

Supplementary Data

Occurrences and behavior of perfluorinated compounds (PFCs) in several wastewater treatment plants (WWTPs) in Japan and Thailand

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Table S1 Concentration of analyzed PFCs in different treatment processes in investigated WWTPs in Japan and Thailand

WWTP & Processes [§]	Suspended solid (SS) mg/L	Sample Type	PFBuS	PFHxS	PFOS	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnDA	PFDoDA	Total PFCs
			ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
A	Inf	Liq	4.8	4.8	378.1	0.4	0.6	4.6	26.7	10.7	1.1	0.3	ND	432.0
		Pr	ND†	ND	30.1	ND	1.0	3.4	14.3	2.8	2.8	2.4	0.4	57.3
	PC	Liq	5.1	3.6	343.5	0.4	1.0	3.3	19.4	14.8	0.2	0.2	ND	391.5
		Pr	ND	ND	85.5	ND	0.6	1.6	4.3	1.1	1.6	1.6	<LOQ	96.3
	AT	Liq	6.6	5.6	250.7	0.7	4.2	8.9	179.9	82.5	12.8	22.5	ND	574.6
		Pr	ND	0.5	477.4	ND	3.4	12.8	57.7	39.4	95.0	301.3	93.7	1081.2
	RAS	Liq	5.7	4.5	216.7	<LOQ†	3.0	7.6	191.3	80.1	12.6	24.7	<LOQ	546.2
		Pr	ND	ND	1001.3	ND	7.9	31.8	159.6	111.2	192.3	679.1	159.6	2342.9
	SC	Liq	4.1	4.5	207.9	0.7	2.4	6.4	139.4	61.9	10.6	17.4	ND	455.3
		Pr	ND	ND	36.1	ND	0.2	0.4	1.9	4.2	3.8	3.8	ND	50.4
	Eff (ozone)	Liq	2.1	4.1	207.5	0.5	5.6	11.9	134.3	56.0	12.4	17.3	<LOQ	451.7
		Pr	ND	ND	32.2	ND	0.1	0.6	3.3	8.5	9.7	9.7	0.2	64.4
B	Inf	Liq	2.3	2.5	1.5	0.2	ND	0.9	4.9	16.5	ND	1.0	ND	29.8
		Pr	ND	ND	1.2	ND	0.4	0.8	2.9	2.2	0.6	2.4	ND	10.5
	PC	Liq	1.3	2.2	ND	ND	ND	0.9	5.1	13.4	ND	0.7	ND	23.5
		Pr	ND	ND	0.6	ND	0.2	0.4	2.2	1.1	0.5	1.5	ND	6.6
	AT	Liq	2.8	3.4	2.5	0.1	0.7	1.4	12.6	19.0	1.1	1.4	ND	45.1
		Pr	ND	ND	16.2	ND	ND	ND	0.6	8.8	3.2	24.8	2.9	56.5
	RAS	Liq	2.5	2.0	1.6	ND	0.7	1.4	11.0	12.3	0.7	1.5	ND	33.7
		Pr	ND	ND	46.4	0.8	ND	0.2	1.3	20.1	9.1	69.4	6.5	153.7
	SC	Liq	2.2	2.7	3.7	ND	0.5	1.4	13.2	8.3	0.8	1.1	ND	33.9
		Pr	ND	ND	0.7	ND	0.1	0.6	1.0	1.6	0.5	0.3	ND	4.9
	Eff (ozone)	Liq	1.9	2.4	3.9	ND	0.6	1.2	12.0	10.1	1.1	0.9	ND	34.3
		Pr	ND	ND	0.8	ND	0.1	0.6	0.5	1.3	0.5	0.4	ND	4.3
C	Inf	Liq	5.9	0.3	ND	0.7	ND	0.6	2.1	ND	ND	ND	ND	9.5
		Pr	ND	ND	ND	ND	0.2	0.8	6.7	1.2	0.7	1.3	ND	10.9
	PC	Liq	1.2	0.3	ND	0.4	ND	0.9	1.7	4.3	ND	<LOQ	ND	8.8
		Pr	ND	ND	ND	ND	0.2	0.9	1.9	0.7	0.4	0.3	ND	4.4
	AT	Liq	1.5	1.2	2.2	0.1	0.6	2.2	21.6	18.9	2.3	1.1	ND	51.8
		Pr	ND	ND	14.7	ND	ND	1.2	5.1	16.6	15.6	36.3	8.7	98.2
	RAS	Liq	1.0	0.7	0.5	1.2	0.7	2.0	13.8	16.8	1.7	0.9	ND	39.4
		Pr	ND	ND	36.7	ND	ND	4.5	8.3	36.9	33.0	77.2	22.3	218.8
	SC	Liq	1.3	1.1	1.6	ND	0.5	2.4	16.4	12.8	1.5	0.7	ND	38.2
		Pr	ND	ND	0.0	ND	0.4	1.3	1.3	2.2	0.9	0.3	<LOQ	6.3
	Eff (Cl)	Liq	1.5	1.2	2.5	ND	0.6	1.9	17.5	12.3	1.3	0.6	ND	39.4
		Pr	ND	ND	0.1	ND	0.5	1.3	1.5	1.5	0.7	<LOQ	<LOQ	5.6
D	Inf	Liq	11.7	10.6	20.1	0.5	ND	1.5	1.6	10.0	ND	0.4	ND	56.4
		Pr	ND	ND	21.3	ND	0.3	1.0	7.7	1.0	0.7	2.1	<LOQ	34.1
	PC	Liq	5.5	7.9	20.7	0.6	0.2	1.5	3.7	9.8	ND	0.3	ND	50.2
		Pr	ND	ND	17.4	ND	0.2	1.2	1.5	0.7	0.8	0.9	<LOQ	22.6
	AT	Liq	1.9	12.1	42.7	0.1	1.4	1.2	22.6	16.9	0.8	1.4	ND	101.1
		Pr	ND	ND	179.5	ND	ND	ND	ND	9.2	2.0	73.2	2.7	266.6
	RAS	Liq	1.6	9.9	38.4	ND	1.8	1.3	32.1	12.9	0.6	1.3	ND	100.0
		Pr	37.0	82.0	422.5	2.9	16.8	37.5	21.4	56.0	48.0	147.1	49.2	920.3
	SC	Liq	2.6	6.8	20.7	ND	0.9	0.8	8.3	9.5	0.6	0.9	ND	51.2
		Pr	ND	ND	6.4	ND	0.1	0.2	0.2	0.8	0.2	ND	ND	7.9
	Eff (Cl)	Liq	1.9	7.2	31.9	ND	1.1	1.2	15.4	12.8	1.9	2.0	ND	75.6
		Pr	ND	ND	9.0	ND	0.2	0.4	1.7	1.7	1.0	1.3	ND	15.3

§ Processes: Inf: influent; PC: after primary clarifier; AT: aeration tank; RAS: returned activated sludge; SC: after secondary clarifier; Eff: effluent; ozone: after ozonation; Cl: after chlorination;

Liq: PFCs concentration (ng/L) in Liquid phase sample; Pr: PFCs concentration (ng/L) in particulate (or solid) phase sample

† ND: Not detected or below LOD (limit of detection); NA: Data not available; <LOQ: Detected concentration was less than limit of quantification (LOQ)

Table S1 Concentration of analyzed PFCs in different treatment processes in investigated WWTPs in Japan and Thailand (continued...)

WWTP & Processes ^s	Suspended solid (SS) mg/L	Sample Type	PFBuS	PFHxS	PFOS	PFPeA	PFHxA	PFHpA	PFOA	PFNA	PFDA	PFUnDA	PFDoDA	Total PFCs	
			ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
E	Inf	Liq	10.0	ND	ND	ND	0.3	1.1	16.2	45.9	ND	ND	ND	73.7	
		Pr	1.1	ND	ND	ND	ND	ND	ND	13.8	6.6	1.0	2.1	ND	24.6
	PC	Liq	2.4	ND	ND	2.3	ND	ND	9.7	26.7	ND	ND	ND	ND	41.1
		Pr	ND	ND	2.5	ND	ND	ND	ND	15.1	1.3	<LOQ	1.1	ND	20.0
	AT	Liq	7.5	0.0	21.3	ND	1.9	1.4	35.0	46.2	0.6	ND	ND	ND	114.0
		Pr	3.8	ND	38.8	7.7	ND	ND	26.6	40.9	22.0	53.2	3.9	ND	196.8
	RAS	Liq	6.4	0.1	8.3	ND	1.3	0.5	19.9	26.9	0.5	ND	ND	ND	63.8
		Pr	2.7	ND	50.6	10.2	ND	ND	31.0	116.8	33.7	115.2	12.5	ND	372.6
	SC	Liq	4.5	0.8	ND	0.8	1.3	1.6	23.6	60.1	1.0	0.3	ND	ND	94.0
		Pr	0.0	ND	1.9	ND	ND	ND	8.5	3.1	0.2	ND	ND	ND	13.7
Eff (ozone)	Liq	0.4	0.6	ND	0.3	3.1	3.2	22.5	28.7	0.5	ND	ND	ND	59.4	
	Pr	0.1	ND	ND	ND	ND	ND	14.6	3.0	0.2	ND	ND	ND	17.8	
Eff (BACF)	Liq	0.4	0.9	1.2	0.7	3.8	3.4	25.7	36.6	1.3	ND	ND	ND	74.1	
	Pr	ND	ND	ND	ND	ND	ND	15.8	3.3	0.5	ND	ND	ND	19.5	
F	Inf	Liq	5.7	ND	ND	ND	ND	ND	5.1	9.9	ND	ND	ND	20.7	
		Pr	ND	ND	ND	ND	ND	0.3	1.3	0.2	0.4	ND	ND	2.2	
	PC	Liq	3.9	ND	ND	ND	ND	ND	ND	6.8	11.2	ND	ND	ND	21.9
		Pr	0.9	ND	0.8	ND	0.1	0.4	25.6	0.8	0.2	0.7	ND	ND	29.5
	AT	Liq	4.2	ND	ND	ND	0.6	0.6	31.5	15.1	0.6	ND	ND	ND	52.6
		Pr	2.8	ND	9.1	0.7	ND	ND	24.0	16.9	12.0	34.2	2.5	ND	102.1
	RAS	Liq	4.6	ND	5.9	ND	0.0	ND	15.3	9.7	0.2	ND	ND	ND	35.9
		Pr	10.1	ND	180.3	6.7	ND	ND	68.5	82.3	30.0	197.6	3.3	ND	578.8
	SC	Liq	2.8	ND	ND	0.1	0.6	0.5	11.6	9.9	0.9	ND	ND	ND	26.4
		Pr	ND	ND	ND	ND	0.5	2.4	4.0	2.1	0.6	ND	ND	ND	9.6
Eff	Liq	2.5	ND	ND	ND	0.6	0.8	16.5	15.3	1.3	0.4	ND	ND	37.5	
	Pr	ND	ND	ND	ND	0.1	0.7	1.6	0.3	0.2	ND	ND	ND	2.8	
G	Inf	Liq	4.6	ND	2.9	4.1	ND	ND	7.2	2.3	ND	ND	ND	21.1	
		Pr	1.4	ND	1.3	ND	ND	ND	14.0	ND	0.1	0.3	ND	ND	17.1
	PC	Liq	1.1	ND	4.3	2.0	ND	ND	4.9	1.7	ND	ND	ND	ND	13.9
		Pr	0.5	ND	0.7	ND	ND	ND	7.7	ND	0.1	<LOQ	ND	ND	9.0
	AT	Liq	3.3	1.4	15.1	ND	1.0	1.6	20.7	3.4	ND	ND	ND	ND	46.4
		Pr	3.6	ND	216.7	1.0	ND	ND	25.1	13.6	17.7	51.6	3.9	ND	333.2
	RAS	Liq	4.0	1.4	52.8	ND	0.4	1.2	17.7	7.6	0.5	ND	ND	ND	85.5
		Pr	5.4	ND	398.3	ND	ND	<LOQ	44.2	18.2	29.1	59.8	ND	ND	555.1
	Eff	Liq	0.9	0.9	21.2	ND	0.6	0.8	12.7	4.1	0.7	ND	ND	ND	41.9
		Pr	0.5	ND	9.0	ND	ND	ND	5.3	0.6	0.2	ND	ND	ND	15.5
H	Inf	Liq	0.8	ND	ND	5.4	ND	ND	6.9	7.5	ND	ND	ND	20.6	
		Pr	1.9	ND	ND	ND	ND	ND	22.0	3.4	0.2	1.2	ND	28.7	
	PC	Liq	1.1	ND	ND	ND	ND	ND	2.7	10.6	10.8	ND	ND	ND	25.2
		Pr	0.5	ND	ND	ND	ND	ND	8.5	2.5	0.3	0.7	ND	ND	12.5
	AT	Liq	1.7	ND	14.4	ND	ND	ND	12.0	17.6	0.6	ND	ND	ND	46.3
		Pr	3.9	ND	13.6	3.5	ND	ND	27.0	19.8	6.2	29.7	ND	ND	103.9
	RAS	Liq	1.8	ND	7.0	ND	ND	ND	14.0	11.7	ND	ND	ND	ND	34.5
		Pr	2.4	ND	15.0	11.0	ND	ND	36.4	41.8	10.9	47.9	ND	ND	165.5
	SC	Liq	0.8	ND	ND	ND	0.3	1.1	13.0	16.4	0.4	ND	ND	ND	31.8
		Pr	0.2	ND	ND	ND	ND	ND	3.9	1.7	0.1	ND	ND	ND	6.0
Eff	Liq	0.7	ND	ND	ND	0.2	0.2	11.5	8.9	ND	ND	ND	ND	21.5	
	Pr	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0	

^s Processes: Inf: influent; PC: after primary clarifier; AT: aeration tank; RAS: returned activated sludge; SC: after secondary clarifier; Eff: effluent; ozone: after ozonation; Cl: after chlorination;

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			ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L
I	Inf	Liq	2.3	2.7	239.8	26.4	908.3	44.7	563.3	19.7	54.0	0.5	0.6	1862.4
		Pr	NA†	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
I	EQ	Liq	7.0	2.7	256.1	32.4	760.6	39.9	634.9	19.9	47.4	1.1	2.5	1804.5
		Pr	ND	ND	24.9	ND	5.5	1.9	9.9	1.3	13.8	0.4	3.8	61.5
I	AT	Liq	10.5	2.6	123.6	88.8	1506.9	73.4	698.4	21.5	67.0	1.2	1.9	2595.7
		Pr	ND	ND	414.2	6.6	200.3	20.5	345.8	9.6	383.2	21.6	225.2	1626.9
I	SC	Liq	2.6	3.5	284.9	64.1	1767.1	74.1	969.8	29.4	104.1	5.5	6.7	3311.8
		Pr	ND	ND	14.8	1.1	5.0	2.0	12.5	1.7	8.2	<LOQ	1.4	46.6
I	Eff	Liq	1.7	4.5	423.2	32.0	1527.8	39.7	894.8	25.3	68.5	6.3	8.9	3032.6
		Pr	ND	ND	7.2	ND	2.0	0.8	3.4	0.6	3.7	ND	0.9	18.7
J	Inf	Liq	0.6	7.9	ND	1.1	4.7	1.4	10.9	4.7	ND	<LOQ	ND	31.3
		Pr	14.2	ND	1.7	ND	0.6	1.0	3.7	1.8	ND	<LOQ	ND	22.9
J	AT	Liq	1.0	4.7	0.5	9.4	16.5	29.5	34.1	11.4	7.6	0.8	ND	115.5
		Pr	9.8	2.7	ND	ND	9.5	2.1	15.0	8.9	18.9	8.2	2.1	77.1
J	Eff	Liq	1.0	23.6	1.4	7.7	11.7	18.2	30.5	14.4	16.9	1.4	ND	126.8
		Pr	0.1	ND	ND	ND	0.8	1.0	26.9	0.3	0.9	0.2	ND	30.3
K	Inf	Liq	194.7	7.5	6.5	ND	1.3	1.6	6.7	ND	ND	ND	ND	218.4
		Pr	0.1	ND	1.6	ND	2.1	2.2	2.1	1.3	0.7	ND	1.8	12.0
K	AT	Liq	298.8	14.8	5.9	1.2	1.7	5.7	5.8	ND	ND	ND	ND	334.0
		Pr	1.3	ND	1.7	ND	1.2	3.4	1.7	0.7	0.7	ND	21.2	32.0
K	Eff	Liq	293.8	11.9	6.1	ND	0.8	1.4	4.2	0.6	0.1	ND	ND	318.9
		Pr	0.2	ND	0.5	ND	0.2	1.4	0.7	0.2	0.1	ND	<LOQ	3.4
L	Inf	Liq	ND	2.0	72.4	43.8	12.2	11.4	90.7	3.1	8.9	7.9	23.5	276.0
		Pr	ND	0.2	18.8	2.1	2.6	2.8	10.2	2.1	1.6	1.3	1.2	42.9
L	AT	Liq	ND	38.0	98.4	28.0	57.2	70.1	89.1	40.7	39.0	31.2	21.5	513.2
		Pr	ND	0.5	78.3	1.7	1.6	3.2	12.2	2.6	1.5	1.1	1.1	103.8
L	Eff	Liq	ND	38.0	92.6	35.9	10.7	7.5	85.2	3.2	8.2	7.0	4.2	292.5
		Pr	ND	0.3	38.9	0.6	1.7	2.6	6.3	1.9	1.6	1.0	1.4	56.4
M	Inf	Liq	2.5	1.5	34.0	6.2	7.6	9.6	86.3	1.7	ND	0.5	ND	149.8
		Pr	1.1	ND	16.0	0.5	0.5	1.1	18.8	0.0	ND	0.4	ND	38.3
M	AT	Liq	2.2	2.5	83.3	11.2	10.7	13.0	173.6	4.8	2.3	1.3	ND	304.8
		Pr	21.2	3.3	110.1	0.2	5.6	6.6	121.0	7.2	26.7	16.7	6.6	325.1
M	Eff	Liq	5.0	4.3	86.3	9.9	10.4	16.6	211.4	5.4	3.1	1.7	ND	354.1
		Pr	1.7	ND	17.8	0.1	0.5	0.3	31.2	ND	ND	<LOQ	ND	51.7

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