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Chapter 5

Perspectives on Biological Treatment of Sanitary Landfill Leachate

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Abstract

Landfilling, one of the prevailing worldwide waste management strategies, is presented together with its benefits and environmental risks. Aside from biogas, another non-avoidable product of landfilling is landfill leachate, which usually contains a variety of potentially hazardous inorganic and organic compounds. It can be treated by different physico-chemical and biological methods and their combinations. The composition and characteristics of landfill leachate are presented from the aspect of biotreatability. The treatment with activated sludge, mainly consisting of bacterial cultures under aerobic and anaerobic conditions in various reactor systems, is explained, including an extensive literature review. The potential of fungi and their extracellular enzymes for treatment of municipal landfill leachates is also presented, with a detailed review of the landfill leachate treatment studies. The future perspectives of biological treatment are also discussed.

Keywords: Activated sludge treatment, biotreatability, fungal treatment, landfill leachate

1. Introduction

Landfilling is still widely accepted and used in any waste management strategy, but it can constitute a hazard for the environment. This method generally offers lower cost of operation and maintenance when compared to other methods, such as incineration. Besides households and urban activities, the industry is directly associated with the production of large amounts...
of solid wastes. Several methodologies and strategies have been developed for the integrated management of these wastes. They start with pollution prevention, waste minimization (zero waste), reuse of products or their parts, as well as material and/or energy recovery. But in spite of all environmental policies, the majority of municipal and industrial wastes still end up at the landfill and the amount of deposited wastes is significant worldwide. Landfill still accounted for nearly 40% of municipal waste treated in the European Union in 2010. In the 25 countries of the European Union, 502 kg of municipal waste was generated per person in 2010, while 486 kg of municipal waste was treated per person: 38% was landfilled, 22% incinerated, 25% recycled, and 15% composted.

In the deposited wastes, organics are still present even after thorough waste separation, mainly due to the dirty packages and other remains that could not be completely separated; thus, microbial processes dominate the stabilization of the waste and lead to the generation of the landfill gas, and dictate the amount and composition of the leachate. Landfill leachate is defined as wastewater formed due to precipitation, deposited waste moisture, and water, formed within the body of the landfill. Untreated leachates can permeate groundwater or mix with surface waters and contribute to the pollution of soil, ground water, and surface waters. Careful site management can reduce the quantity and increase the purity of the formed leachate, but it cannot completely eliminate it. Its composition is therefore site- and time-specific, based on the characteristics of deposited solid wastes, physico-chemical conditions, rainfall regime that regulates moisture level, and landfill age. Even within a single landfill site, variability is frequently evident [1, 2, 3]. Significant components of leachate at the beginning of landfill operation are heavy metals and degradable organics, while persistent organic pollutants usually appear later as a result of biotic (i.e., living components that constitute an ecosystem) and abiotic (i.e., non-living chemical and physical components that affect living organisms and the performance of ecosystems) processes in the system. Among these substances are several compounds classified as potentially hazardous: bio-accumulative, toxic, genotoxic (chemical compounds that damage the genetic information within a cell causing mutation that may lead to cancer), and they could have endocrine disruptive effect [2]. Hazardous substances from the leachate should be caught and removed properly, to avoid spreading in the receiving environment. Efficient treatment methods must be matched to the actual characteristics of a particular leachate and they could vary with time. Often, biological processes are employed if biotreatability in terms of low toxicity and at least moderate biodegradability of the leachate is indicated [2, 4].

Biodegradability of the wastewaters and also leachates is usually determined using various non-standardized laboratory or pilot-scale long-term tests with activated sludge as the source of active microorganisms [5]. Toxicity tests must be accomplished prior to the biodegradability determination to assess the impact of landfill leachate components on microorganisms of the aerobic or anaerobic activated sludge. Biodegradability assessment of leachates usually starts with the determination of ready biodegradation in common environmental conditions, it is upgraded with the assessment of biodegradation potential in an inherent biodegradability assessment test under optimal conditions, and it is finally concluded with a simulation of biodegradation in the wastewater treatment plant. All of the mentioned tests are based on the


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