5 UV-TRANSFORMATION OF DOC IN LANDFILL LEACHATE – A LABORATIVE STUDY

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ABSTRACT

Leachate from a MSW landfill was irradiated with UV radiation in order to increase bioavailability of present DOC. Despite high energy input no increase of bioavailability was observed.

KEYWORDS

Leachate, Organic substances, Dentitrification, Humic substances, UV.

INTRODUCTION

Leachate from MSW landfills is generally characterised by high levels of ammonia and organic substances. To meet discharge limits treatment of leachate is often needed. Typically treatment aims to reduce the level of nitrogen in the leachate. A common method to reduce nitrogen levels in leachate is nitrification followed by dentrification. To ensure successful denitrification carbon is needed as an electron acceptor. According to reference (1), based on a literature study, the recommended ratio of organic carbon to nitrogen is in the range of 3-10 g COD/g N. If the ratio is to low, a source of carbon, typically methanol, has to be added in order to promote the denitrification process. The major drawback with adding extra carbon sources such as methanol is increased costs and increased volumes.

In a survey of leachates from twelve Swedish landfills (2) the range of the ratio COD:N was 0,4-9,8 (avg: 2,8, median: 2,25). This means that for some landfills there is enough carbon in the leachate to perform full denitrification. However, often the organic carbon in MSW landfill leachates is not availble for microbes (i.e. the BOD:COD ratio is low).

A considerable amount of the organic material in landfill leachate consists of humic substances (3). It's known from literature that humic substances found in natural environments are effected by UV irradiation (4). It's also known from literature that other organic materials such as petroleum resins can be oxidized by UV-light (5).

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If humic substances and/or other organic substances present in leachate could be transformed by means of UV light in to a bioavailble form the need for external carbonsources in denitrification processes would decrease.

OBJECTIVE

The objective of the study was to examine the potential for UV-light to partly oxidize organic material in a leachate thereby increasing the biodegradability. The leachate studied was taken from Högbytorp landfill 40 km NW of Stockholm. In an earlier study of the leachate (1) a good correlation was found between DOC and UV absorbance at 250 nm. Based on that study our hypothesis was that the DOC was able to absorb energy from light in this wavelength and that if the input of energy were high enough the organic matter would transform in to a more biodegradable form.

METHODS AND MATERIALS

Sampling

Leachate is collected from the landfill by a network of drainage pipes in the bottom of the landfill and is led by gravity to a collection pond. Leachate for the experiment was collected directly from the pipe ending in the collection pond. Leachate was collected in eight plastic cans (25 l.) and was then transferred by car to the laboratory.

Experimental setup

Upon arrival to the laboratory leachate was tranfered to two plastic barrels (160 l.), each holding 100 l. of leachate. Thereafter each barrel was aerated for 23 days in order to reduce BOD_7 in the leachate. After stopping aeration the water was left in the barrel for 24 h to allow sedimentation then the water was decanted to new barrels. Water from one of the barrels was recirculated over a UV lamp (Tropical Marine G25T8, 25 W, λ 254 nm) by means of a pump made of Teflon. The flow was 0,23 l/min and the volume of the lampkyvette was 0,25 l. In the control barrel there was no recirculation. Both barrels were protected from direct sunlight.
Sub samples was taken from the barrels on a regularly basis and was unanalysed for TOC (SS 02 81 99), COD_{Cr} (LCK 114/814, Dr Lange) and BOD_7 (SS 02 81 43-2; SS EN 25 814). Even the raw leachate was analysed. During the experiment temperature was measured. Losses due to evaporation was measured by means of wehing the barrels.

RESULTS

During aeration the quality of the leachate was changed according to table 1. During aeration pH increased from 7,9 to 8,4 but was lowered again during the rest of the experiment. As a result of aeration an approximately 0,2 liter of sediment was formed. After aeration and sedimentation the leachate became a lot clearer.

The temperature varied from 22 to 26° C during the experiment. In the experimental barrel temperature rised 2° C due to heat generated from the UV–lamp and the pump. The loss of water due to evaporation in the experimental barrel was measured to 9,6 liters and to 0,9 liters in the control barrel.

At the end of the experiment the saturation of oxygen was measured to 22%. Thus aerobic conditions prevailed throughout the experiment.

Parameter	Raw leachate	Experimental barrel after aeration for 23 days.	Control barrel 2 after aeration for 23 days.
BOD_7 (mg/l)	61	6	3
COD_{Cr} (mg/l)	1150	1100	1200
TOC (mg/l)	290	300	300
pH	7,9	8,4	8,4

Table 1. Composition of leachate before and after aeration.

In table 2 the results from irriadiation of leachate is summarized. The irradiation time is corrected for samples taken out for analysis.

		UV-irradiated barrel			Control barrel (no UV-irradiation)		
Irradiaton time (s)	Energy input (kWh/m^3)	BOD_7 (mg/l)	COD_{Cr} (mg/l)	TOC (mg/l)	BOD_7 (mg/l)	COD_{Cr} (mg/l)	TOC (mg/l)
0	0,00	6	1100	300	3	1200	300
1	0,03	6	1100	300	3	1200	300
2	0,06	6	1100	300	5	810	210
5	0,14	5	1100	300	5	1200	290
10	0,28	6	870	230	5	1200	300
35	0,98	8	1100	290	3	1200	290
59	1,66	8	1100	290	<3	1200	280
469	13,20	8	1100	300	4	1200	280
1292	36,30	7	1100	300	4	1200	280
5314	149,00	7	1100	290	<3	1200	430

Table 2. Results from UV-irradiation of leachate.

DISCUSSION AND CONCLUSIONS

Despite high input of energy to the water the ratio BOD/COD in the leachate was not effected by UV-irradiation. Plausible reasons for this might be the following:

a) There were too many particles in the water even after sedimentation thereby decreasing energy transfer to the water.

b) The wavelength was not the optimum with respect to energy and/or the UV-adsorbing capacity of the dissolved organic matter in the water.

Based on the present study it can be concluded that UV-irradiation did not increase the biodegradability of the leachate.

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