Ground Water, Surface Water, and Leachate

Bioreactors

Introduction:

Contaminants in ground water are put into contact with microorganisms in attached or suspended growth biological reactors. Suspended systems, such as activated sludge, consist of contaminated ground water that is distributed in an aeration basin. For attached systems, for example rotating biological contractors and trickling filters, microorganisms are located on a static support matrix.

Description:

Bioreactors break down contaminants in water with microorganisms through attached or suspended biological systems. In suspended growth systems, the cells form a sludge, which is settled out in a clarifier, and is recycled to the aeration basin or disposed of.

One hopeful methodology comprises of the use of active supports (such as activated carbon, which adsorbs the contaminant and slowly releases it to the microorganisms for degradation). The microbial population can be either from the contaminant source or from an inoculum of organisms that are specific to a certain contaminant. Other functions include wetland ecosystems and column reactors. Nutrients are frequently added to the bioreactors to sustain the growth of microorganisms.

Bioreactors are a long-term technology, with the process potentially taking several years.

An additional aerating wastewater treatment is the trickling filter. The trickling filter consists of a bed of permeable media, a water distributor, and an under drain system. Wastewater is spread over the top of the filter bed through which wastewater is trickled. The microorganisms attached to the filter medium break down the organic contaminants in wastewater. The filter media can be rocks, plastic, or wood. The filter bed is generally round with depth varying from 3 to 8 ft (0.9 to 0.5 m) and average 6 ft (1.8 m). As wastewater flows over the filter media, it is aerated and the microorganisms attached to the media surface degrade the organic contaminants. The under drain system is employed to collect the treated water and any biomass that detaches from the filter media during the treatment process. It is also essential as a porous structure through which air will be able to circulate.

The period of operation and maintenance of sprinkler irrigation is governed by the sum of time required to capture and treat the contaminated wastewater and the monitoring of possible metal accumulation that may occur.

Applicability:

Bioreactors are utilised principally to treat SVOCs, fuel hydrocarbons, and any biodegradable organic material. The process is less effective for some pesticides. Successful pilot-scale field studies have been performed on a few halogenated compounds, such as PCP, chlorobenzene and dichloro-benzene isomers. Bioreactors with co-metabolites are used to treat PCBs, halogenated VOCs, and SVOCs in extracted ground water.

Limitations:

- The dilute nature of contaminated ground water regularly will not support an adequate microbial population density. Nutrient addition may be necessary.
- Especially high contaminant concentrations may be toxic to microorganisms.
- Air pollution controls may be required if there is volatilisation from activated sludge processes.
- Low ambient temperatures considerably decrease the biodegradation rates, resulting in longer cleanup times or increased costs for heating.

- Undesirable microorganisms may preferentially colonise bioreactors, leading to reduced effectiveness.
- Waste from sludge processes will require treatment or disposal.
- Discharge of treated effluents could be regulated.

Data Needs:

Data wants include identification of the contaminants and their concentrations, pH, presence of compounds toxic to microorganisms, contaminant biodegradability potential, BOD5, COD, suspended solids, temperature, nutrient levels and flow rate.

Performance Data:

This technology is well developed and has been used for decades to treat public and industrial wastewater. Only in the past decade, studies have been carried out to appraise the effectiveness of bioreactors at treating ground water and leachate from hazardous waste sites. Required equipment and materials are easily available and in accordance other pump-and-treat technologies, the time needed to clean up is dependent upon subsurface conditions and the rate of desorption of contaminants from subsurface materials. The start-up process can also be slow if the degrading micororganisms need to acclimatise to the waste stream. However, the existence of cultures that have been earlier adapted to certain hazardous wastes can aid in decreasing the start-up and detention times.

Cost:

Chemical Oxygen Demand (COD) is the primary cost driver, with pH adjustment the secondary cost driver due to the amount of acid/base required to neutralise the pH of the waste stream.