or is associated, include:

- Chlorinated solvents manufacturing (as a stabilizer)
- Organic chemical manufacturing
- Textile processing
- Paper manufacturing
- Varnish stripper and paint production
- Pesticide production

Few manufacturers of 1,4-dioxane exist globally as many previous uses of 1,4-dioxane have been discontinued due to the potential carcinogenic effects of the chemical. In 2009, a single manufacturer was present in the United States (U.S.), Europe and India, and three manufacturers were in East Asia.

In the U.S., approximately 10 million pounds (lbs) of 1,4-dioxane are produced per year.

When released into the air, 1,4-dioxane degrades relatively quickly through reactions with photochemically-produced hydroxyl radicals. However, degradation in water and soil is slow. For this reason, 1,4-dioxane is persistent in the environment, and will remain present in areas of groundwater contamination. Approximately 150 facilities in the U.S. release reportable amounts (greater than 10 lbs) of the chemical each year. The annual release in 2009 was approximately 130,000 lbs. Of this, 60% was released to air, 35% were surface water emissions, with the remaining being released to land. Due to the ubiquitous nature of 1,4-dioxane, contamination can be found in many parts of the U.S.

A PROBABLE CARCINOGEN

Until recently, 1,4-dioxane was not considered a priority contaminant. However, in 2010 the United States Environmental Protection Agency's (USEPA) Integrated Risk Information System (IRIS) updated its toxicological review of the contaminant to include a cancer assessment. IRIS designated 1,4-dioxane as "likely to be carcinogenic to humans". In addition, the IRIS system indicated that 1,4-dioxide concentrations of 0.35 ppb (ug/L) or higher in drinking water would result in 1 in 1,000,000 people developing cancer. In animal testing, 1,4-dioxane increased the incidence of cancer in the liver, lungs, gall bladder, and on the skin.

- CHEMICAL NAME: 1,4-Dioxane
- CHEMICAL FORMULA: $C_4H_8O_2$
- MOLECULAR WEIGHT: 88.12
- WATER SOLUBILITY: Highly soluble
- DENSITY: 1.033 g/mL
- VOLATILITY: Semi-volatile

Non-carcinogenic side effects of 1,4-dioxane include liver and kidney toxicity. The primary routes of human exposure to 1,4-dioxane are inhalation, ingestion, and dermal contact.

The USEPA included 1,4-dioxane on its third Unregulated Contaminant Monitoring Rule (UCMR3) for drinking water contaminants. Levels of 1,4-dioxane will be monitored at 800 water treatment plants across the U.S. between 2013 and 2015 to determine if federal regulations are necessary.

FACT**SHEET**

ULTRAVIOLET (UV) LIGHT KEY TO TREATMENT PROCESS

1,4-Dioxane's low vapor pressure and high solubility render air stripping, carbon adsorption and reverse osmosis ineffective for its removal. However, UV-oxidation using UV light and hydrogen peroxide is effective at breaking down 1,4-dioxane. The irradiation of hydrogen peroxide by UV light generates hydroxyl radicals. These radicals effectively oxidize 1,4-dioxane, breaking it down into its non-toxic molecular components.

EXTENSIVE UV INSTALLATIONS

Trojan has conducted numerous pilot studies to verify the efficacy of 1,4-dioxane destruction using UV light and hydrogen peroxide. Currently, Trojan has dozens of surface and groundwater UV-oxidation installations designed for its removal. Collectively, these installations treat over 230 million gallons of drinking water each day.

TREATING MULTIPLE CONTAMINANTS WITH ONE UV SYSTEM

As an added benefit to 1,4-dioxane treatment, Trojan's UV-oxidation systems also disinfect (inactivating pathogenic microorganisms including *Cryptosporidium*) and treat for other compounds including *N*-nitrosodimethylamine (NDMA), endocrine disruptor compounds, pesticides, volatile organic compounds (VOCs), and taste and odor causing compounds such as MIB and geosmin.

Figure 1. TrojanUVPhox™ system treating 1,4-dioxane

For more information regarding the treatment of multiple contaminants using Trojan's UV solutions, including 1,4-dioxane treatment, please contact Trojan.

References: National Toxicology Program: 12th Report on Carcinogens, 2011; EPA Toxic Release Inventory, 2009; EPA Integrated Risk Information System (IRIS)

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WATER CONFIDENCE™

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