

Wastewater influent and effluent concentrations from on-site package plants in Northern Sweden and Finland

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Description of the data

The data contains influent and effluent concentrations of traditional parameters measured in on-site package plants for domestic wastewater treatment serving single houses or small communities (2-30 person equivalent). The purpose of the collected dataset was to investigate the treatment efficiency of package plants operating in cold climate conditions throughout different seasons. The samples were collected in the northern regions of Sweden (Norrbotten) and Finland (North Ostrobothnia and Lapland) characterised by low winter temperatures and deep frost penetration.

The investigated facilities included six package plants operated in continuous mode: one with a trickling filter (TF), one with a rotating biological contactor (RBC) and four with activated sludge with phosphorus removal by coagulation (ASC) or alkaline filter (ASF1, ASF2, ASF3) systems. Additionally, five plants supplied by three different manufacturers operated in batch mode with activated sludge and coagulation for phosphorus removal (SBR1-5).

The parameters analysed include organic matter, suspended solids, nutrients (phosphorus and nitrogen compounds) and indicator bacteria, as well as other physicochemical parameters such as temperature, pH and turbidity, and chloride as a tracer compound to detect dilution effects. Additional influent and effluent concentrations of micropollutants from two slightly larger plants (ASC and TF, serving 12-30 person equivalent) are also included. These micropollutants consisted of 19 selected pharmaceuticals, caffeine and the sweetener Acesulfame K, and 15 phthalates.

The data has not been processed and consists of results (raw data) obtained directly from our university laboratory in Luleå university of technology (nutrient samples from facilities in Sweden) and accredited laboratories (traditional parameters, microbiology, micropollutants).

Wastewater samples collection, management and analysis

The data was collected during different occasions between August 2019 and April 2021, covering different seasons and temperature ranges. Influent samples were collected from the facilities' sedimentation tanks before the biological process and effluent samples from an outlet pipe, sampling chamber, or the last chamber containing the treated wastewater before discharge. As the influent wastewater was not collected directly after exiting the buildings, some pre-sedimentation likely occurred in the septic tank prior the sampling.

On each sampling occasion the wastewater temperature, total suspended solids (TSS) contents and pH of the samples was measured, and their turbidity on some occasions and only in the Swedish samples.

The temperature and pH were measured using a WTW pH330 pH meter with a WTW SenTix41 pH electrode (Swedish samples) and a WTW multi 350i with Sentix electrode (Finnish samples) calibrated on each occasion (two-point calibration). The turbidity was measured based on ratio turbidimetric determination using a primary nephelometric light scatter signal (90°) to the transmitted light scatter signal (Model HACH 2100Q).

In addition, the water temperature was continuously measured in the process tank of three PP (SBR1, ASF1 and ASF2) with HOBO® Pendant®MX Temp (MX2201) loggers. The three data files are provided separately. Air temperature data was retrieved from the Swedish meteorological institute (SMHI), from the closest weather stations available to the locations of the package plants. Two files are provided for in case data analysis comparing air and wastewater temperature is conducted.

Levels of BOD, phosphorus (total and dissolved: tot-P and dis-P, respectively), nitrogen (total, nitrite, nitrate and ammonium nitrogen: tot-N, NO₂-N, NO₃-N, NH⁴⁺-N), and the indicator microorganisms *Escherichia coli* and enterococci were measured in approximately 3 L grab samples of influent and effluent water (and chloride in some of these samples for facilities ASC, ASF1-3, SBR1-2 and TF). Portions of samples used for analyses of BOD and nutrients were stored frozen (<-18°C) until analysis according to the corresponding standards, and portions used to determine densities of the bacteria were stored at 5 °C and examined in an accredited laboratory within 24 hours.

Table 1 Parameters including abbreviations used in the file containing the raw data and methods of analysis.

Abbreviation	Parameter	Method(s) of analysis	
		Facilities in Sweden ¹	Facilities in Finland ²
BOD	Biological oxygen demand	CSN EN 1899-1	CSN-EN 1899-1
	Chloride	liquid determination of anions according to CSN EN ISO 10304-1 and CSN EN 16192 (ISO 10304-1, 2007)	Not measured
DOC	Dissolved oxygen demand	CEN/TC 230. EN 1484:1997	CEN/TC 230. EN 1484:1997
Diss-P	Dissolved phosphorus	SS-EN 1189:1996 performance 6.4; A-031- 04	Not measured
HN ₄ -N	Ammonium nitrogen	SS-EN 1189:1996 performance 6.4; ISO 11732 and DIN 38 406 (Part 23, section 2) standard methods.	ISO 3032:1976 (IC106)
NO ₂ -N	Nitrite nitrogen	SS-EN 1189:1996 performance 6.4; Q-001-04	Not applicable
NO ₂₋₃ - N ₂	Nitrite and nitrate nitrogen	Not applicable	ISO 13395:1997 FIA-technique (IC104)
NO ₃ -N	Nitrate nitrogen	SS-EN 1189:1996 performance 6.4; Q-001-04	Not applicable
N-tot	Total nitrogen	SS-EN 1189:1996 performance 6.4; Q-003-04	ISO 11905-1:1998 FIA-technique
PO ₄ -P	Orthophosphate	Not measured	ISO 15681-1:2005(IC101)
TOC	Total organic carbon	CEN/TC 230. EN 1484:1997	Not measured

Tot-P	Total phosphorus	SS-EN 1189:1996 performance 6.4; A-031- 04	ISO 15681-1:2005
TSS	Total suspended solids	European standard EN 872:2005	Not measured
w0_(g)	Filter initial weight	-	-
w1_(g)	Filter weight after filtration	-	-
	<i>E. coli</i>	SS EN-ISO 9308-2:2014. Results reported as Most Probable Number (MPN) per 100 ml.	SFS 4088:2001 / ROI. Results reported as Colony Forming Units (CFU) per 100 ml.
	Enterococci	IDEXX Enterolert® Results reported as Most Probable Number (MPN) per 100 ml.	SFS-EN ISO 7899-2:2000. Results reported as Colony Forming Units (CFU) per 100 ml.

¹ The facilities sampled in Sweden were ASC, ASF1-3, SBR1-2 and TF.

² The facilities sampled in Finland were RBC and SBR3-5.

Micropollutant sampling and analyses

Grab samples of the influent and effluent of two facilities (ASC and TF) and blank samples of the sampling equipment (using tap water) were collected on three occasions (March, June and August 2021) for micropollutant analyses, using a stainless-steel sampler, then stored in glass jars before analysis. The investigated micropollutants included 19 pharmaceuticals (Table 2), an artificial sweetener (acesulfame K), caffeine and 15 phthalate: Bis(2-ethylhexyl) phthalate (DEHP), Bis(4-methyl-2-pentyl) phthalate (BMPP), Benzyl butyl phthalate (BBP), Bis(2-ethylhexyl) terephthalate (DEHT), Dibutyl phthalate (DBP), Diethyl phthalate (DEP), Di-n-hexyl phthalate (DHP), Diisobutyl phthalate (DIBP), Diisononyl phthalate (DINP), Diisopentyl phthalate (DISP), Dimethyl phthalate (DMP), Dioctyl phthalate (DNOP), Dipentyl phthalate (DPP), Dicyclohexyl phthalate (DCHP) and Hexyl-2-ethylhexyl phthalate (HEHP).

The samples were extracted with liquid-liquid extraction (for phthalates) and solid-phase extraction (pharmaceuticals, sweetener and caffeine) and were not pre-filtered. The samples were concentrated and analysed directly after the extraction with LC-MS/MS for pharmaceuticals, sweetener and caffeine and with GC-MS/MS for phthalates. Method and field blanks were used to evaluate potential background levels of target phthalate compounds. Quality control was performed in the laboratory, and included spiked control samples, at least one procedural blank per sample set and internal standards. The recoveries of the spiked controls were used to ensure the method's performance, by assuring that the known target value(s) had been met. Procedural blanks were taken to ensure that there was no background contamination from the laboratory (vessels, instruments, chemicals, lab air, etc.). For phthalates, three procedural blanks per sample set were used to evaluate the background. The phthalate procedural blanks were subtracted from the sample results. The internal standards included the addition of mass labelled internal standards to the samples before the extraction to account for the losses of analytes during the pretreatment and matrix suppression in the instrumental

analysis (LC-MS/MS or GC-MS/MS). The recovery rates of the internal standards were used to verify that the sample pretreatment and analysis procedure worked as it should.

Table 2 Analyzed pharmaceuticals in the influent and effluent of two package plants (ASC and TF).

Compound	Characterization/uses
Diclofenac	Analgesic and anti-inflammatory
Ibuprofen	Analgesic and anti-inflammatory
Bisoprolol	β -blocking agents
Candesartan	ACE inhibitor
Clarithromycin	Antibiotic
Enalapril	ACE inhibitor
Eprosartan	ACE inhibitor
Fenbendazole	Antiparasitic drug
Fluconazole	Antifungal medication
Gabapentin	Anticonvulsant
Ketoprofen	Analgesic and anti-inflammatory
Levetiracetam	Anticonvulsant
Metoprolol	β -blocking agents
Primidone	Anticonvulsant
Ramipril	ACE inhibitor
Sertraline	Antidepressant
Venlafaxine	Antidepressant
Warfarin	Anticoagulant
Xylometazoline	Nasal decongestant

Other abbreviations used in the excel file:

NM= Not Measured

MPN = most probable number (for bacterial counts)

NA = Not Applicable

References

ISO 10304-1:2007(en), *Water quality — Determination of dissolved anions by liquid chromatography of ions — Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate* (2007).

European Committee for Standardization, *CEN/TC 230. EN 1484:1997. Water analysis - Guidelines for the determination of total organic carbon (TOC) and dissolved organic carbon (DOC)* (1997).

European Committee for Standardization, *CEN/TC 230. EN 1899-1:1998. Water quality - Determination of biochemical oxygen demand after n days (BOD_n) - Part 1: dilution and seeding method with allylthiourea addition (ISO 5815:1989, modified)* (1998).

European Committee for Standardization, *CEN/TC 230. EN 872:2005. Water quality - Determination of suspended solids - Method by filtration through glass fibre filters* (2005).

European Committee for Standardization, CEN/TC 444. EN 16192:2011. *Characterization of waste - Analysis of eluates* (2011).

ISO 11732:2005, ISO 11732:2005 - *Water quality - Determination of ammonium nitrogen - Method by flow analysis (CFA and FIA) and spectrometric detection* (2005).

SS-EN 1189, SS-EN 1189 Standard - *Water quality - Determination of phosphorus - Ammonium molybdate spectrometric method*. Swedish Institute for Standards.