

Case Study: Treatment of PFAS contaminated landfill leachate using Surface Active Foam Fractionation (SAFF)

Tveta Recycling plant and Landfill is owned and operated by Telge Återvinning AB and is located in Lerhaga, Södertälje. Within the property, several collection ponds are situated, but all are connected to one large collection pond at the bottom of the landfill. As many materials and soils handled and deposited at the plant contains PFAS, the water in the storage ponds are contaminated with PFAS. Envytech is carrying out treatment of the water as the waste water treatment plant receiving the leachate water from the landfill has set a limit to the amount PFOS allowed to be discharged to the plant to 50 ng/l. This as the treatment plant have been rewarded with a REVAQ certification, allowing them to use the sludge produced as fertilizers on crop fields. The treatment is carried out using a full-scale SAFF40 treatment plant.



Figure 1: Full scale SAFF40 treatment system installed at Tveta Landfill

The leachate water contains a mixture of co-contaminants, as well as as nitrogen, phosphorus DOC, TOC, suspended solids and more, in accordance with table 1. In summer, the pond also “produces” large amounts of larva and zooflagelats, as well as algae. This combined has led to all of the previous treatment trials performed with various filter technologies have failed.

The total amount of PFAS vary through out the seasons depending on the amount of rain or snow melt reaching the pond, but average concentrations ranges between 2000 - 4000 ng/l for PFAS Sum11, see table 3 for untreated leachate PFAS concentrations. The leachate is pumped straight into the SAFF40, using no pretreatments except for two bag filters with 100 µm filter size. In periods where the algae and larva production have caused the bag filters to clog up rapidly, the filter socks

Substance	Unit	Feb	May	Jul	Sep	Dec
Turbidity	FNU	76	20	30	45	
Colour (410 nm)	mg Pt/l	620	190	280	310	
pH		7,5	7,8	7,9	7,8	7,6
Alkalinity	mg HCO ₃ /l	910	590	560	490	610
Conductivity	mS/m	1300	1200	1100	1100	
Chloride	mg/l	3200	3000	2700	3300	2000
Sulphate	mg/l	270	360	180	300	410
TOC	mg/l	80	72	74	63	
Ammonium-nitrogen (NH ₄ -N)	mg/l	130	100	120	99	85
Nitrat+Nitrit nitrogen	mg/l	15	19	22	22	
Phosphorus P	mg/l	4,2	1,2	1,2	1	
Nitrogen N	mg/l	170	140	170	120	
Sodium Na	mg/l	1200	1400	1300	1200	
Potassium K	mg/l	670	810	720	670	
Arsenic As	mg/l	0,0028	0,0029	0,0034	0,0025	
Lead Pb	mg/l	0,0005	<0,00050	0,00079	0,00092	0,00089
Cadmium Cd	mg/l	0,0001	<0,00010	0,0001	0,0001	0,00011
Copper Cu	mg/l	0,01	0,011	0,011	0,0079	0,019
Chromium Cr	mg/l	0,0068	0,018	0,0048	0,005	0,0041
Mercury Hg	mg/l	0,0001	<0,00010	0,0001	0,0001	0,0001
Nickel Ni	mg/l	0,017	0,029	0,02	0,018	0,016
Silver Ag	mg/l	0,00005	0,000079	0,00005	0,00005	0,00005
Zinc Zn	mg/l	0,022	0,024	0,016	0,029	0,038
Oil index	mg/l	0,1	0,1	0,17	0,23	0,14

Table 1: Compilation of leachate water data for the year of 2019

have been removed, and no pre treatment have been used without any lowering of treatment results.

The leachate is treated with a batch time of 18 min. The average flowrate is about 20 m³/h, resulting in treatment volumes of 500 m³/day. The treated water is released to the recipient, Himmelfjärdsverkens waste water treatment plant.

The treatment removal efficiency has been stable throughout the project, regardless of seasonal variations. PFOS concentrations are treated down to non detect in almost every sample, and the target criteria of 50 ng/l has never been exceeded. Treatment efficiency for PFAS₄, PFOS, PFOA, PFHxS and PFNA are >99%. Treatment efficiencies of >99% are also achieved for PFNA, 6:2 FTS, PFHpA, see table 3 on next page for compilation of treatment results.

The treatment has been carried out since February 2020, when the plant was commissioned, and is contracted to stay at the Tveta site until September 2023. Treatment volumes up until now are recorded to approx. 150 000 m³ (150 000 000 liters).

Case Study: Treatment of PFAS contaminated landfill leachate using Surface Active Foam Fractionation (SAFF)



Figure 2: Photos of the leachate pond in summer and the algae blooming that occurs. The SAFF40 treatment plant is situated in the white tent at the far end.

Substance	Removal rate % 18 min	Removal rate % 18 min	Removal rate % 18 min	Removal rate % 18 min	Removal rate % 18 min	Removal rate % 18 min	Removal rate % 18 min	Average removal rate %
	2021-01-28	2021-03-09	2021-05-28	2021-08-20	2021-10-26	2022-01-13	2022-02-22	2020-02-10 – 2022-04-20
6:2 FTS	97%	98%	100%	100%	96%	97%	100%	99%
PFDA	72%	81%	100%	100%	90%	83%	100%	84%
PFHpA	97%	99%	99%	97%	98%	67%	96%	95%
PFHxS	98%	98%	100%	100%	99%	89%	99%	99%
PFNA	98%	99%	100%	100%	99%	96%	98%	99%
PFOA	100%	100%	100%	100%	100%	87%	99%	99%
PFOS	100%	99%	99%	97%	99%	96%	97%	99%
PFBA	15%	18%	0%	0%	0%	0%	0%	2%
PFBS	22%	21%	6%	0%	9%	8%	0%	17%
PFHxA	49%	51%	39%	19%	20%	18%	12%	36%
PFPeA	23%	10%	0%	16%	11%	0%	10%	8%

Table 2: Presents PFAS removal efficiency for various dates throughout the 1,5 year project. Only minor variations have been noted, regardless of the seasonal changes. Average removal efficiency is calculated from all 26 samples taken in the period 2020-02-10 – 2022-04-20.

Substance	Untreated	Treated	Removal rate % 18 min	Untreated	Treated	Removal rate % 18 min	Untreated	Treated	Removal rate % 18 min
	2021-05-14	2021-05-14	2021-05-14	2021-10-26	2021-10-26	2021-10-26	2022-04-20	2022-04-20	2022-04-20
6:2 FTS	50	<1,0	100%	23	<1	96%	100	<1,0	100%
PFDA	5,1	<1,0	100%	<10	<1	90%	10	<1,0	100%
PFHpA	330	9,8	97%	480	9,6	98%	520	7,7	98%
PFHxS	140	<1,0	100%	190	<1	99%	170	<1,0	100%
PFNA	120	<1,0	100%	160	<1	99%	81	<1,0	100%
PFOA	690	1,1	100%	1300	<1	100%	1100	1,8	99%
PFOS	210	4,4	98%	290	4,3	99%	200	2,5	98%
PFBA	340	310	9%	280	320	0%	200	190	5%
PFBS	110	110	0%	110	100	9%	82	100	0%
PFHxA	550	480	13%	400	320	20%	350	450	0%
PFPeA	490	570	0%	460	410	11%	380	400	0%
PFAS 11	3000	1500	50%	3700	1200	68%	3200	1200	62%

Table 3: Presents examples of inlet concentrations, outlet concentrations and removal efficiencies for various dates in different seasons throughout the project.