Leachate treatment

Requirements on Wastewater for the Discharge Point

(Appendix 51 of the Wastewater Ordinance, 15.10.02)

		Qualified random sample or 2-hour mixed sample	Common concentration in the raw leachate
Chemical oxygen demand (COD) [1)]	mg/L	200	1.000 – 60.000
Bio-chemical oxygen demand in 5 days (BOD_5)	mg/L	20	50 – 40.000
Nitrogen, total, as sum of ammonium, nitrite, and nitrate nitrogen[2)]	mg/L	70	400 – 4.000
Phosphorous, total	mg/L	3	0,01 – 1,0
Hydrocarbons, total	mg/L	10	200 – 30.000 (TOC)
Nitrogen from nitrite (NO_2-N)	mg/L	2	< 1
Fish toxicity	mg/L	2	8 - > 64

[1)] If it can be assumed that the contents of chemical oxygen demand (CDO) of a given wastewater amounts to more than 4,000 mg/l prior to treatment, there applies for the COD an effluent value of the qualified random sample or the 2-hour mixed sample which is equivalent to a reduction of the COD b at least 95%. The reduction refers to the ratio of the pollutant load in the influent of the wastewater treatment plant to that in the effluent of the WTP within 24 hours.
[2)] The requirements on Nitrogen total applies for a wastewater temperature of 12°C or more in the effluent of the biological reactor of the wastewater treatment plant.

Requirements on the Wastewater before Admixing

(Appendix 51 of the Wastewater Ordinance, 1999)

		Qualified random sample or 2-hour mixed sample	Common concentration in the raw leachate
Adsorbable organically bound halogenes (AOX)	µg/L	500	500 – 5.000
Mercury	µg/L	50	< 1 – 50
Cadmium	µg/L	100	0,5 - 140
Chromium	µg/L	500	30 – 1.600
Chromium VI	µg/L	100	k. A.
Nickel	µg/L	1.000	20 – 2.000
Lead	µg/L	500	10 – 1.000
Copper	µg/L	500	4 – 1.400
Zinc	µg/L	2.000	500 – 3.000
Arsenic	µg/L	100	< 0,1 – 1.000
Cyanide, easily releasable	µg/L	200	k. A.
Sulphide	µg/L	1.000	k. A.

Leachate concentrations of conventional Municipal Waste Landfills

(without waste management measures)

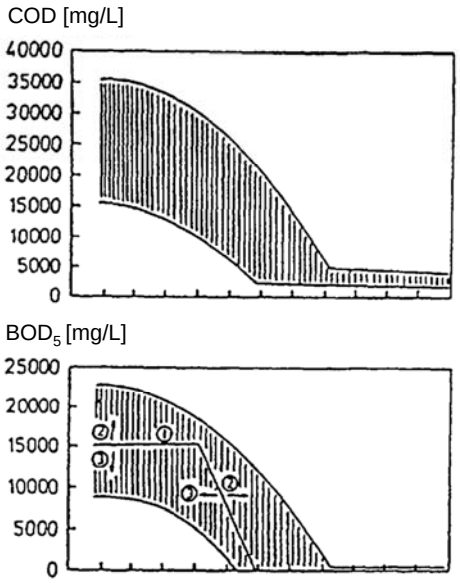
		Acidic Phase		Methanogenic Phase	
		Range	Average	Range	Average
pH-value	---	4,5 –7,5	6,1	7,5-9	8
COD	mg O_2/L	6.000-60.000	22.000	500-4500	3.000
BOD_5	mg O_2/L	4.000-40.000	13.000	20-550	180
Ca	mg/L	10-2.500	1.200	20-600	60
SO_4	mg/L	70-1.750	500	10-420	80
Zn	mg/L	0,1-120	5	0,03-45	0,6
Fe	mg/L	20-2.100	780	3-280	15

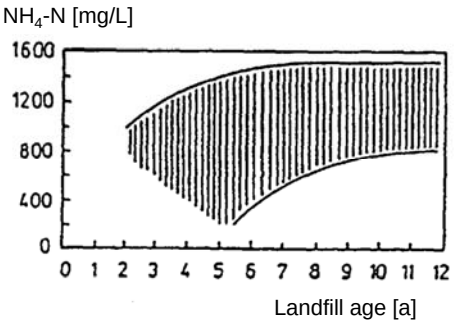
		Parameter without significant changes	
		Range	Average
TKN	mg/L	50-5.000	1.350
NH_4-N	mg/L	30-3.000	(750)
Cl	mg/L	100-5.000	2.100
Pb	µg/L	8-1.020	90
Cd	µg/L	0,5-140	6
Cu	µg/L	4-1.400	80
Ni	µg/L	20-2.050	200
Hg	µg/L		
Cr	µg/L	30-1.600	300
AOX	µg/L	320-3.350	2.000

[EHRIG, 1980]

General Development of the COD, BOD_5 and NH_4-N Concentrations

in Relation to the Landfill Age and the Landfill Operation





General development of the COD, BOD_5 and NH_4-N concentrations in relation to the landfill age

1 = average development with 2 m layers and 2-4 m build-up per year

2 = tendency with faster build-up

3 = tendency with slower build-up or recirculation

Effects on the Landfill Technology

High concentrations with long durations of sometimes more than 10 years are found on landfills with:

- compactor filling in layers of 2 m or more,
- higher pouring height speeds,
- no setting of an optimal water contents through leachate recirculation

Fast-dropping or generally low concentrations are found on landfills with:

- aerobic (preliminary) rotting, even if only as lower waste layer,
- thin layer filling („short layer rotting"),
- leachate recirculation to guarantee the optimal water contents,
- aerobic or anaerobic preliminary treatment to degrade the organic components (mechanical-biological treatment MBT).

Crucial for the quality of the leachate discharge from a landfill is the formation of the bottom waste layer.

Storage Dimensioning

$V_{Storage}$ = ca. 500 m^3/ha of open landfill area

For nearly all known landfills, the planning approval notifications forbid the damming of the leachate at the landfill bottom. The TI Municipal Waste and the drafted Landfill Ordinance (DepV) demand the discharge of the collected leachate over a free inclination to drainage shafts outside the depositing area, which basically means an interdiction of the damming of the leachate. It is thus not possible to use the landfill body as leachate storage tank.

Comparison of various Method Combinations

	VSS	BOD_5	COD	Total in-org. N	NH_4-N/ NH_3-N	Heavy metal	AOX	Salt	Fich toxicity
Biological treatment		+	+[2)]	+	+	-	-	-	[7)]
Adsorption	-		+[3)]	-	-		+	-	[7)]
Sedimentation/ Flotation [8)]		-	-	-	-	-	-	-	[7)]
Flocculation/ Precipitation	-		+[3)]	-	-	+[5)]	+	-	[7)]
Filtration	+	-	-	-	-	-	-	-	[7)]
Reverse osmosis	+	+[1)]	+[1)]	+	+	+	+[1)]	+	[7)]
Nano-filtration	+	+	+	-	-	[9)]	+	[9)]	[7)]
Stripping	-	-	-	+	+	-	-[6)]	-	[7)]
Chemical oxidation	-		+	-	-	-	+	-	[7)]
Evaporation	+		+[4)]	+	-	+	+[4)]	+	[7)]
Incineration	+	+	+	+	+	+	+	+	

\+ generally suitable
\- generally unsuitable
1) less suitable for small molecule sizes
2) only suitable for degradable organic substances
3) less suitable for bio-degradable substances
4) less suitable for substances which are volatile under the process conditions
5) only with special heavy metal precipitation
6) not suitable for hardly volatilisable substances
7) reaching of a limit value cannot be evaluated safely
8) separation of solids in combination with other methods
9) separation done for bivalent or superior ions

Effluent Values and Discharged Loads of the Various Method Combinations for Direct Discharge

Effluent concentrations (C_e) and effluent loads (B_a) of various combinations										
Q_d= 150 m³/d		Raw	Combination I		Combination II		Combination III		Combination IV	
Parameter	Unit	leachate	UO/ED/TR/NA		BIO/UO/ED/TR		BIO/CHO/BIO		BIO/AC	
		(influent)	C_e	B_a (t/a)	C_e	B_a (t/a)	C_e	B_a (t/a)	C_e	B_a (t/a)
COD	mg/L	2500	15	0,821	25	1,369	150	8,213	150	8,213
BOD_5	mg/L	250	5	0,274	10	0,548	5	0,274	5	0,274
TKN	mg/L	1300	10	0,548	30	1,643	70	3,833	100	5,475
NH_4-N	mg/L	1100	7	0,383	0,5	0,027	1	0,055	1	0,055
NO_3-N	mg/L	<10	0,1	0,005	60	3,285	60	3,285	60	3,285
inorg. N	mg/L	1110	7	0,383	62	3,395	62	3,395	62	3,395
AOX	µg/L	2500	50	2,738	100	5,475	300	16,425	300	16,425
LF	mS/cm	15	0,40		0,30		12,50	0,684	12,50	0,684
Cl^-	mg/L	2000	50	2,738	150	8,213	2000	109,500	2000	109,500
TR	%	1,00	0,01	5,475	0,09	49,275	0,9	492,750	0,9	492,750

Discharge Loads of COD, inorganic N, AOX (100 times superelevated) and Evaporation Residue