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TREATMENT OF COMPLEX LEACHATES OF A MUNICIPAL SOLID WASTE LANDFILL

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Introduction

Dudaim landfill is located about 10 km northwest of Be'er-Sheva, Israel, and occupies 470 dunam. It started its activity in the year of 1990 as a local municipal solid waste disposal site serving Be'er-Sheva and the nearby local and regional councils. Dudaim was upgraded according to stringent environmental requirements and expanded to serve as a significant central waste site, due to a governmental decision of shutting down Hiriya (Tel-Aviv) and unregulated garbage dumps and despite attempts to foil the idea by Be'er-Sheva residents (Not in My Back Yard syndrome). Dudaim currently collects more than 1,000 tons of solid waste per day. One ton of solid waste is estimated to generate approximately 0.2 m3 of leachates. The base and sides of the tip are engineered using a composite clay and high-density polyethylene liner overlain with a sand leachates collection layer to avoid a possibility of liner shrinkage resulting in a crack formation, following leachate migration to pollution of groundwater. Leachates collection system allows the leachates to be recycled back to the waste body in the tip (thus reduces both the time required for a sealed tip to become stable, and the final volume of leachates drained due to increased evaporation loss). It also serves to supply humidity for biodegradation of organic material, and to improve generation of biogas or to be removed using evaporation treatment in the leachate's evaporation lagoon. As a result of height differences between the bottom of the tips and the leachates evaporation lagoon, leachates are pumped to the leachates evaporation lagoon via pumping stations.

Materials and methods

An SBR tank served as a pilot biological reactor for the treatment of leachates. It consisted of a cylindrical PVC vessel with a diameter of 1.4 m and a total water volume of 2.7 m3. The SBR operated in half of its volume with two cycles per day to treat a total of 400 L/day, resulting in a hydraulic residence time (HRT) of 3.33 days. Every cycle began with a short filling of leachates from the settling chamber by underwater pump, followed by four times of aeration and settling stages (settling stage served as anoxic/anaerobic stage) for about two hours and one hour, respectively and finally decanting.

Precipitation of Magnesium-Ammonium-Phosphate (MAP, commonly known as struvite), was carried out to investigate an alternative process for the removal of ammonium due to the limited nitrification achieved. It was done at ambient laboratory temperature. MgO and dil. H_3PO_4 were added to raw leachates in a 1 L Erlenmeyer with a magnetic stirrer. After pH adjustment to 9 by addition of NaOH in concentration of 10 M, the residue obtained was settled by centrifuge in tubes and the supernatant was filtered. The residue was dried for 72 hours at ambient temperature, scaled, and sent to XRD and XRF and the supernatant was tested in biodegradability tests.

Results and conclusions

The results show that biological treatment is feasible for the removal of biodegradable organic matter, with a mean BOD_5, COD and TOC removal of 84.5%, 42.7% and 40.9% respectively. However, aiding processes should be incorporated to improve organics removal. The removal of high ammonia concentrations cannot be achieved by biological nitrification (removal of 23.2% was achieved, see Fig. 1). In laboratory conditions, a chemical precipitation (Struvite) of the leachates with $MgO+H_3PO_4$ or with $MgCl_2{\cdot}6H_2O+Na_2HPO_4{\cdot}7H_2O$ in equal molar ratio of $Mg:NH_4:PO_4$ demonstrated high removal of ammonia (76.8±6.4% and 80.7±4.5%, respectively), as shown in Table 1. Incorporation of an anoxic stage in reactor operation enables to achieve efficient denitrification (80.0%) to remove nitrates present in the raw leachates.

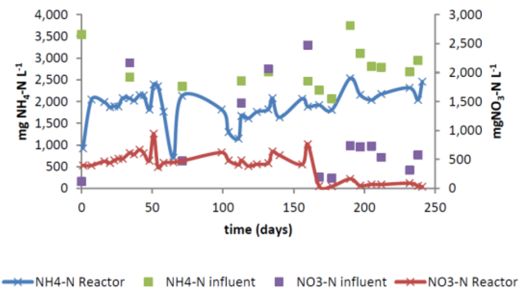

Fig.1. Transformations of nitrogen compounds in the biological reactor.

Table 1. Ammonia removal by MAP (Struvite) precipitation with molar ratio 1:1:1

Chemicals added	NaOH 10M (ml 100 ml^{-1})	%NH_4 Removal	Residue (mg ml^{-1} leachates)
MgO H_3PO_4	3.36±0.47	76.8±6.4	42.65±6.56
$MgCl_2{\cdot}6H_2O$ $Na_2HPO_4{\cdot}7H_2O$	1.76±0.09	80.7±4.5	42.35±1.27

➢ The leachates of Dudaim are considered difficult for treatment because of low amount of biodegradable organic matter and high amount of ammonia.

➢ Biological treatment of Dudaim leachates was found to be a feasible solution for the removal of biodegradable organic matter. However, aiding processes should be incorporated to improve organics removal.

➢ The removal of the high ammonia concentrations cannot be achieved by biological nitrification. A chemical precipitation (Struvite) with $MgO+H_3PO_4$ or with $MgCl_2 \cdot 6H_2O+Na_2HPO_4 \cdot 7H_2O$ in molar ratio of 1:1:1 demonstrated high removal of ammonia (76.8±6.4% and 80.7±4.5%, respectively). In addition, Struvite precipitation with $MgO+H_3PO$ resulted in a decrease of organic matter in the pre-treated leachates.

➢ Incorporation of anoxic periods in SBR operation (during Fill and Settling stages) enables to achieve efficient denitrification to remove nitrates present in the raw leachates.

High diversities of bacteria were found, especially in the raw leachates. *γ-proteobacteria* was the most abundant class in the reactor and in the raw leachates, whereas in the evaporation lagoon, it was *Thermotogae*. In addition, a large portion of Sulfate Reducing Bacteria (SRB) was found in the evaporation lagoon.