

Styrene Resin Used in Cured in Place Pipe Rehabilitation May Have a Significant Localized Ecotoxicity, Despite Fast General Biodegradation

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KEY SEARCH TERMS:

Styrenes

Environment

Environmental Impacts

Aquatic Life

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Does Styrene Resin Used in CIPP Pose a Significant Ecological Threat?

Research indicates that in high concentrations styrene can pose a health threat to waters taken for municipal purposes. However, styrene does appear to be highly biodegradable. There is evidence to suggest that its potential impact on aquatic life forms is mitigated by both its volatility and biodegradability. It may pose a brief but acute “localized ecological threat” to aquatic life forms at the point of application.

Furthermore, human exposure to styrene during CIPP installation may result in negative health symptoms (due to exposure to fumes or direct contact with the skin) for employees handling it during the installation. CIPP using styrene resins appears to be a common procedure in modern pipe rehabilitation, however, other aromatic hydrocarbons (typically more toxic substances) have also been used. Field research on how VDOT is using styrene for CIPP may be warranted.

--- Ken Winter, MLIS

Databases Searched

Medline
Aqualine
ASFA: Aquatic Sciences and Fisheries Abstracts
GeoRef
Biological Sciences
Toxline
AGRICOLA
Environmental Sciences and Pollution Management
Dissertation Abstracts
Zoological Record
Science Direct
WorldCat

OVERVIEW

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The Breakdown of Aromatic Hydrocarbons In The Aqueous Environment

CITATION: T. Bogacka, Z. Makowski and R. Ceglarski. , Roczniki Panstwowego Zakladu Higieny, 1997, ISSN: 0035-7715 Vol. 48, No. 2, Pg. 149-161.

ABSTRACT: The purpose of this study was to establish the dynamics and kinetics of the aromatic hydrocarbons breakdown in aqueous environment. The investigated compounds were: benzene, toluene, m-xylene, p-xylene and styrene. These substances even in low concentrations threaten surface waters taken for municipal purposes because of their toxicity and also mutagenic and tumorigenic properties. The study was carried out under model conditions simulating the environment of river water moderately contaminated and laboratory water ecosystem. The obtained results indicate that the concentration of aromatic hydrocarbons, river microflora adapted to the environment of aromatic hydrocarbons as well as decreased temperature affected the process of the aromatic hydrocarbons' degradation. Due to the significant evaporation, the studied compounds are present in river water only for a short period of time. The half-times calculated in accordance with the kinetic equation of 1st order amounted to 1.1- 8.7 days; the contribution of evaporation was on average 28%. When the microflora had been adapted to the presence of these compounds, the process of degradation was as rule more rapid for both investigated temperatures (20 degrees C and 8 degrees C) and for most of the series. This process was slowed down by temperature fall to about 8 degrees C, but only in the range of low concentrations (1-32 mg/l). This regularity was not observed for higher concentrations up to 146 mg/l. The mixture of aromatic hydrocarbons at concentrations of 3.14-37.11 mg/l, exposed for 20 days to water ecosystem under dynamic conditions was reduced up to 99%. The investigated aromatic hydrocarbons were not absorbed by *Elodea canadensis* and *Physa fortinalis* and were weakly condensed in *Lebistes reticulatis* (cumulation coefficients-0.5-22.8). In the case of bottom sediments, it was stated that these compounds were not cumulated. The investigated concentrations of aromatic hydrocarbons didn't have a positive or negative effect on the aquatic biocenosis settled in the ecosystem. Note: RN: 0 (Hydrocarbons, Aromatic); 0 (Water Pollutants); 7732-18-5 (Water); LR: 20061115.

ACCESS: Available through InterLibrary Loan.

NOTE: Source is TOXLINE, abstract in English, article may be in Polish.

Acute Health Effects After Accidental Exposure To Styrene From Drinking Water In Spain

CITATION: Alberto Arnedo-Pena, Juan Bellido-Blasco, Jose-Luis Villamarin-Vazquez, et al. , Environmental health.: a.global access science source, 2003. Vol. 2, No. 1, Pg. 6, ISBN: 1476-069X.

ABSTRACT: We studied subjective health symptoms in a population accidentally exposed to high styrene concentrations in drinking tap water. The contamination occurred during the reparation of a water tank. METHODS: Residents of 27 apartments in two buildings using the contaminated water were contacted. A questionnaire on subjective symptoms was administered to 84 out of 93 persons living in the apartments at the time of the accident. Styrene concentration was measured in samples of water collected two days after the accident. The means of exposure associated with appearance of symptoms were examined through case-control analyses. RESULTS: Styrene in water reached concentrations up to 900 microg/L. Symptoms were reported by 46 persons (attack rate 55 %). The most frequent symptoms were irritation of the throat (26%), nose (19%), eyes (18%) and the skin (14%). General gastrointestinal symptoms were observed with 11% reporting abdominal pain and 7% diarrhea. The factors most strongly associated with symptoms were drinking tap water (OR = 7.8, 95% CI 1.3-48), exposure to vapors from the basement (OR = 10.4, 2.3-47) and eating

foods prepared with tap water (OR = 8.6, 1.9-40). All residents in the ground floor reported symptoms. CONCLUSIONS: This accidental contamination led to very high styrene concentrations in water and was related to a high prevalence of subjective symptoms of the eyes, respiratory tract and skin. Similar exposures have been described in workers but not in subjects exposed at their residence. Various gastrointestinal symptoms were also observed in this population probably due to a local irritative effect. Note: RN: 0 (Irritants); 0 (Water Pollutants, Chemical); 100-42-5 (Styrene).

ACCESS: Available through InterLibrary Loan.

Analysis Of Chemical Contamination Within A Canal In A Mexican Border Colonia

CITATION: Janel E. Owens and Emily D. Niemyer. , Environmental Pollution, 2006. Vol. 140, No. 3, Pg. 506-515.

ABSTRACT: This study examines urban pollution within Derechos Humanos, a colonia popular in Matamoros, Tamaulipas, Mexico. General water quality indicators (coliform bacteria, total dissolved solids, ecologically relevant cations and anions), heavy metals (copper, lead, nickel, zinc, iron and cadmium), and volatile organic compounds (benzene, toluene, ethylbenzene, styrene, and dichlorobenzene and xylene isomers) were quantified within a wastewater canal running adjacent to the community. Water samples were collected at multiple sites along the banks of the canal and evidence of anthropogenic emissions existed at each sampling location. Sample site 2, approximately 10 m upstream of the colonia, contained both the widest range of hazardous pollutants and the greatest number exceeding US Environmental Protection Agency surface water standards. At each sampling location, high concentrations of total coliform (>10 super(4) colonies/100 mL sample), lead (ranging from 0.05 to 0.40 mg/L), nickel (levels from 0.21 to 1.45 mg/L), and benzene (up to 9.80 mg/L) were noted. This study quantifies widespread industrial and urban contamination within a canal located in a colonia (unplanned community) in Matamoros, Tamaulipas on the US-Mexico border. Note: TR: CS0631556.

ACCESS: Available through InterLibrary Loan.

Aquatic Toxicity Evaluation of Para-Methylstyrene

CITATION: Kevin N. Baer, Robert L. Boeri, Timothy J. Ward, et al. , Ecotoxicology and Environmental Safety, 2002/11. Vol. 53, No. 3, Pg. 432-438.

ABSTRACT: The aquatic toxicity of para-methylstyrene was evaluated in acute toxicity studies using fathead minnows (*Pimephales promelas*), daphnids (*Daphnia magna*), and freshwater green algae (*Selenastrum capricornutum*). Static tests were performed in sealed containers with no headspace to minimize loss of this volatile compound to the atmosphere. Concentrations of para-methylstyrene in test solutions were analyzed by gas chromatography equipped with a purge and trap module and flame ionization detection. Test results are based on mean, measured concentrations. para-Methylstyrene was moderately toxic to fathead minnows, daphnids, and green algae. The 96-h LC50 and NOEC for fathead minnows were 5.2 and 2.6 mg/L, respectively. The 48-h EC50 and NOEC for daphnids were 1.3 and 0.81 mg/L, respectively. The 72-h EC50 and NOEC for green algae were 2.3 and 0.53 mg/L, respectively; these effects were algistatic rather than algicidal. Para-Methylstyrene's potential impact on aquatic ecosystems is significantly mitigated by its volatility, an important fate process.

ACCESS: Available through InterLibrary Loan.

Assessment of The Aquatic and Terrestrial Toxicity Of Five Biodegradable Polymers

CITATION: D. P. Arfsten, D. T. Burton, D. J. Fisher, et al. , Environmental Research, 2004. Vol. 94, No. 2, Pg. 198-210.

ABSTRACT: Radiofrequency countermeasures (i.e., chaff) may be released by fighter jets during tactical countermeasures training. Chaff cartridges, pistons, and endcaps (i.e., chaff dispenser materials), all currently made of styrene, are also released into the environment. Accumulation of chaff dispenser materials in the environment is a concern of the Department of Defense. The US Navy is exploring the possibility of constructing degradable chaff dispenser components made of biodegradable polymers. Five polymers are being considered. Degradability and toxicity tests are two of several criteria being used to evaluate various available biodegradable options. Dissolution products from four of five polymers being considered were toxic to aquatic organisms with LC50s/LOELs ranging between 1.24 and 731.30mg total organic concentration/L. Supernatant from dissolving a 90:10 polyester amide/polyvinyl alcohol copolymer in water for 24h inhibited shoot growth of Brassica rappa and Lepidium sativum. Since our results were obtained using fractions of saturated degradable polymer solutions (1 or 10g/L), we conclude that the tested degradable polymers were of low toxicity to the seven aquatic organisms and two terrestrial plant species used in our assays. However, our characterization of the toxicity of these degradable polymers may not be applicable to all species or environmental situations. Information gained from these studies will be used for making decisions on which polymers should be used in the engineering of environmentally friendly chaff dispenser cartridges, pistons, and endcaps.

ACCESS: Available through InterLibrary Loan.

Bacterial Degradation of Styrene In Waste Gases Using a Peat Filter

CITATION: M. Arnold, A. Reittu, A. Von Wright, et al. , Applied Microbiology and Biotechnology 1997. Vol. 48, No. 6, Pg. 738-744.

ABSTRACT: A biofiltration process was developed for styrene-containing off-gases using peat as filter material. The average styrene reduction ratio after 190 days of operation was 70% (max. 98%) and the mean styrene elimination capacity was 12 g m^{super(-3)} h^{super(-1)} (max. 30 g m^{super(-3)} h^{super(-1)}). Efficient styrene degradation required addition of nutrients to the peat, adjustment of the pH to a neutral level and efficient control of the humidity. Maintenance of the water balance was easier in a down-flow than in an up-flow process, the former consequently resulting in much better filtration efficiency. The optimum operation temperature was around 23 degree C, but the styrene removal was still satisfactory at 12 degree C. Seven different bacterial isolates belonging to the genera Tsukamurella, Pseudomonas, Sphingomonas, Xanthomonas and an unidentified genus in the gamma group of the Proteobacteria isolated from the microflora of active peat filter material were capable of styrene degradation. The isolates differed in their capacity to decompose styrene to carbon dioxide and assimilate it to biomass. No toxic intermediate degradation products of styrene were detected in the filter outlet gas or in growing cultures of isolated bacteria. The use of these isolates in industrial biofilters is beneficial at low styrene concentrations and is safe from both the environmental and public health points of view.

ACCESS: Available through InterLibrary Loan.

Biodegradation of Styrene In Samples Of Natural Environments

CITATION: M. H. Fu and M. Alexander. , Environmental Sciences & Technology (ES&T) 1992. Vol. 26, No. 8, Pg. 1540-1544.

ABSTRACT: Results are reported from laboratory experiments to assess the fate of styrene in various types of environmental sample. There was rapid volatilization from shallow lake water, with 50 per cent loss in 1-3 h, but only 26 per cent was volatilized in 31 d from a 1.5 cm depth of soil. Microbial mineralization of styrene was rapid in sewage, in a mineral soil at pH 7.23, and in an organic soil. It was slower in aquifer sand, waterlogged soil, and a mineral soil

at pH 4.87. Sorption on mineral and organic soils did not necessarily limit microbial transformation of styrene. Note: Publication focus: Experimental.
ACCESS: Available through InterLibrary Loan.

Chlorostyrenes In Fish And Sediment Samples From The River Elbe

CITATION: K. Bester, S. Biselli, T. Ellerichmann, et al. , Chemosphere, 1998. Vol. 37, No. 9-12, Pg. 2459-2471.

ABSTRACT: Chlorinated styrenes were identified in fish (bream) and sediment samples from the river Elbe. Four hexachlorostyrenes, four heptachlorostyrenes (concentrations in fish 1-10 ng/g wet weight) and octachlorostyrene (10-45 ng/g wet weight) were analysed. The gas chromatographic retention times and the electron impact (EI) mass spectra of the respective hepta- and hexachloro congeners found in the environment as well as those of some synthesised compounds are presented and discussed. The comparison of the chromatograms from the samples in the upper part of the river with those from the estuary revealed a possible difference in the pattern of chlorostyrenes. Note: Special Issue: Chlorinated Dioxins and related Compounds 1996.

ACCESS: Available through InterLibrary Loan.

Considerations Necessary In Gathering Occurrence Data For Selected Unstable Compounds In The USEPA Unregulated Contaminant Candidate List In USEPA Method 526

CITATION: S. D. Winslow, B. Prakash, M. M. Domino, et al. , Environmental Science & Technology: ES&T, 2001. Vol. 35, No. 9, Pg. 1851-1858.

ABSTRACT: U.S. Environmental Protection Agency (EPA) Method 526 was developed for the analysis of target analytes that are subject to degradation by hydrolysis. Two technical hurdles that had to be overcome were preservation of the target analytes and selection of a suitable solid-phase extraction material. The target analytes were diazinon, disulfoton, fonofos, terbufos, prometon, 1,2-diphenylhydrazine, nitrobenzene, acetochlor, 2,4,6-trichlorophenol, 2,4-dichlorophenol, and cyanazine. Diazolidinyl urea was used for the first time as a microbial inhibitor in an EPA drinking water method. Experiment confirmed antimicrobial agents containing copper or mercury salts increased hydrolysis degradation rates. Trisodium ethylenediaminetetraacetic acid salt was added to chelate metal ions that may increase hydrolysis rates. A pH 7 buffer of tris-(hydroxymethyl)aminomethane (Tris) and Tris hydrochloride was used to minimize rates of hydrolysis. The use of ascorbic acid prevented degradation of 2,4-dichlorophenol, terbufos, fonofos, diazinon, and disulfoton due to residual chlorine. Samples were extracted using a styrene divinylbenzene solid-phase material and analyzed by capillary column gas chromatography/mass spectrometry. A 21-day storage stability study, together with precision and accuracy studies, showed that this method has suitable sensitivity, accuracy, precision, and ruggedness for use in the EPA's Unregulated Contaminant Monitoring Rule drinking water occurrence survey.

ACCESS: Available through InterLibrary Loan.

Desorption and Biodegradation of Sorbed Styrene In Soil and Aquifer Solids

CITATION: Min Hong Fu, Hilary Mayton and Martin Alexander. , Environmental Toxicology and Chemistry, 1994. Vol. 13, No. 5, Pg. 749-753.

ABSTRACT: Not available. Note: FE: References: 14; illus. incl. 1 table; CY: GeoRef, Copyright 2006, American Geological Institute.

ACCESS: Available through InterLibrary Loan.

Determination of Triazine Pesticides and Related Compounds In Environmental Water By Liquid Chromatography-Mass Spectrometry

CITATION: Akiko Tanabe and Kuniaki Kawata. , Analytical sciences : the international journal of the Japan Society for Analytical Chemistry, 2004. Vol. 20, No. 1, Pg. 227-230.

ABSTRACT: A method for the determination of 5 triazine herbicides and 12 degradation products in environmental water samples using liquid chromatography-electrospray ionization mass spectrometry (LC/ESI/MS) has been developed. The pesticides in water were extracted with two types of solid phase: a styrene-divinylbenzene copolymer and a graphitized carbon black. Desorption solvents for the extracted compounds were acetone for the styrene-divinylbenzene copolymer and methanol for the graphitized carbon black. Overall recoveries from ground water and river water ranged from 73% to 111%. The limits of detection (LODs) were 0.2 to 28 ng l(-1). This method was applied to several ground water samples. Note: RN: 0 (Herbicides); 0 (Triazines); 0 (Water Pollutants, Chemical).

ACCESS: Available through InterLibrary Loan.

Drinking Water Criteria Document For Styrene / Prepared By Environmental Criteria And Assessment Office, Office Of Health And Environmental Assessment, U.S. Environmental Protection Agency

CITATION: United States. Environmental Protection Agency. Environmental Criteria and Assessment Office (Cincinnati, Ohio). , 1991. Note: SO: Cincinnati, OH: The Office, 1991; "Revised January 1991."; Prepared for Office of Drinking Water; "PB91-143370."; Includes bibliographical references.

ACCESS: Available through InterLibrary Loan.

Drinking Water Health Document on Styrene

CITATION: Environmental Protection Agency. , Available from the National Technical Information Service, Springfield, 1988. Vol. A01 in microfiche. Final Report no. ECAO-CIN-409, Pg. 294 ref.

ABSTRACT: The Safe Drinking Water Act, as amended in 1986, requires the Administrator of the Environmental Protection Agency (EPA) to publish maximum contaminant level goals (MCLGs) and promulgate National Primary Drinking Water Regulations for each contaminant , which, in the judgment of the Administrator, may have an adverse effect on public health and which is known or anticipated to occur in public water systems. The Office of Drinking Water of the EPA has prepared a Drinking Water Criteria Document on Styrene. This Criteria Document is an extensive review of the following topics: physical chemical properties of styrene, toxicokinetics and human exposure to styrene, health effects of styrene in humans and animals, mechanisms of toxicological effect of styrene, and quantification of toxicological effects of styrene. Styrene is a clear, colorless liquid with a characteristic odor, molecular weight of 104.16, vapor pressure of 4.3 torr, and a water solubility of 320 mg/L. Animal studies indicate that distribution of absorbed styrene is widespread and rapid, but is fairly readily eliminated. Exposure estimates for styrene in drinking water (low-high) are 0-0.25 microg/L, in food 100 microg/kg, and in air 0-6,500 microg/cu m. The major source of exposure is from ambient and indoor air. When the animal bioassay data and the metabolic/genotoxicity data are considered, there is a reasonable basis for classifying styrene as having a ' sufficient ' level of carcinogenic evidence in animal test systems, but there are inadequate data to indicate that styrene is a human carcinogen. (Fish-PTT).

ACCESS: Undetermined.

Eco-Materials In Railway - Recycling And Chemical Analysis

CITATION: Ito, M Suzuki, M. Mifune, N. , Railway Technical Research Institute, Quarterly Reports, Vol. 40, No. 4.

ABSTRACT: In this paper, organic materials are studied for environmental purposes. First, recycled materials, such as anti-vibration blocks made of SBR (styrene-butadiene rubber) track pads are used for reducing vibrations of the railroad. It has been found that low density and porous rubber blocks have suitable properties for reducing vibration and exhibit good performance. Second, an elemental analysis was carried out to evaluate environmental consciousness and development of desirable materials in the future. Based on this result, desirable concepts of future materials, such as making simple components and reducing heavy materials, are proposed. Note: Description: p. 199-203; Figures(12); References(6); TRIS Files: RRIS.

ACCESS: Unknown.

ONLINE AT: http://www.rtri.or.jp/infoce/gr_E.html

Ecotoxicity Hazard Assessment of Styrene

CITATION: J. R. Cushman, G. A. Rausina, G. Cruzan, et al. , Ecotoxicology and environmental safety, 1997. Vol. 37, No. 2, Pg. 173-180.

ABSTRACT: The ecotoxicity of styrene was evaluated in acute toxicity studies of fathead minnows (*Pimephales promelas*), daphnids (*Daphnia magna*), amphipods (*Hyaella azteca*), and freshwater green algae (*Selenastrum capricornutum*), and a subacute toxicity study of earthworms (*Eisenia foetida*). Stable exposure levels were maintained in the studies with fathead minnows, daphnids, and amphipods using sealed, flowthrough, serial dilution systems and test vessels. The algae were evaluated in a sealed, static system. The earthworms were exposed in artificial soil which was renewed after 7 days. Styrene concentrations in water and soil were analyzed by gas chromatography with flame ionization detection following extraction into hexane. Test results are based on measured concentrations. Styrene was moderately toxic to fathead minnows, daphnids, and amphipods: fathead minnow: LC sub(50) (96 hr), 10 mg/liter, and NOEC, 4.0 mg/liter; daphnids: EC sub(50) (48 hr), 4.7 mg/liter, and NOEC, 1.9 mg/liter; amphipods: LC sub(50) (96 hr), 9.5 mg/liter, and NOEC, 4.1 mg/liter. Styrene was highly toxic to green algae: EC sub(50) (96 hr), 0.72 mg/liter, and NOEC, 0.063 mg/liter; these effects were found to be algistatic rather than algicidal. Styrene was slightly toxic to earthworms: LC sub(50) (14 days), 120 mg/kg, and NOEC, 44 mg/kg. There was no indication of a concern for chronic toxicity based on these studies. Styrene's potential impact on aquatic and soil environments is significantly mitigated by its volatility and biodegradability.

ACCESS: Available through Interlibrary Loan.

Effect Of Environmental Pollutants and Their Metabolites On A Soil Mycobacterium

CITATION: B. L. Burback, J. J. Perry and L. E. Rudd. , Applied Microbiology and Biotechnology, 1994. Vol. 41, No. 1, Pg. 134-136.

ABSTRACT: The relative toxicity of seven major groundwater pollutants (benzene, chlorobenzene, propylbenzene, ethylbenzene, trichloroethylene, toluene, and styrene) and their metabolites to a soil Mycobacterium (*Mycobacterium vaccae* strain JOB-5) that can catabolize all of these pollutants was determined. The metabolites of chlorobenzene, styrene and trichloroethylene degradation (4-chlorophenol, styrene oxide, and 2,2,2-trichloroethanol, respectively) were less toxic to *M. vaccae* than was their parent compound. The pollutants propylbenzene, ethylbenzene and benzene were less toxic than their metabolites (4-propylphenol, 4-ethylphenol, and phenol). Metabolites were also examined for their ability to interfere with the biodegradation of selected groundwater pollutants. The metabolites of

ethylbenzene, propylbenzene and chlorobenzene biotransformation by *M. vaccae* were found to adversely affect biodegradation by *M. vaccae*. Toluene degradation by *M. vaccae* was inhibited by 4-chlorophenol, 4-ethylphenol and 4-propylphenol at 0.2 mM, 0.4 mM, and 0.4 mM, respectively.

ACCESS: Available through Interlibrary Loan.

Enhanced Microbial Degradation of Styrene In Shallow Soils and Ground Water; Groundwater Contamination

CITATION: Paul Dean Kuhlmeier. , IAHS-AISH Publication, 1989. Vol. 185, Pg. 189-197.

Note: CD: PIHSD9; FE: References: 6; illus. incl. 4 tables; CY: GeoRef, Copyright 2006, American Geological Institute.

ACCESS: Unknown.

Environmental Degradation of Tire-Wear Particles

CITATION: Cadle, S H Williams,R.L. , Rubber Chemistry and Technology, Vol. 53, No. 4.

ABSTRACT: Four sample types (tire-wear particulate and tread rubber each in roadside soil and in glass beads) were analyzed periodically for total rubber content by thermogravimetric (TGA), pyrolysis-gas chromatography (GC), and extraction-pyrolysis-GC analyses. Results of the extraction analysis (the most reliable method) show that after 16 months, 52% of the polymer in tread-wear particulate was degraded in soil and only 36% in glass beads (possibly due to lack of soil microorganisms to degrade sulfur linkages in the vulcanized portion of the polymer). Fresh tread particles of the same size showed no degradation. Pyrolysis-GC results, although showing wide scatter, showed that the unsaturated bonds of polybutadiene undergo oxidative degradation more rapidly than the aromatic bonds of styrene units. These results strongly suggest that one important mode of degradation of tread-wear particles is atmospheric oxidation. TGA results show that biodegradation did not reduce the total carbon content of the wear particles in the 16 months, although more than half of the extender oil was oxidized sufficiently to increase its vaporization temperature to the polymer temperature range. Biooxidation may have detoxified some of the polynuclear aromatic hydrocarbon portion of the oil. The rate of environmental degradation was 0.15% per day, 22% of the total removal rate found in a California roadside study. Wind erosion and water run-off probably account for some removal. Note: Description: p. 903-914; References(15); Document Source: National Highway Traffic Safety Administration.

ACCESS: Available through Interlibrary Loan.

Environmental Fate and Effects of Styrene

CITATION: M. Alexander. , Crit.Rev.Environmental Science & Technology: ES&T, 1997. Vol. 27, No. 4, Pg. 383-410.

ABSTRACT: Enormous quantities of styrene are produced each year. Monitoring studies show that the concentrations in air usually are less than 10 $\mu\text{g}/\text{m}^3$ and the levels in waters are usually less than 20 $\mu\text{g}/\text{l}$. The compound is highly reactive in air, and it readily biodegrades under aerobic conditions in soils and waters. Many evaluations have been made of the toxicity of styrene. Based on the results of these toxicological studies, information on the concentrations of the compound in natural environments, and data showing its reactivity in the air, volatilization from soil and water, and rapid biodegradation, styrene is not deemed to cause deleterious effects on nonmammalian species, mammals, or natural communities of organisms as a consequence of environmental exposures, except in the immediate vicinity of a spill.

ACCESS: Unknown.

Expanded Polystyrene As A Source Of Contaminants

CITATION: V. Zitko. , Marine Pollution Bulletin, 1993. Vol. 26, No. 10, Pg. 584-585.

ABSTRACT: The low molecular weight components of expanded polystyrene were investigated by dissolving a sample in carbon tetrachloride, evaporating and extracting with hexane. The insoluble portion was identified by infra-red spectroscopy as hexabromocyclododecane. Three halogenated compounds were revealed in the soluble material by thin layer chromatography, while styrene dimers and trimers were detected by gas chromatography-mass spectrometry. These compounds were found in hexane-extractable fractions of beach foam or in the surface of the sea. Alternative plastic formulations were desirable for marine use.

ACCESS: Available through Interlibrary Loan.

Generation of Volatile Organic Compounds from Nonvolatile Precursors in Water by Treatment With Chlorine or Ozone

CITATION: R. E. Sievers, R. M. Barkley, G. A. Eiceman, et al. , Water Chlorination: Environmental Impact and Health Effects Vol.2, Jolley, R.L., Gorchev, H.and Hamilton, D.H., Jr., (Eds.).Proceedings of a Conference, October 31 - November 4, 1978. Vol. Tennessee. p 615-624, Pg. 12 ref. EPA R804472010 & R803968020.

ABSTRACT: The presence of toluene, styrene and xylenes formed by chlorine treatment in the drinking water of approximately 20 US cities is reported. The major products of ozonolysis of wastewater are identified as being aliphatic aldehydes and alkanes. In some samples, the concentration of toluene also was found to increase upon ozonolysis. The production of aliphatic compounds in ozonized wastewater and the enhanced level of toluene found in some samples indicate that appropriate conditions of ozone treatment and/or plant influent composition may result in production of aromatic species as well as aliphatic hydrocarbons. It is suggested that investigations should be directed to determination of possible precursors of these products.

ACCESS: Available through Interlibrary Loan.

The Impact Of Organic-Rich Waste Released Into New York Bight Sediment; Dredging Harbors; What To Do With Toxic Waste; A Symposium

CITATION: Aleksandra Moch and Gerald M. Friedman. , Northeastern Geology and Environmental Sciences, 1999. Vol. 21, No. 1-2, Pg. 49-101.

ABSTRACT: The New York Bight sediment has been a subject of research for almost a century. The huge amount of toxic waste dumped into the Bight has a visible impact on the biota and has become an important concern to human health. Analyses of sediments from 11 sites located in the New York Bight Apex, mostly between preexisting Sewage Sludge and Dredged Material dump-sites, show various sources of pollution. Some pollutants derive from past dumping, which is documented in the sediment by persistent compounds such as polycyclic aromatic hydrocarbons (PAHs) and dicarboxylic acids. Sites located closer to the Dredged Material Dump Site are richer in hydrocarbons, whereas sites located closer to the Sewage Sludge Dump Site are richer in plasticizers (dicarboxylic acids). Recently the main sources of pollution are run-off, fall-out, emergency releases of sewage, and oil spills. The Hudson-Raritan estuary is the main way of pollution transport. Sites located closer to the estuary are the most polluted. The total carbon concentration did not improve significantly since the dumping period. This fact indicates the increase in primary production, slow dumped sewage decomposition, or/and continuous input of carbon-rich wastes. Styrene (straight-chain hydrocarbon) and plasticizers present in the sediment samples originate from sewage sludge. High amounts of PAHs (polycyclic aromatic hydrocarbons) originate from both ash and petroleum. The rest of detected hydrocarbons have biogenic and/or petroleum origin. The

amount of organic matter and fine-grained sediment (silt and clay) control the distribution of contaminants in the study area by adsorption processes. The highest concentrations of organic matter and fine-grained sediment were found in cores located close to Sandy Hook and in Hudson Shelf Valley. The sediment samples are predominantly sandy with only a minor amount of silt, clay and gravel. The solid particles of the waste such as ash, synthetic fibers, pieces of bricks, porcelain, plastic, and glass introduced into the sediment changed its natural texture. Most of the sediment samples represent a reducing to strongly reducing environment causing the depletion of oxygen and of aquatic life as well as the increase in time of pollutants decomposition. The presence of hydrogen sulfide makes the environment toxic for most of the biota. Some of the detected hydrocarbons are polycyclic aromatic hydrocarbons (PAHs) which have been shown to be carcinogens and/or mutagens. Note: CD: #05160; FE: References: 62; illus. incl. 11 tables, sketch maps.

ACCESS: Available through Interlibrary Loan.

Investigation of Selected Potential Environmental Contaminants: Styrene, Ethylbenzene, and Related Compounds

CITATION: Santodonato, J Meylan, W M Davis, L N Howard, P H Orzel, D.M.

ABSTRACT: This report reviews the potential environmental hazard from the commercial use of four related compounds: ethylbenzene, styrene, alpha-methylstyrene, and divinylbenzene. Both ethylbenzene and styrene are produced in 6-7 billion pounds per year while the other two compounds are produced in much smaller quantities. Ethylbenzene is used to produce styrene and styrene and the other monomers are used to make polystyrene and other resins, elastomers, and rubbers. Significant non-commercial sources of the compounds are also possible including automobile exhaust, gasoline, and other combustion sources. Ethylbenzene and styrene have both been detected in air and water samples. Information on physical and chemical properties, production methods and quantities, commercial uses and factors affecting environmental contamination and information related to health and biological are reviewed.

Note: Description: 279 p.; Document Source: National Technical Information Service.

ACCESS: Available through Interlibrary Loan.

Leaching of Tetrachloroethylene From Vinyl-Lined Pipe

CITATION: A. H. Demond. , Journal of Environmental Engineering Vo.111, 1985. Vol. February, Pg. 12 Ref.

ABSTRACT: Tetrachloroethylene (perchloroethylene, or PCE) was used as a solvent for Piccotex, a vinyl-toluene methyl styrene co-polymer, which was then sprayed on the interior of finished asbestos cement pipe. A total of about 1050 miles of pipe were installed before a PCE contamination problem was discovered in water from the pipes. The movement of PCE through Piccotex can be described by the diffusion equation with a concentration dependent diffusion coefficient. Extrapolation of the laboratory drying curves to zero concentration yielded an estimate of the total drying time under idealized laboratory conditions of 1,250 days. Use of this drying time to predict a problem lifetime in the field is difficult. There may exist large differences not only between the laboratory and field environment, but also between individual pipelines in the field. An analysis of some of the differences between the laboratory condition and the field situation supports the conclusion that the leaching of PCE in the field may continue over a longer time period than in the laboratory. (Baker-IVI).

ACCESS: Available through Interlibrary Loan.

Marine and Estuarine Geochemistry

CITATION: Geological Survey Reston, VA. , Lewis Publishers, Inc., 1985.

ABSTRACT: As the world 's terrestrial environments become further populated, marine and estuarine ecosystems are being increasingly impacted by anthropogenic activities, particularly by the disposal of waste products. To predict the effects of these activities, it is necessary to understand fundamental marine and estuarine processes. Both directly and indirectly the chapters in this book address this issue, integrating concepts and analytical techniques from chemistry, biochemistry, geochemistry and oceanography. Topics in organic and inorganic geochemistry, as well as data on nutrient cycling, are represented. Studies of specific biogenic compounds are complemented by studies of the distributions and fate of anthropogenic PCBs (polychlorinated biphenyls), silicones and the pyrolyzate styrene. Many of the chapters emphasize the need for in-depth measurements over annual cycles to establish baseline biogenic inputs. Even in the deep sea, the flux of organic matter in the water column, and its composition, are subject to seasonal fluctuations of primary productivity in surface waters. Geographically, these chapters cover the Pacific , Atlantic and antarctic oceans, and major estuaries from Tokyo Bay and the Keum Estuary (Korea) in Asia to San Francisco Bay, Chesapeake Bay, and the St. Lawrence Estuary in North America. Studies include transport processes, and nutrient and metal distributions by depth as well as regionally. Nutrient cycling and the mass balance of essential elements such as carbon and nitrogen have been considered using a wide range of analytical methods and state-of-the-art sampling techniques. To determine the effects of anthropogenic activities on marine and estuarine environments, these processes must continue to be studied and adequately understood.

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The Neutral Red Lysosomal Retention Assay And Comet Assay On Haemolymph Cells From Mussels (Mytilus Edulis) And Fish (Symphodus Melops) Exposed To Styrene

CITATION: Emina Mamaca, Renee K. Bechmann, Sigfryd Torgrimsen, et al. , Aquatic Toxicology, 2005/11/10. Vol. 75, No. 3, Pg. 191-201.

ABSTRACT: Despite the extensive transport of chemicals at sea, there is current lack of knowledge of the fate and effects of many of them on the marine biota. The current regulation that follows the GESAMP-MARPOL classification is mainly based on ecotoxicity assessment from fresh water based studies. Repetitive spills in marine coastal environment from tanker ship loaded with several thousand tonnes of chemicals raised concern about whether the existing freshwater data location can be used to predict the behaviour and the environmental effects of contaminants in marine surroundings. There is a general lack of information of the fate of chemicals at sea. A deviating pattern in marine environment from that in freshwater may have significant consequences for the counteracting actions taken to fight the spill, on staff working on the site of spill as well as on marine life present in the vicinity of the accident. In the present article, an environmental effect study of styrene was conducted as part of the ECOPEL program. We report some biological effects of styrene in laboratory-exposed marine organisms. Styrene was continuously supplied at a nominal concentration of 2 mg L⁻¹ over 7 days to both mussels (*Mytilus edulis*) and fish (*Symphodus mellops*). At the end of this period, DNA damage was assessed by the Comet assay performed on blood (fish) and haemolymph (mussel) cells. In mussels, the lysosomal membrane stability was additionally assessed by the neutral red retention time assay (NRRT). Significant biological responses were observed over the studied period in both organisms with these two tests. Hence, the results favour the use of a biomarker-based approach to assess the health conditions in case of spill.

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Occurrence and Distribution Of Organic Contaminants In The Aquatic System In Berlin. Part II: Substituted Phenols In Berlin Surface Water

CITATION: K. Schmidt-Baumler, T. Heberer and H. J. Stan. , *Acta hydrochimica et hydrobiologica*, 1999. Vol. 27, No. 3, Pg. 143-149.

ABSTRACT: As part of a screening programme, 30 representative samples of surface water taken from rivers, canals and lakes in the Berlin area were studied with reference to their content of 22 substituted phenol derivatives, including those contained in the U.S. EPA priority list. The target compounds were extracted by adsorption onto a styrene-divinylbenzene polymer and derivatized by reaction with a substituted N-methyl-trifluoroacetamide compound, then analysed using capillary gas chromatography with mass spectrometric detection. In addition to phenol the samples contained cresols, 2-ethylphenol, 2-chlorophenol, 4-chloro-3-methylphenol, pentachlorophenol, 2-nitrophenol and 4-nitrophenol in amounts which ranged from 0.02 ug per litre to 7.8 ug per litre. Their distribution was such that none of these compounds, apart from pentachlorophenol and 2-ethylphenol, appeared to originate from municipal effluent discharges. Many of the compounds are therefore assumed to be either of natural origin or to occur as a result of non-point source contamination of anthropogenic origin. (See also Aqualine Abstract No.99-1129). (See also following abstract).
ACCESS: Available through Interlibrary Loan.

Prevalence Of Microplastics In Singapores Coastal Marine Environment

CITATION: K. L. Ng and J. P. Obbard. , *Marine Pollution Bulletin*, 2006. Vol. 52, No. 7, Pg. 761-767.

ABSTRACT: Microplastics have been recently identified as marine pollutants of significant concern due to their persistence, ubiquity and potential to act as vectors for the transfer and exposure of persistent organic pollutants to marine organisms. This study documents, for the first time, the presence and abundance of microplastics (>1.6 m) in Singapores coastal environment. An optimized sampling protocol for the collection and analysis of microplastics was developed, and beach sediments and seawater (surface microlayer and subsurface layer) samples were collected from nine different locations around the coastline. Low density microplastics were separated from sediments by flotation and polymer types were identified using Fourier transform infrared (FTIR) spectrometry. Synthetic polymer microplastics identified in beach sediments included polyethylene, polypropylene, polystyrene, nylon, polyvinyl alcohol and acrylonitrile butadiene styrene. Microplastics were detected in samples from four out of seven beach environments, with the greatest quantity found in sediments from two popular beaches in the eastern part of Singapore. Polyethylene, polypropylene and polystyrene microplastics were also found in the surface microlayer (5060 m) and subsurface layer (1 m) of coastal waters. The presence of microplastics in sediments and seawater is likely due to on-going waste disposal practices from industries and recreational activities, and discharge from shipping. Note: TR: CS0718844.
ACCESS: Available through Interlibrary Loan.

Purgeable Organics In Great Lakes Raw and Treated Water

CITATION: R. Otson. , *International Journal of Environmental Analytical Chemistry*, 1987. Vol. 31, No. 1, Pg. 41-53.

ABSTRACT: Levels of 51 volatile organics from the U.S. EPA priority pollutants list were determined (GC-MS) in raw and treated water samples from 9 designated priority municipalities (including 10 water treatment works) along a portion of the Great Lakes system. Comparisons of raw and treated water supplies enabled an assessment of the effects of treatment on levels of organics in potable water to be made. Only dichloromethane and chloroform had maximal concentrations above 10 ug per litre and bromodichloromethane, chlorodibromomethane, dichloroacetonitrile, toluene and styrene were detected at least once

above 1.0 ug per litre. Trihalomethane (THM) values did not exceed 32 ug per litre. Water treatment was, overall, not very effective in removal of low levels (0.1 to 5 ug per litre) of volatile organics from raw water. No trends in selected organics along the Great Lakes system were evident and levels were comparable to those found in other Canadian water supplies.

Note: Publication focus: Case Study.

ACCESS: Available through Interlibrary Loan.

Research In Environmental Pollution. 1. Determination of Polychlorinated Styrenes (PCS's) In Rhine Fish

CITATION: H. Steinwandter and L. Zimmer. , Analytical Chemistry, 1983. Vol. 316, No. 7, Pg. 705-710.

ABSTRACT: From 159 possible isomeric polychlorinated styrene compounds 14 isomers were identified in Rhine fish. The identification was performed by gas-chromatography, mass-spectroscopy and mass-fragmentography after liquid chromatographic fraction of 6 x 1 ml on silica gel.

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Site Of Train Wreck Near Lewisburg, Tennessee Which Resulted In The Release Of Over 15,000 Gallons Of Chloroform (DNAPL) And 4,000 Gallons Of Styrene (LNAPL) Into a Karst Aquifer

CITATION: Nicholas C. Crawford, Geary M. Schindel, Elwin D. Hannah, et al. , 1991. Note: LL: Latitude:N352700,N352700 Longitude:W0864800,W0864800; CY: GeoRef, Copyright 2006, American Geological Institute.

ACCESS: Unknown

Study On Acute Toxicity Effect of Styrene On Aquatic Organism

CITATION: Xin-qiang Shen and Qi Yuan. , Marine Environmental Science, 2006. Vol. 25, No. 4, Pg. 33-35.

ABSTRACT: The standard experiment animals *Daphnia magna* and *Brachydanio rerio* were used to study the acute toxicity effect and safety concentration of styrene on aquatic organism. The experiment results showed that the semi-lethal concentrations of *Daphnia magna* and *Brachydanio rerio* presented a declining trend with increasing time exposing in experiment solution of styrene and reflected the enduring degree of *Daphnia magna* and *Brachydanio rerio* for styrene toxicity reduced with time. The 96h-LC50 of styrene for *Daphnia magna* and *Brachydanio rerio* were 11.35 and 121.04 mg/L, respectively. The LC50 in various time stages of styrene on *Daphnia magna* and *Brachydanio rerio* were obtained through changing the experiment solution each 6h and 4h, respectively and actual semi-lethal concentrations should be lower than experiment values because styrene in different concentrations still exist volatilization during 6h and 4h. The safety concentration of styrene for the aquatic organism should be lower than 0.11 mg/L according to styrene toxicity and following most sensitive principle. Note: Record Owner: Copyright 2004 The Thomson Corporation.; Language of Summary: Chinese; English; Super-Taxa: Crustacea, Branchiopoda, Cladocera; Pisces, Actinopterygii, Cypriniformes, Cyprinidae.; Systematics: *Daphnia magna* (Cladocera); *Brachydanio rerio* (Cyprinidae).; Update Code: 200703.

ACCESS: Available through Interlibrary Loan.

Note: Need to be sure this is in English.

Styrene Toxicity: An Ecotoxicological Assessment

CITATION: B. F. Gibbs and C. N. Mulligan. , Ecotoxicology and environmental safety, 1997.

Vol. 38, No. 3, Pg. 181-194.

ABSTRACT: Although other aromatic compounds (e.g., benzene, toluene, polycyclic aromatic hydrocarbons (PAH), etc.) have been thoroughly studied over the years, styrene has been given little attention probably due to its lower rate of industrial use. In addition, it is less toxic than benzene and PAH, proven carcinogens. However, it is classified as a mutagen and thus potentially carcinogenic. Its main use is in the production of the polymer polystyrene and in the production of plastics, rubber, resins, and insulators. Entry into the environment is mainly through industrial and municipal discharges. In this review, the toxicological effects of styrene on humans, animals, and plants are discussed. Its mode of entry and methods of monitoring its presence are examined. Although its effects on humans and aquatic life have been studied, the data on short- or long-term exposures to plants, birds, and land animals are insufficient to be conclusive. Since exposure to workers can result in memory loss, difficulties in concentration and learning, brain and liver damage, and cancer, development of accurate methods to monitor its exposure is essential. In addition, the review outlines the present state of styrene in the environment and suggests ways to deal with its presence. It might appear that the quantities are not sufficient to harm humans, but more data are necessary to evaluate its effect, especially on workers who are regularly exposed to it. Note: RN: 0 (Carcinogens); 0 (Mutagens); 0 (Plastics); 0 (Styrenes); 0 (Water Pollutants, Chemical); 100-42-5 (Styrene).

ACCESS: Available through Interlibrary Loan.

Toxicity Tests To Assess Pollutants Removal During Wastewater Treatment and The Quality Of Receiving Waters In Argentina

CITATION: C. E. Gómez, L. Contento and A. E. Carsen. , Environmental toxicology, 2001. Vol. 16, No. 3, Pg. 217-224.

ABSTRACT: In Argentina, legislation to control adverse impacts of effluent discharges and the quality of receiving waters is scant and relies mainly on the physicochemical characteristics of the effluents and receiving waters. Objectives of this study were to use standardized acute toxicity tests to assess treatment of petrochemical industry effluents and the toxicity of various treated industrial effluents in the Buenos Aires metropolitan area and their receiving waters. Tests for the first objective used *Daphnia magna* and *Ceriodaphnia dubia*; those for the second used *D. magna*, *Spirillum volutans*, and *Scenedesmus spinosus*. Chemical analyses demonstrated that the removal of aromatic hydrocarbon compounds (benzene, toluene, ethylbenzene, xylene, styrene, and naphthalene) from the petrochemical effluents ranged between 77 and 93%, but toxicity removal was significantly lower: untreated effluents were very toxic and treated effluents were very toxic to toxic [acute toxicity units (TUa) > 3]. Physicochemical parameters measured according to current Argentinian regulations indicated that industrial effluents (e.g., from textile and paper industries) were within established guidelines, but 25% of the samples were moderately to highly toxic (TUa > 1.33). However, for the receiving waters, toxicity tests were moderate to very toxic. The results show the need of including tests for toxicity of discharged effluents, and their effects on receiving waters of Argentina, especially for regulatory purposes. Note: RN: 0 (Polycyclic Hydrocarbons, Aromatic); LR: 20031114.

ACCESS: Available through Interlibrary Loan.

Unusual Polyhalogenated Chemical Residues Identified In Fish Tissue From The Environment

CITATION: D. W. Kuehl. , 1981.

ABSTRACT: Unusual polyhalogenated compounds identified in fish are the subject of a review

of the 1970-80 literature. Not included are papers on routine monitoring or papers describing laboratory bioassays. Some of the compounds were pesticides, their metabolites, or their manufacturing intermediates: methylthiopentachlorobenzene and di-(methylthio)tetrachlorobenzene, dimethyltetrachloroterephthalate, chloronorborene and chloronorborene compounds, polychlorinated dibenzo-p-dioxins, trifluralin, 1,3,5-trichloro-2-(4-nitrophenoxy)benzene, polychloro-2-(chloromethylsulfonamide) diphenyl ethers and metabolic products, pentachlorophenol, dichlorobenzophenone, hexachlorobenzene, mirex, kepone, chlordane epoxide, 1-hydrolychlordane, and toxaphene. Industrial chemicals and their intermediates are chlorofluorotoluene mixture, hexachloro-1,3-butadiene, 2,4,6-trichlorophenol, isomers of chloroguaiacol, polychlorinated dibenzofurans, polychlorinated terphenyls, polychlorinated styrene, and 2-chloroaniline. Many brominated compounds were found in fish living in waters receiving effluents disinfected with bromine chloride. Other compounds include chloramines, trichlorophenol, pentachloroanisole, and polychlorinated naphthalenes. (Cassar-FRC).

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