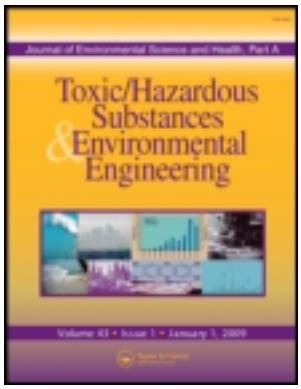

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Vinyl chloride removal from an air stream by biotrickling filter

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Vinyl chloride removal from an air stream by biotrickling filter

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A biofiltration process was used for degradation of vinyl chloride as a hazardous material in the air stream. Three biotrickling filters in series–parallel allowing uniform feed and moisture distribution all over the bed were used. Granular activated carbon mixed with compost was employed as carrier bed. The biological culture consisted of mixture of activated sludge from PVC wastewater treatment plant. Concurrent flow of gas and liquid was used in the bed. Results indicated that during the operation period of 110 days, the biotrickling bed was able to remove over 35% of inlet vinyl chloride. Maximum elimination capacity was calculated to be 0.56 $g.m^{-3}.hr^{-1}$. The amount of chlorine accumulated in the circulating liquid due to the degradation of vinyl chloride was measured to be equal to the vinyl chloride removed from the air stream.

Keywords: Biofiltration, biotrickling filter, vinyl chloride, gas pollutants.

Introduction

Vinyl chloride (VC) is a colorless compound with a fairly sweet odor in gas state at room temperature. VC is heavier than air, has relatively low solubility in water but is soluble in almost all of the organic solvents. Hydrogen chloride is produced with combustion of vinyl chloride in air. In the absence of air and at room temperature it is very stable and non-corrosive. Vinyl chloride is a human carcinogen, targeting liver, brain, lung and hemo-lymphopoietic system. The common route of toxic exposure with VC is by inhalation.[1]

USA Occupational Safety and Health Administration (OSHA) has set a limit of 1.0 ppm (2.56 mg/m^3) VC in air for the workplace, averaged or 8-h exposure per day over or during any work shift. An employee's exposure may not exceed a ceiling concentration limit of 5 ppm (12.8 mg/m^3), over any period not to exceed 15 min.[2]

Most of the vinyl chloride production in the world is for producing polyvinyl chloride and other copolymers with vinyl acetate and vinylidine chloride monomers. The largest use of PVC is in the production of plastic piping and conduits. Other applications are in floor coverings, consumer goods, electrical and transportation applications.[2]

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A major part of the industrially produced VC vents to the environment by air or wastewater streams.[3] Biofiltration has been known as an effective waste control technology for odors and Volatile Organic Compounds (VOCs). Biofiltration is energy efficient, cost effective and does not produce toxic by-products and has some advantages over other physical and chemical methods such as catalytic and thermal oxidations, wet scrubbing and activated carbon adsorption.[4] Biofiltration is very effective for gas flows with low pollutant concentrations and high volumetric flow rates. In spite of these advantages, biofiltration efficiency is affected by biomass instability. Microorganisms are very sensitive to high concentration peaks of pollutants that can suddenly reduce the performance of the process. Moreover, long start-up periods are required to reach the maximum efficiency.[4]

A biofilter is a fixed bed reactor whose porous matrix acts as support for microorganisms. Volatile compounds migrate through the gas phase of the biofilter, dissolve into the "biofilm" and get biodegraded by microorganisms. Water and in most cases nutrients and a buffer solution, have to be furnished for microorganisms.[5] Microorganisms consume nutrients for the synthesis of lipids, proteins and polysaccharides, which are found in the cellular matter.[4]

Biotrickling filters consist of a bed of rough media such as crushed trap rock, granite, activated carbon, limestone, clinkers, wood slats, plastic tubes, corrugated plastic sections, hard coal, or other material over which gas and water are distributed and contacted.[6] Contaminated air flows over the contact media on which a biofilm develops.