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Copper, Cadmium and Ferrous Removal by Membrane Bioreactor

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Abstract

One of the important concerns in Tehran municipal landfill is the production of leachate and its potential for water resources pollution. This paper investigates the removal of heavy metals from landfill leachate by using a membrane Bioreactor (MBR). The leachate was collected from a landfill in the vicinity of Tehran nearly 1 year old, The results of this study indicated that the system provided high removals of Fe, Cu and Cd equal to 96%, 23% and 84% respectively and heavy metal concentration in MBR effluent is a function of aeration ratio and bioaccumulation. Among the metals investigated in the present study it can be concluded that the extracellular adsorption, is the principal removal process of the metals, compared to other removal mechanisms such as bioaccumulation or intracellular accumulation.

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Keywords: Landfill Leachate, Heavy Metals, Membrane Bioreactor, Adsorption.

1. Introduction

The method of anaerobic sanitary landfill for the disposal of municipal solid wastes continues to be widely used in most countries throughout the world [1-3]. One of the most important issues of concern in landfill management is the production of landfill leachate and its potential for degrading water resources [4].

Heavy metals constitute one of the pollutant groups that are kept under surveillance in leachate from

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landfills for municipal solid waste (MSW) [5]. Since 1970s heavy metals have been causing a growing concern over their toxic effects on humans and aquatic ecosystems. A significant part of anthropogenic emissions containing heavy metals ends up in wastewaters treated by activated sludge processes, affecting microbial biomass growth and thus the depurative efficiency of the treatment. In fact biological wastewater systems are mainly designed for organic matter removal and only side-benefit can be observed in the treatment of heavy-metal-bearing streams. Microorganisms of activated sludge can remove heavy metals by different mechanisms, which can be classified according to their dependence or less on the metabolism activity as bioaccumulation and biosorption, respectively [6]. The chemical forms of heavy metals are rather complex in leachates, and usually consist of organic complexes, inorganic complexes, and free ions. Of these three forms, organic and inorganic complexes are usually the major components, which mean that a portion (often the major portion) of the heavy metals is colloid-bound [7]. The technologies available for the removal of heavy metals include chemical precipitation, adsorption, ion exchange and Reverse Osmosis. Metal removal in biological treatment processes is mainly by adsorption and complexation of the metals with the microorganisms, Microorganisms combine with metals and adsorb them to cell surfaces because of interactions between the metal ions and the negatively charged microbial surface. Metals may also be complexed by carboxyl groups found in microbial polysaccharides and other polymers, or absorbed by protein materials in the biological cell. A significant amount of soluble metal removal has been observed in biological processes, with removal ranging from 50 to 98 percent depending on the initial metal concentration, the biological reactor solids concentrations and systems SRT [8]. This finding indicated that main mechanisms operating in metal removal by active sludge are metabolism-independent biosorption mechanisms. The prominence of biosorption phenomena in metal removal by activated sludge has been already reported in the literature [6]. The removal of metals in biological processes has been found to fit adsorption characteristics displayed by the Freundlich isotherm model. The Freundlich isotherm is used most commonly to describe the adsorption characteristics [8]. In this study, Using these values Fe, Cu, and Cd Removal (QMe, mg/g VSS) can be calculated by the metal material balances in the reactor by equation number 1 [6]:

$$F.\ (C_0 - C) = F_w\ .\ X\ .\ QMe \qquad (1)$$

Where F (L/d) and F_w (L/d) are the influent and the sludge withdrawal flow-rates, respectively. C_0 (mg/l) and C (mg/l) are influent and residual metal concentrations at steady rate, and X (g/l) is the biomass concentration at the end of the aerobic phase in the sludge withdrawal stream [6].

Regarding the above facts, the present study set one of its goals to investigate the efficiency of municipal landfill leachate metals removal in a combined adsorption and biological treatment system. In the experimental phase of the study, a MBR system used in the pilot scale to assess the treatability of metals removal and defining the absorption rate of metals (Fe, Cu and Cd) by absorbent (MLSS).

Table 1. Average quality of landfill leachate used as fed

Parameter	Values	Parameter	Values
COD, mg/L	68250±8000	**Cl⁻, mg/L**	14800±1000
BOD, mg/L	44500±3000	**SO_4, mg/L**	5500±300
NH_3+NH_4-N, mg/L	1470±90	**Conductivity, µmhos/cm**	44150±4500
NO_3+ NO_2-N, mg/L	150±50	**Turbidity, Ntu**	190±8.4
pH	6.9±0.2	**Fe, mg/L**	35.85
PO_4-P, mg/L	130±40	**Cu, mg/L**	2.149
BOD/COD	0.65	**Cd, mg/L**	0.489

2. Material and Methods