Assignment #2: Ethylbenzene and Gallium Fact Sheets – Lizette Romano

Ethylbenzene

Ethylbenzene is a colorless liquid with an aromatic smell (The National Institute for Occupational Safety and Health [NIOSH], 2019). It is found in styrene production, solvents, and fuel (Agency for Toxic Substances and Disease Registry [ATSDR], 2007). Ethylbenzene is a strong oxidizer and breaks down into other chemicals (NIOSH, 2019 & ATSDR, 2007). It can get from water and soil into the air easily (ATSDR, 2010). Ethylbenzene has a vapor pressure of 7 mmHg (The National Institute for Occupational Safety and Health [NIOSH], 2019); this high volatility allows it to become a vapor and get into the air (Hanson et al., 2016).

Ethylbenzene exposures can occur through air, water, soil, occupational settings, and certain consumer products contain the chemical. Ethylbenzene may be present in the air from factories and gasoline vehicles that emit the chemical on highways. A common way it is inhaled is when a person is pumping gasoline at gasoline stations. People who live closer to freeways have higher concentrations found in the air outdoors and there are higher concentrations typically found in indoor settings (ATSDR, 2010). Water can contain ethylbenzene if groundwater and well sources are contaminated by fuel storage tanks through runoff and leaking (ATSDR, 2010). People with contaminated water might then be exposed to the chemical with daily water usage such as bathing and drinking water. Similarly, ethylbenzene could contaminate soil through runoff of chemicals in residential and occupational disposal of products containing ethylbenzene and fuel spills. People who live near manufacturing and processing plants, refineries, and waste disposal sites may experience these water and soil issues more commonly (ATSDR, 2010). Workers in workplaces that manufacture products with ethylbenzene such as the petroleum industry could be exposed dermally or through inhalation (ATSDR, 2010). Ethylbenzene can be found in household products like paints, varnishes, gasoline, vehicle products, and carpet glue.

When inhaled, the health effects include eye and respiratory tract irritation, hearing loss, dizziness, increased lymphocyte cells and a decrease in hemoglobin cells (ATSDR, 2010 & 2007). Other health effects include cough, sore throat, drowsiness, headache, dermatitis, narcosis, and coma (International Labour Organization [ILO] & World Health Organization [WHO], 2021 & NIOSH, 2019). Dermal exposure can cause eye irritation and when liquid ethylbenzene is absorbed in the skin, irritation can occur (ATSDR, 2010 & NIOSH 2019). Oral ingestion may lead to chemical pneumonitis (ILO & WHO, 2021). Absorption occurs quickly through inhalation since exposure to ethylbenzene is typically in a vapor form. Lungs absorb 40-60% of inhaled ethylbenzene (National Center for Biotechnology Information, 2022). Because of how quickly it is absorbed, biomarker sampling should occur "within a few hours" of exposure (ATSDR, 2007).

Ethylbenzene leaves the body through urine, feces, and lungs within 2 days of exposure (ATSDR, 2010). Biomarker sampling media of ethylbenzene include urine, blood, human tissue such as subcutaneous tissue, breastmilk, and expired air (ATSDR, 2010). Samples are analyzed using headspace gas chromatographic analysis. Most commonly, urine sampling is used. In urine, mandelic acid and phenylglyoxylic acid are measured. Biomarkers which are less sensitive are increased lymphocyte cells and a decrease in hemoglobin cells. Breath samples or expired air are measured on traps, bags, or canisters using spirometers, according to ATSDR (2010). The recommended TLV-TWA for ethylbenzene is 20ppm. Ethylbenzene is a known animal carcinogen (American Conference of Governmental Industrial Hygienists, 2022) but there is debate around whether it is a human carcinogen.

Gallium

Gallium is a silvery white liquid that can produce toxic fumes at high temperatures (National Oceanic and Atmospheric Administration, n.d.): it is a reducing agent that has violent reactions with halogens at room temperature. As a solid, it has a low melting point of 29°C which makes it desirable for making metal alloys. Gallium is used as a semiconductor in the production of optoelectronics, analog integrated circuits, laser and light-emitting diodes, smartphones, medical devices, and mirrors (Chitambar 2010 & Foley and Jaskula, 2013). Gallium is sometimes mixed with arsenic to produce electronics (Agency for Toxic Substances and Disease Registry [ATSDR], 2007). Medical imaging scans where a small dose of gallium citrate is inserted in the body help observe inflammation and abnormal cell division with x-rays (Cedars-Sinai, 2022).

Since gallium is mainly used in the production and manufacturing process, the most common exposures are in workplaces. Gallium is not produced in the U.S. but is instead imported from other countries (Foley and Jaskula, 2013). Exposures could occur through leaks of the chemical, inappropriate personal protective equipment, and breathing in vapors and fumes during gallium fires (Association of American Railroads, 1994). Exposures can also occur dermally through contaminated clothing of workers and if solid Gallium is dry swept inhalation can occur (New Jersey Department of Health and Senior Services [NJDHSS], 2001). Gallium in community settings is less common but can occur if there are fires involving the chemical, spills, and contamination of water and air (NJDHSS, 2001). Some side effects of using gallium citrate in medical imaging include allergic reactions, nausea, and a rash (Cedars-Sinai, 2022).

The health effects of gallium include lung edema, respiratory arrest, shock, seizures, irritation of exposed body parts, eye damage, and skin burns upon contact (Bronstein, 1994 & Gleason 1969). In addition, it can cause dermatitis and lead to reduced bone marrow functions (Lewis, 1996). Aside from physical symptoms experienced by individuals, biomarkers that are used include liver, kidney, nervous system, or lung functions; blood count tests; and chest x-rays (NJDHSS, 2001) Large amounts of gallium reach the bones within 4 hours and stay in the body for at least 3 months (Clayton, 2008). It's important to note that the form of gallium used for medical scans, gallium citrate, is excreted from the body within a few days (Cedars-Sinai, 2022).

Most of the gallium, over 85%, is excreted through urine so this would be the preferred sampling medium (Clayton, 2008). Liao et al. (2004) tested whole blood and urine samples for gallium using an "inductively coupled plasma-mass spectrometer autoanalyzer" and found that urine is a more sensitive sampling medium. To test gallium exposure, Liao et al. (2004) collected samples from workers in the optoelectronic industry who were regularly in contact with gallium. Samples were collected after workers had fasted from eating for at least 8 hours. Both blood and urine samples were kept at –20°C before analysis and during transport (Liao et al., 2004). Aside from tracing gallium in samples, another biomarker that can be used to determine gallium poisoning is looking at "decreased serum sodium and phosphate levels" (Ivanoff et al., 2012). Sampling is recommended when physical symptoms are felt, regularly during worker's physical examinations, and when large doses of gallium are accidentally inhaled, ingested, or touched.

Since gallium is mixed with different chemicals in the production of products, there are variations in recommendations for testing and toxicities. According to the American Conference of Governmental Industrial Hygienists [ACGIH] (2005), the recommended TLV-TWA for gallium arsenide is 0.3 µg/m^3 GaAs/m^3 respirable particle mass. There is a lack of studies around toxicity and biomarker sampling of gallium for humans, but gallium arsenide is classified as a confirmed animal carcinogen (ACGIH, 2005).

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