Landfill leachate treatment

Planted soil filter Hamburg-Havighorst

root and rhizome meshwork of reed (Phragmites communis)

Operator:

Freie und Hansestadt Hamburg (City of Hamburg)
Umweltbehörde, Amt für Umweltschutz (environmental authority)
Fachamt für Gewässer- und Bodenschutz
Hermannstr. 40
D-20095 Hamburg

Author:

Dipl. -Ing. M. Blumberg
Ingenieurbüro Blumberg (Blumberg-Engineers)
Gänsemarkt 10
D-37120 Bovenden
Tel. 05593 937750
Germany

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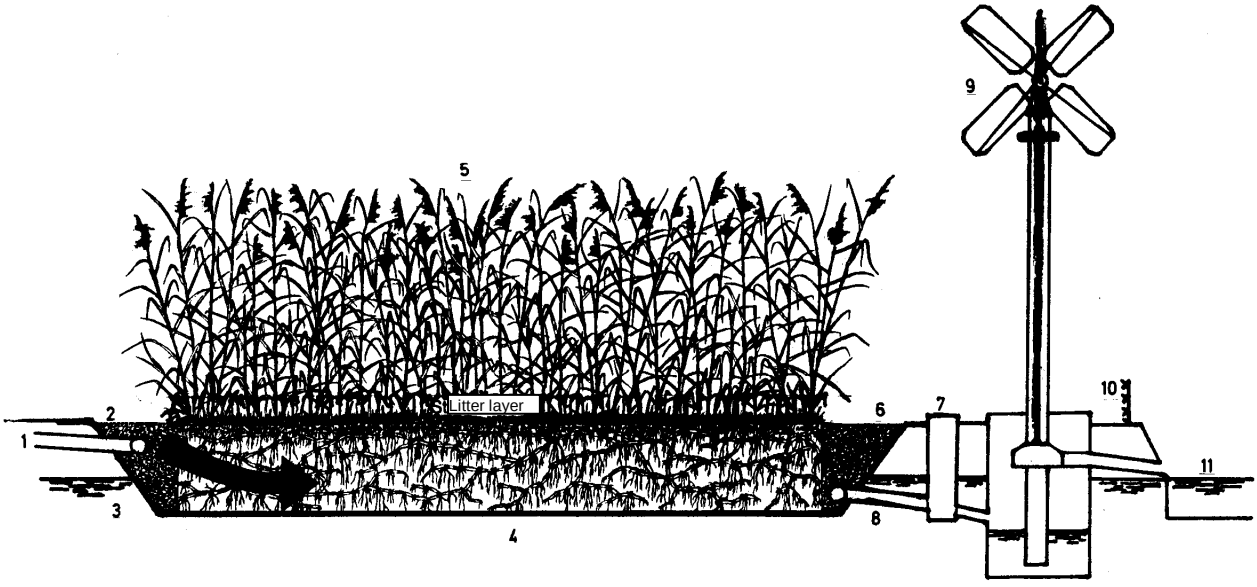
In the south-east of Hamburg, on the area of the depleted moor of Havighorst, surveyors in 1978 detected that major quantities of contaminated seepage water were leaking from the south-western boundary of a former construction waste dumping site (18 ha), which had been closed down and recultivated. Due to the bad smell it emanated, the seepage also had a negative impact on the local recreational area. In a move to solve this inherited problem, the leaking waters were captured and a constructed wetland system was built using the rhizosphere filter technique. This close-to-nature disposal concept, at the heart of which is a reed bed, was put into practise by the city of Hamburg in 1986.

Description of the water treatment procedure

The constructed wetland of Hamburg-Havighorst consists of a synthetic membrane sealed reed bed which has a surface area of 2500 m^2 and a depth of 60 cm. The collected seepage is supplied to the reed bed via a gravity pipe; discharge into the neighbouring circular ditch is provided by a wind power-operated lifting facility and an electrical pump.



1 Influent pipe
2 Inlet distribution ditch
3 Ground-water level
4 HD-PE membrane (2.5 mm)
5 Reed (*Phragmites communis*)
6 Outlet ditch
7 Control and measurement shaft
8 Drain pipe
9 Windmill pump
10 Fence
11 Draining ditch

In a root zone system the sewage is purified through an interaction of plants, soil, and the microorganisms living in the soil. Important sub-processes are microbial decomposition, attachment to soil constituents and outgassing of volatile components.

Previous removal rates

The effluent of the Havighorst waste landfill differs from domestic sewage in many respects. For example, the biochemical (BOD_5) and chemical (COD) oxygen demand is relatively low, and further reduced by root zone filtering by 60 - 70 % and 15 - 20 %, respectively. The low feed concentrations of nitrogen and phosphorus are also subject to significant further reduction (approx. 40 % of the nitrogen load and 25 % of the total phosphorus load).

The main problem substances in the landfill leachate are a number of chlorinated hydrocarbons (chlorbenzenes and chlorphenols) as well as specific aromatic hydrocarbons, in particular benzene, ethylene benzene and naphthalene. The conspicuously high concentrations of these persistent harmful substances are reduced by 94 - 100 % as they pass through the root zone.

The most troublesome substance in the heavy-metal fraction is arsenic which is present at a mean concentration of 29 µg/l (limit value for drinking water = 10 µg/l) in the landfill leachate. The mean value measured at the outlet of the planted soil filter is as low as 8 µg/l. Likewise, the mercury concentration of 0.9 µg/l (limit value for drinking water = 1 µg/l) has been reduced to 0.6 µg/l.

Clarification results - mean decomposition rates of selected parameters

		Feed pipe	Drain pipe
Chlorinated hydrocarbons			
Chlorbenzenes	(µg/l)[(1)]	47.2	1.6
Chlorphenols	(µg/l)	25.5	1.6
Aromatic hydrocarbons			
Benzene	(µg/l)	62	1.35
Ethylene benzene	(µg/l)	22	n.d. [(2)]
Naphthalene	(µg/l)	31	0.02
Heavy metals			
Arsenic	(µg/l)	29	8
Mercury	(µg/l)	0.9	0.6

Sum parameters of oxygen depletion and nutrients			
COD	(mg/l)	104	87
BOD_5	(mg/l)	26	9
total N [3]	(mg/l)	26	15
total P [4]	(mg/l)	1.0	0.8

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([1] µg/l – microgram per liters = 0.000001 g/l; [2] n.d. - not detectable; [3] N – nitrogen; [4] P – phosphorus)

Operational experience

The soil filled in, consisting of a clay-peat mixture from local sources, has so far performed very well in terms of percolation capacity (hydraulic conductivity) and pollutant removal rates (root zone process). Specific design-related features have resulted in a non-uniform flow pattern where some areas have quantitative loads that are significantly higher than those of others.

The introduced reed vegetation (*Phragmites communis*) has fully displaced the strong local rival plant, reed mannagrass (*Glyceria ssp*.), and formed a dense reed bed.

The inflow volume, largely influenced by precipitation events, fluctuate between 0.2 and 3.0 l per second.

It still remains a mystery why the feed concentrations (effluents of the landfill) do not follow a decay curve but have instead remained almost unchanged during the previous times of service.

After 25 years of operation this close-to-nature landfill leachate treatment plant (constructed wetland) is still operating at a continuously high quality level. In addition, the building and operating costs have been much lower than those of conventional technical procedures.