

**Consolidated Vs new advanced treatment methods for the removal of
contaminants of emerging concern from urban wastewater.**

Supplementary information

Table SI1. The classification, source and legislation of wastewater effluent relevant CEC.

Category	Name of CEC	Abbreviations	CAS	Source	Regulated concentration, µg/L	Legislation
PhACs	Sulfamethoxazole	SMZ or SMX	723-46-6	Antibiotics	Class I 35	(GWRC 2008) (NRMMC 2008)
	Erythromycin	ERY	114-07-8	Antibiotics	Class I 17.5	(EU Decision 2015/495a) (GWRC 2008) (NRMMC 2008)
	Clarithromycin	CLR	81103-11-9	Antibiotics	Class II 250	(EU Decision 2015/495b) (GWRC 2008) (NRMMC 2008)
	Azithromycin	AZM	83905-01-5	Antibiotics	3.9	(EU Decision 2015/495b) (NRMMC 2008)
	Ciprofloxacin	CIPX	85721-33-1	Antibiotics	Class I 250	(GWRC 2008) (NRMMC 2008)
	Diclofenac	DfNA	15307-86-5	Analgesics	Class I 1.8	(EU Decision 2015/495b) (GWRC 2008) (NRMMC 2008)
	Carbamazepine	CZP, CAR, CARB	298-46-4	Psychiatric drugs	Class I 100 10	(GWRC 2008) (NRMMC 2008) (NWRI, 2013)
	Metformin	MF	657-24-9	Diabetes type 2 agent	Class III 250	(GWRC 2008) (NRMMC 2008)
	Metoprolol	METO, MP	37350-58-6	β receptor blocker type	Class II 25	(GWRC 2008) (NRMMC 2008)
	Bezafibrate	BFB, BZ, BZF	41859-67-0	Lipid lowering agent	Class I 300	(GWRC 2008) (NRMMC 2008)
Steroidal estrogens	Primidone	INN, BAN, USP	125-33-7	Anticonvulsant	10	(NWRI, 2013)
	Iopromide	IPM	7334-07-3	Contrast agent	Class II 750	(GWRC 2008) (NRMMC 2008)
	17-Alpha-ethynodiol	EE2	57-63-6	Medical use	0.175	(EU Decision 2015/495a) (NRMMC 2008)
	17-Beta-estradiol	E2	50-28-2, 53-16-7	Medical use	0.050	(EU Decision 2015/495a) (NRMMC 2008)

Pesticides	Mecoprop	MCPP	93-65-2	Agricultural use	10	None
	Bisphenol A	BPA	80-05-7	Plastic compound	200	(NRMCC 2008)
Industrial chemicals	Benzotriazole	BT	95-14-7	Corrosion inhibitor	-	None
	Methylbenzotriazole	TTA	29385-43-1	Corrosion inhibitor	-	None
	Acesulfame	ACE	33665-90-6	Food additive (sweetener)	-	None
	Perfluorooctanoic acid	PFOA	335-67-1	Teflon dishes	-	None
	Perfluorooctanesulfonic acid	PFOS	1763-23-1	Teflon dishes	-	None
	2,6-Di-tert-butyl-4-methylphenol	BHT	128-37-0	Antioxidant food additive	2	(EU Decision 2015/495a) (NRMCC 2008)
	2-Ethylhexyl 4-methoxycinnamate	EHMC	5466-77-3	Cosmetics sun blocker		(EU Decision 2015/495a)
Complexing agents	Ethylene-diamine-tetracetic acid	EDTA	60-00-4	Industrial and medical use	-	None
	Nitrilotriacetic acid	NTA	139-13-9	Used for water softening	-	None

Table SI2. Second-order reaction rate constants of the reviewed CEC with ozone at pH7 and $\cdot\text{OH}$ radicals

CEC sorted in groups according to ozone reactivity	$k_{\text{O}_3, \text{pH7}}$ $\text{M}^{-1} \text{s}^{-1}$	Reference	$k_{\cdot\text{OH}}$ $\text{M}^{-1} \text{s}^{-1}$	Reference
Group A				
Azithromycin	1.1×10^5	Dodd et al. (2006)	2.9×10^9	Dodd et al. (2006)
Bisphenol A	1.6×10^6	Deborde et al. (2005)	1×10^9	Rosenfeldt and Linden (2004)
Carbamazepine	3.0×10^5	Huber et al. (2003)	8.5×10^9	Wenk et al. (2011)
Ciprofloxacin	1.9×10^4	Dodd et al. (2006)	4.1×10^9	Dodd et al. (2006)
Clarithromycin	4.0×10^4	Lange et al. (2006)	$\sim 5 \times 10^9$	Lee et al. (2014)
Diclofenac	1×10^6	Huber et al. (2003)	7.5×10^9	Huber et al. (2003)
Erythromycin	7.9×10^4	Lee et al. (2014)	$\sim 5 \times 10^9$	Lee et al. (2014)
Metoprolol	2.0×10^3	Benner et al. (2008)	7.3×10^9	Benner et al. (2008)
Sulfamethoxazole	5.5×10^5	Dodd et al. (2006)	5.5×10^9	Huber et al. (2003)
17 α -Ethinylestradiol, EE2	1.6×10^6 (5)	Deborde et al. (2005)	9.8×10^9	Huber et al. (2003)
17 β -Estradiol, E2	1.7×10^6 (5)	Deborde et al. (2005)		
Group B				
Benzotriazole	~ 190	Bourgin et al. (2018)	$(8.6-10) \times 10^9$	Leitner and Roshani (2010)
Bezafibrate	590	Huber et al. (2003)	7.4×10^9	Huber et al. (2003)
Mecoprop	111	Beltran et al. (1994)	1.9×10^9	Beltran et al. (1994)
Methylbenzotriazole	460	Bourgin et al. (2018)		
Group C				
Acesulfame	88	Kaiser et al. (2013)	4.6×10^9	Kaiser et al. (2013)
Iopromide	< 0.8	Huber et al. (2003)	3.3×10^9	Huber et al. (2003)
Metformin	1.2	Jin et al. (2012)	$\sim 10^7$	Scheurer et al. (2012)
PFOA			$\leq 10^5$	Vecitis et al. (2009)
PFOS			$< 10^6$	Vecitis et al. (2008)
Primidone	1	Real et al. (2009)	6.7×10^9	Real et al. (2009)

Table SI3. Abatement of a selection of CECs from wastewater effluents by ozonation (when the concentration after ozonation is below LOQ the abatement is labelled with >)

CEC	Scale	WWTP	DOC (mg/L)	NO ₂ -N (mg/L)	Initial pH	D _{spec} (g O ₃ /g DOC)	Abatement by ozonation (%)	Reference
Group A: good elimination: $k_{O_3} > 10^3$								
Azithromycin	pilot scale	2 German WWTPs				0.75	94	Götz et al. (2015)
		hospital WW	6.25		8.6	0.64±0.01	>91	Kovalova et al. (2013)
			6		8.55	0.89±0.03	>91	
			5.8		8.55	1.08±0.05	>91	
	full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32	>89	Bourgin et al. (2018)
						0.36	>90	
						0.36	90	
						0.44	>92	
						0.45	>85	
						0.45	>91	
						0.45	>64	
						0.46	90	
						0.47	>95	
						0.47	>95	
						0.47	>96	
						0.48	>37	
						0.49	>55	
						0.50	>86	
						0.52	>74	
						0.52	>80	
						0.54	>68	
						0.54	>57	

Bisphenol A	lab scale	AWWTP	7	0.05	7.1	0.57	>43					
						0.59	>50					
						0.62	>93					
						0.64	>86					
						0.65	>90					
						0.66	>87					
						0.68	>94					
						0.70	>89					
						0.82	>94					
						0.84	>64					
						0.91	>95					
						0.92	>95					
						1.07	94					
						81	Lee et al. (2013)					
						0.5	98					
						1	98					
						1.5	98					
						0.28	70					
						0.53	97					
						1.03	97					
						1.53	97					
						0.25	66					
						0.5	97					
						1	97					
						1.5	97					
						0.25	99					
						0.5	99					
						1	99					
						1.5	99					

	LaWWTP	6	0.16	7.2	0.25	96
					0.5	97
					1	97
					1.5	97
	LoWWTP	26.4	0.45	7.3	0.1	74
					0.2	98
					0.3	98
					0.4	98
					0.5	98
					0.6	98
	MWRDGC	5.7	<0.05	7.6	0.25	97
					0.5	97
					1	97
					1.5	97
	PCU	7	<0.05	7.3	0.25	97
					0.5	97
					1	97
					1.5	97
	RWWTP	4.7	0.01	7.2	0.25	99
					0.5	99
					1	99
					1.5	99
	WBMWD	15	0.17	7.3	0.29	98
					0.54	98
					1.04	98
					1.54	98
full scale	Tokyo	3.5	0.039	6.77	0.86	81 Nakada et al. (2007)
		3.2	0.004	7	0.94	87
pilot scale	municipal WW	7.6	0.22	6.8	0.56*/0.65	>98 Schaar et al. (2010)
		5.8	0.07	6.8	0.81	>86
		7.0	0.01	6.7	1.08	>58

Carbamazepine	lab scale	A		14.4		0.28	80	Altmann et al. (2014)
		B		14.2		0.28	80	
		C		11.1		0.28	80	
		D		9.6		0.24	80	
	full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32	96	Bourgin et al. (2018)
						0.36	95	
						0.36	94	
						0.44	>99	
						0.45	95	
						0.45	>98	
						0.45	>98	
						0.46	93	
						0.47	>96	
						0.47	>96	
						0.47	>96	
						0.48	>97	
						0.49	>98	
						0.50	97	
						0.52	>98	
						0.52	94	
						0.54	99	
						0.54	>98	
						0.55	>98	
						0.57	97	
						0.59	>98	
						0.62	>96	
						0.64	>98	
						0.65	>98	

				0.66	>98
				0.68	>96
				0.70	>98
				0.82	>95
				0.84	>98
				0.91	>98
				0.92	>98
				1.07	>98
pilot scale	2 German WWTPs			0.75	96 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0	7	0.36 ± 0.00	98 ± 1 Hollender et al. (2009)
				0.51 ± 0.06	99 ± 1
				0.64 ± 0.03	99 ± 1
				0.79 ± 0.03	99 ± 1
				1.16	100
pilot scale	hospital WW	6.25	8.6	0.64±0.01	>99 Kovalova et al. (2013)
		6	8.55	0.89±0.03	>99
		5.8	8.55	1.08±0.05	>99
pilot scale	municipal WW	7.4±1.2 0.17±0.13 6.7-7.9 (7.0)		0.41±0.02	100 Kreuzinger et al. (2015)
				0.51±0.04	100
				0.62±0.03	100
				0.69±0.03	100
				0.81±0.03	100
				0.88±0.02	100
lab scale	AWWTP	7	0.05	7.1	0.25
					73 Lee et al. (2013)
				0.5	100
				1	100
				1.5	100
	CCWRD	7.1	0.06	6.9	0.28
					69

				0.53	99
				1.03	99
				1.53	99
GCGA	6.3	0.3	7.3	0.25	52
				0.5	99
				1	99
				1.5	99
KOWWTP	4.7	0.07	7	0.25	97
				0.5	100
				1	100
				1.5	100
LaWWTP	6	0.16	7.2	0.25	88
				0.5	99
				1	99
				1.5	99
LoWWTP	26.4	0.45	7.3	0.1	55
				0.2	95
				0.3	99
				0.4	99
				0.5	99
				0.6	98
MWRDGC	5.7	<0.05	7.6	0.25	99
				0.5	99
				1	99
				1.5	99
PCU	7	<0.05	7.3	0.25	99
				0.5	99
				1	99
				1.5	99
RWWTP	4.7	0.01	7.2	0.25	99
				0.5	100

					1	100
					1.5	100
					0.29	99
					0.54	99
					1.04	99
					1.54	99
lab scale	Bottrop	9.5		7.5	1.2	>95 Nöthe (2009)
	Bottrop	9.5		7.5	1.6	>95
	Düsseldorf-Süd	17		7.5	0.8	>95
	Köln Stammheim	9.5		7.5	1.2	>96
full scale	Water Reclamation Plant				0.5 (approx.)	>98 Reungoat et al. (2010)
pilot scale	municipal WW	7.6	0.22	6.8	0.56*/0.65	>99 Schaar et al. (2010)
		5.8	0.07	6.8	0.81	>99
		7.0	0.01	6.7	1.08	>99
Ciprofloxacin	pilot scale	2 German WWTPs			0.75	88 Götz et al. (2015)
	pilot scale	hospital WW	6.25	8.6	0.64±0.01	100 Kovalova et al. (2013)
			6	8.55	0.89±0.03	100
			5.8	8.55	1.08±0.05	100
Clarithromycin	full scale	Neugut	3.5-6.0	0-0.04 6.8-7.9 (7.6)	0.32	94 Bourgin et al. (2018)
					0.36	94
					0.36	91
					0.44	97
					0.45	94
					0.45	96
					0.45	93
					0.46	90
					0.47	>90
					0.47	>90
					0.47	>96

				0.48	>97
				0.49	>95
				0.50	96
				0.52	>97
				0.52	94
				0.54	>96
				0.54	>96
				0.55	>97
				0.57	>97
				0.59	>95
				0.62	>92
				0.64	>94
				0.65	>98
				0.66	>94
				0.68	>93
				0.70	>94
				0.82	>93
				0.84	>96
				0.91	>98
				0.92	>98
				1.07	>96
pilot scale	2 German WWTPs			0.75	92 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0	7	0.36 ± 0.00	92 ± 8 Hollender et al. (2009)
				0.51 ± 0.06	94 ± 5
				0.64 ± 0.03	99 ± 1
				0.79 ± 0.03	98 ± 1
				1.16	99
pilot scale	hospital WW	6.25	8.6	0.64±0.01	100 Kovalova et al. (2013)

Diclofenac	lab scale	A	6	8.55	0.89±0.03	100	
		B	5.8	8.55	1.08±0.05	100	
		C	14.4		0.25	80	Altmann et al. (2014)
		D	14.2		0.24	80	
	full scale	Neugut	11.1		0.2	80	
			9.6		0.19	80	
			3.5-6.0	0-0.04 6.8-7.9 (7.6)	0.32	97	Bourgin et al. (2018)
					0.36	96	
					0.36	95	
					0.44	99	
					0.45	96	
					0.45	99	
					0.45	95	
					0.46	94	
					0.47	>99	
					0.47	>99	
					0.47	99	
					0.48	99	
					0.49	99	
					0.50	97	
					0.52	100	
					0.52	95	
					0.54	99	
					0.54	100	
					0.55	99	
					0.57	98	
					0.59	100	
					0.62	>99	

				0.64	99
				0.65	100
				0.66	99
				0.68	>99
				0.70	100
				0.82	>99
				0.84	100
				0.91	>99
				0.92	>99
				1.07	100
pilot scale	2 German WWTPs			0.75	97 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0	7	0.36 ± 0.00	98 ± 1 Hollender et al. (2009)
				0.51 ± 0.06	99 ± 1
				0.64 ± 0.03	99 ± 1
				0.79 ± 0.03	99 ± 1
				1.16	99
pilot scale	hospital WW	6.25	8.6	0.64±0.01	100 Kovalova et al. (2013)
		6	8.55	0.89±0.03	100
		5.8	8.55	1.08±0.05	100
pilot scale	municipal WW	7.4±1.2	0.17±0.13	6.7-7.9 (7.0)	0.41±0.02
				0.51±0.04	100
				0.62±0.03	100
				0.69±0.03	100
				0.81±0.03	100
				0.88±0.02	100
lab scale	AWWTP	7.1	0.05	7.1	0.25
					78 Lee et al. (2013)
				0.5	98
				1	98

				1.5	98
CCWRD	6.9	0.06	6.9	0.28	72
				0.53	97
				1.03	97
				1.53	97
GCGA	7.3	0.3	7.3	0.25	61
				0.5	98
				1	98
				1.5	98
KOWWTP	7	0.07	7	0.25	99
				0.5	99
				1	99
				1.5	99
LaWWTP	7.2	0.16	7.2	0.25	91
				0.5	99
				1	99
				1.5	99
LoWWTP	7.3	0.45	7.3	0.1	65
				0.2	96
				0.3	98
				0.4	98
				0.5	98
				0.6	99
MWRDGC	7.6	<0.05	7.6	0.25	97
				0.5	97
				1	97
				1.5	97
PCU	7.3	<0.05	7.3	0.25	97
				0.5	97
				1	97
				1.5	97

	RWWTP	7.2	0.01	7.2	0.25	99
					0.5	99
					1	99
					1.5	99
	WBMWD	7.3	0.17	7.3	0.29	98
					0.54	98
					1.04	98
					1.54	98
lab scale	Bottrop	9.5		7.5	1.2	>95 Nöthe (2009)
	Bottrop	9.5		7.5	1.6	>95
	Düsseldorf-Süd	17		7.5	0.8	>95
	Köln Stammheim	9.5		7.5	1.2	>97
full scale	Water Reclamation Plant				0.5 (approx.)	>94 Reungoat et al. (2010)
pilot scale	municipal WW	7.6	0.22	6.8	0.56*/0.65	>99 Schaar et al. (2010)
		5.8	0.07	6.8	0.81	>99
		7.0	0.01	6.7	1.08	>99
Erythromycin	pilot scale	hospital WW	6.25	8.6	0.64±0.01	>93 Kovalova et al. (2013)
			6	8.55	0.89±0.03	>93
			5.8	8.55	1.08±0.05	>93
	pilot scale	municipal WW	7.6	0.22	6.8	0.56*/0.65
			5.8	0.07	6.8	0.81
Metoprolol	full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32
						77 Bourgin et al. (2018)
					0.36	74
					0.36	73
					0.44	80
					0.45	77
					0.45	78
					0.45	75
					0.46	66

					0.47	91
					0.47	91
					0.47	83
					0.48	88
					0.49	91
					0.50	82
					0.52	97
					0.52	78
					0.54	89
					0.54	93
					0.55	89
					0.57	80
					0.59	97
					0.62	94
					0.64	89
					0.65	97
					0.66	94
					0.68	97
					0.70	99
					0.82	>98
					0.84	>99
					0.91	98
					0.92	>99
					1.07	>99
pilot scale	2 German WWTPs				0.75	71 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0	-	7	0.36 ± 0.00	45 ± 4 Hollender et al. (2009)
					0.64 ± 0.03	92 ± 3

				0.79 ± 0.03	94 ± 4	
				1.16	97	
pilot scale	hospital WW	6.25	8.6	0.64±0.01	98 ± 1	Kovalova et al. (2013)
		6	8.55	0.89±0.03	>97	
		5.8	8.55	1.08±0.05	>97	
pilot scale	municipal WW	7.4±1.2	0.17±0.13	6.7-7.9 (7.0)	0.41±0.02	56 Kreuzinger et al. (2015)
				0.51±0.04	63	
				0.62±0.03	70	
				0.69±0.03	83	
				0.81±0.03	89	
				0.88±0.02	88	
lab scale	Bottrop	9.5	7.5	1.2	>96	Nöthe (2009)
	Bottrop	9.5	7.5	1.6	>95	
	Düsseldorf-Süd	17	7.5	0.8	>95	
	Köln Stammheim	9.5	7.5	1.2	>97	
full scale	Water Reclamation Plant			0.5 (approx.)	86	Reungoat et al. (2010)
Sulfamethoxazole	lab scale	A	14.4	0.39	80	Altmann et al. (2014)
	B	14.2		0.37	80	
	C	11.1		0.47	80	
	D	9.6		0.21	80	
full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32	87 Bourgin et al. (2018)
				0.36	84	
				0.36	83	
				0.44	92	
				0.45	87	
				0.45	91	
				0.45	86	
				0.46	61	

				0.47	>93
				0.47	93
				0.47	89
				0.48	96
				0.49	96
				0.50	91
				0.52	>97
				0.52	89
				0.54	94
				0.54	97
				0.55	95
				0.57	94
				0.59	>97
				0.62	>92
				0.64	95
				0.65	>96
				0.66	97
				0.68	>91
				0.70	>98
				0.82	>91
				0.84	>95
				0.91	>96
				0.92	>96
				1.07	>91
full scale	Regensdorf	4.2 - 6.0	7	0.36 ± 0.00	80 ± 1 Hollender et al. (2009)
				0.51 ± 0.06	96 ± 4
				0.64 ± 0.03	97 ± 1
				0.79 ± 0.03	96 ± 3

				1.16	96	
pilot scale	hospital WW	6.25	8.6	0.64±0.01	96 ± 1	Kovalova et al. (2013)
		6	8.55	0.89±0.03	98	
		5.8	8.55	1.08±0.05	99	
pilot scale	municipal WW	7.4±1.2	0.17±0.13	6.7-7.9 (7.0)	0.41±0.02	98 Kreuzinger et al. (2015)
				0.51±0.04	100	
				0.62±0.03	100	
				0.69±0.03	96	
				0.81±0.03	100	
				0.88±0.02	100	
lab scale	AWWTP	7.1	0.05	7.1	0.25	69 Lee et al. (2013)
				0.5	97	
				1	99	
				1.5	99	
lab scale	CCWRD	6.9	0.06	6.9	0.28	64
				0.53	98	
				1.03	99	
				1.53	99	
lab scale	GCGA	7.3	0.3	7.3	0.25	45
				0.5	92	
				1	98	
				1.5	98	
lab scale	KOWWTP	7	0.07	7	0.25	97
				0.5	99	
				1	99	
				1.5	99	
lab scale	LaWWTP	7.2	0.16	7.2	0.25	82
				0.5	98	
				1	98	
				1.5	98	

lab scale	LoWWTP	7.3	0.45	7.3	0.1	67
					0.2	87
					0.3	94
					0.4	97
					0.5	99
					0.6	99
lab scale	MWRDGC	7.6	<0.05	7.6	0.25	95
					0.5	98
					1	98
					1.5	98
lab scale	PCU	7.3	<0.05	7.3	0.25	88
					0.5	98
					1	99
					1.5	99
lab scale	RWWTP	7.2	0.01	7.2	0.25	96
					0.5	99
					1	99
					1.5	99
lab scale	WBMWD	7.3	0.17	7.3	0.29	87
					0.54	98
					1.04	98
					1.54	98
lab scale	Bottrop	9.5		7.5	1.2	>88 Nöthe (2009)
	Köln Stammheim	9.5		7.5	1.2	>72
full scale	Water Reclamation Plant				0.5 (approx.)	>93 Reungoat et al. (2010)
pilot scale	municipal WW	7.6	0.22	6.8	0.56*/0.65	>86 Schaar et al. (2010)
		5.8	0.07	6.8	0.81	>90
		7.0	0.01	6.7	1.08	>93
17 α -Ethinylestradiol, EE2	pilot scale	municipal WW	7.0	0.01	6.7	1.08
17 β -Estradiol, E2	full scale	Tokyo	6.77	0.039	0.44	97 Nakada et al. (2007)

			7	0.004	0.43	>97
Group B: intermediate elimination: $k_{03} = 10^2\text{-}10^3$						
Benzotriazole	lab scale	B		14.2	0.74	80 Altmann et al. (2014)
		C		11.1	0.72	80
		D		9.6	0.64	80
full scale	Neugut		3.5-6.0	0-0.04 6.8-7.9 (7.6)	0.32	52 Bourgin et al. (2018)
					0.36	51
					0.36	52
					0.44	59
					0.45	60
					0.45	56
					0.45	57
					0.46	48
					0.47	75
					0.47	75
					0.47	64
					0.48	64
					0.49	70
					0.50	65
					0.52	80
					0.52	61
					0.54	73
					0.54	74
					0.55	74
					0.57	61
					0.59	77
					0.62	77

				0.64	74
				0.65	79
				0.66	79
				0.68	83
				0.70	88
				0.82	91
				0.84	92
				0.91	87
				0.92	91
				1.07	96
pilot scale	2 German WWTPs			0.75	63 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0	7	0.36 ± 0.00	18 ± 15 Hollender et al. (2009)
				0.51 ± 0.06	63 ± 6
				0.64 ± 0.03	66 ± 6
				0.79 ± 0.03	86 ± 1
				1.16	98
pilot scale	hospital WW	6.25	8.6	0.64±0.01	66 ± 5 Kovalova et al. (2013)
		6	8.55	0.89±0.03	82
		5.8	8.55	1.08±0.05	90
pilot scale	municipal WW	7.4±1.2	0.17±0.13	6.7-7.9 (7.0)	0.41±0.02
				0.51±0.04	10 Kreuzinger et al. (2015)
				0.62±0.03	25
				0.69±0.03	43
				0.81±0.03	52
				0.88±0.02	65
				0.88±0.02	67
pilot scale	municipal WW	7.0	0.01	6.7	1.08
					83 Schaar et al. (2010)
Bezafibrate	lab scale	A	14.4		0.61
					80 Altmann et al. (2014)

B		14.2		0.65	80
C		11.1		0.56	80
D		9.6		0.47	80
pilot scale	Berlin Ruhleben	7.3		0.4	17 Bahr et al. (2005)
full scale	Neugut	3.5-6.0	0-0.04 6.8-7.9 (7.6)	0.32	57 Bourgin et al. (2018)
				0.36	68
				0.36	>62
				0.44	75
				0.45	75
				0.45	77
				0.45	65
				0.46	67
				0.47	
				0.47	
				0.47	74
				0.48	72
				0.49	>76
				0.50	68
				0.52	89
				0.52	72
				0.54	>84
				0.54	>78
				0.55	85
				0.57	66
				0.59	
				0.62	>86
				0.64	
				0.65	>87

					0.66	
					0.68	>79
					0.70	
					0.82	>76
					0.84	>80
					0.91	
					0.92	
					1.07	>20
pilot scale	2 German WWTPs				0.75	71 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0		7	0.36 ± 0.00	54 ± 16 Hollender et al. (2009)
					0.64 ± 0.03	87 ± 4
					0.79 ± 0.03	66 ± 15
					1.16	89
pilot scale	hospital WW	6		8.55	0.89±0.03	87 ± 4 Kovalova et al. (2013)
lab scale	Bottrop	9.5		7.5	1.2	>91 Nöthe (2009)
	Köln Stammheim	9.5		7.5	1.2	>94
pilot scale	municipal ww	7.6	0.22	6.8	0.56*/0.65	81 Schaar et al. (2010)
		5.8	0.07	6.8	0.81	* NO ₂ -compensated
		7.0	0.01	6.7	1.08	76
						87
pilot scale	municipal WW	7.4±1.2	0.17±0.13	6.7-7.9 (7.0)	0.41±0.02	47 Kreuzinger et al. (2015)
					0.51±0.04	61
					0.62±0.03	66
					0.69±0.03	81
					0.81±0.03	89
					0.88±0.02	91
Mecoprop	full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32
						57 Bourgin et al. (2018)
					0.36	59
					0.36	61

0.44	61
0.45	65
0.45	56
0.45	39
0.46	53
0.47	80
0.47	80
0.47	61
0.48	73
0.49	76
0.50	72
0.52	>76
0.52	74
0.54	75
0.54	76
0.55	68
0.57	66
0.59	80
0.62	>72
0.64	76
0.65	76
0.66	80
0.68	>75
0.70	90
0.82	>90
0.84	>93
0.91	88

					0.92	92
					1.07	>94
pilot scale	2 German WWTPs				0.75	64 Götz et al. (2015)
full scale	Regensdorf	4.2 - 6.0		7	0.36 ± 0.00	29 ± 5 Hollender et al. (2009)
					0.64 ± 0.03	72 ± 10
					0.79 ± 0.03	48 ± 42
					1.16	96
Methylbenzotriazole	full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32 Bourgin et al. (2018)
					0.36	65
					0.36	64
					0.44	73
					0.45	70
					0.45	71
					0.45	71
					0.46	59
					0.47	88
					0.47	88
					0.47	77
					0.48	81
					0.49	86
					0.50	82
					0.52	94
					0.52	71
					0.54	83
					0.54	88
					0.55	86
					0.57	72
					0.59	93

					0.62	91
					0.64	85
					0.65	93
					0.66	88
					0.68	95
					0.70	97
					0.82	99
					0.84	99
					0.91	96
					0.92	98
					1.07	99
full scale	Regensdorf		4.2 - 6.0	7	0.36 ± 0.00	36 ± 6 Hollender et al. (2009)
					0.64 ± 0.03	85 ± 4
					0.79 ± 0.03	98 ± 1
					1.16	99

Group C: weak elimination: $k_{O3} < 10^2$

Acesulfame	full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32	33	Bourgin et al. (2018)
						0.36	42	
						0.36	42	
						0.44	54	
						0.45	55	
						0.45	46	
						0.45	41	
						0.46		
						0.47	65	
						0.47	65	
						0.47	43	

			0.48	42
			0.49	50
			0.50	55
			0.52	63
			0.52	57
			0.54	56
			0.54	60
			0.55	58
			0.57	52
			0.59	68
			0.62	39
			0.64	63
			0.65	70
			0.66	70
			0.68	70
			0.70	78
			0.82	82
			0.84	83
			0.91	87
			0.92	88
			1.07	>95
pilot scale	2 German WWTPs		0.75	54 Götz et al. (2015)
pilot scale	municipal ww	7.4±1.2 0.17±0.13 6.7-7.9 (7.0)	0.41±0.02 0.51±0.04 0.62±0.03 0.69±0.03 0.81±0.03	36 Kreuzinger et al. (2015) 40 54 58 66

				0.88±0.02	75
lopromide		7.3		0.4	13 Bahr et al. (2005)
				0.8	38
				1	46
				1.2	64
full scale	Neugut	3.5-6.0	0-0.04	6.8-7.9 (7.6)	0.32
				0.36	27 Bourgin et al. (2018)
				0.36	29
				0.44	29
				0.45	43
				0.45	71
				0.45	19
				0.45	21
				0.46	2
				0.47	
				0.47	
				0.47	27
				0.48	43
				0.49	42
				0.50	
				0.52	25
				0.52	31
				0.54	37
				0.54	47
				0.55	41
				0.57	33
				0.59	41

0.44	56
0.45	58
0.45	48
0.45	53
0.46	56
0.47	73
0.47	73
0.47	64
0.48	58
0.49	67
0.50	53
0.52	73
0.52	58
0.54	64
0.54	65
0.55	66
0.57	55
0.59	67
0.62	71
0.64	63
0.65	71
0.66	66
0.68	77
0.70	81
0.82	87
0.84	84
0.91	83

					0.92	85
					1.07	92
full scale	Regensdorf	4.2 - 6.0	7	0.51 ± 0.06	61 ± 6	Hollender et al. (2009)
				0.64 ± 0.03	58 ± 7	
				0.79 ± 0.03	75 ± 6	
				1.16	91	
pilot scale	hospital WW	6.25	8.6	0.64 ± 0.01	49	Kovalova et al. (2013)
		6	8.55	0.89 ± 0.03	68	
		5.8	8.55	1.08 ± 0.05	78	
lab scale	AWWTP	7	0.05	7.1	0.25	17 Lee et al. (2013)
					0.5	53
					1	88
					1.5	97
CCWRD		7.1	0.06	6.9	0.28	21
					0.53	64
					1.03	95
					1.53	99
GCGA		6.3	0.3	7.3	0.25	20
					0.5	40
					1	86
					1.5	98
KOWWTP		4.7	0.07	7	0.25	20
					0.5	57
					1	92
					1.5	99
LaWWTP		6	0.16	7.2	0.25	22
					0.5	51
					1	83
					1.5	91
LoWWTP		26.4	0.45	7.3	0.1	23

				0.2	26
				0.3	42
				0.4	54
				0.5	70
				0.6	78
MWRDGC	5.7	<0.05	7.6	0.25	24
				0.5	48
				1	84
				1.5	96
PCU	7	<0.05	7.3	0.25	38
				0.5	62
				1	90
				1.5	95
RWWTP	4.7	0.01	7.2	0.25	34
				0.5	57
				1	91
				1.5	99
WBMWD	15	0.17	7.3	0.29	37
				0.54	65
				1.04	93
				1.54	99

Table SI4. The physico-chemical characteristics of selected CECs. K_{ow} , octanol-water partition coefficient; pKa acid dissociation constant; D_{ow} , corrected form of K_{ow} at pH 7; N.m: Not measurable.

CEC	Physico-chemical characteristics				
	$\log K_{ow}^a$	pKa ^b	Charge (at pH 7)		
			Neutral	Cationic	Anionic
Sulfamethoxazole	0.89	1.8, 5.6		X	0.14
Erythromycin	2.37	8.88		X	1.20
Clarithromycin	3.16	8.99		X	1.84
Azithromycin	4.02	8.7, 9.5		X	-1.99
Ciprofloxacin	0.28	6.1	X	X	X
Diclofenac	4.51	4.0			X
Carbamazepine	2.77	/	X		
Metformin	-2.64	12.33		X	
Metoprolol	1.88	9.67		X	
Bezafibrate	4.25	3.83			X
Primidone	0.91	11.50	X		
Iopromide	-2.05	11.4	X		
17-Alpha –ethinylestradiol, EE2	3.63	10.4	X		
17-Beta estradiol, E2	4.01	/	X		
Mecoprop	2.98	3.47			X
Bisphenol A	3.32	10.1	X		
Benzotriazole	1.44	8.2	X		X
Methylbenzotriazole	1.71	8.5	X		
Acesulfame	-0.55	3.02			
Perfluorooctanoic acid, PFOA	N.m.	-4.20		X	N.m.
Perfluorooctanesulfonic acid, PFOS	N.m.	-3.32		X	N.m.
2,6 Di tert butyl 4-methylphenol, BHT	5.1	12.23		X	5.10
2 Ethylhexyl 4-methoxycinnamate, EHMC	5.8	/		X	5.8

Ethylene diamine –	-3.86	0.26	X	-6.78
tetraacetic acid, EDTA				
Nitrilotriacetic acid	-3.81	3.03	X	-5.54

- ^alogKow values for selected CECs were taken from: <http://chem.sis.nlm.nih.gov/chemidplus/>
- ^bpKa values for selected CECs were taken from: www.chemicalize.org, and completed with data taken from: (Arias Espana et al. 2015, Kovalova et al. 2013)
- ^clogD_{ow} values for selected CECs were calculated following equation (Schwarzenbach et al., 2003): logD_{ow} = logK_{ow}, for neutral molecules, log D_{ow} = log K_{ow} - log(1+10^(pH-pKa)) for acids and log D_{ow} = log K_{ow} -log(1+10^(pKa-pH)) for bases.
-

Table S15. Removal of a selection of CECs from wastewater effluents by PAC adsorption

CEC	CEC source, WWTP	Scale ^a	Effluent concentration (C_{eff}), ng/L	DOC, mg/L	PAC dosage, mg/L	Contact time, h	Effluent concentration after advanced treatment (C_{effa}), ng/L	Advanced treatment removal ^b , %	Reference
Sulfamethoxazole	Municipal WWTPs, Switzerland	Full and pilot scale	-	5-10	15	1.0	-	58	Boehler et al. (2012)
	Seine Centre (Colombes, France)	Pilot scale	419 ± 318 ^c	5.6 ± 0.9 ^d	5-10	0.4-0.8	151	64	Mailler et al. (2015)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	300	12.48	10-50	24	15	95	Altmann et al. (2016)
	WWTP Münchehofe (Berlin, Germany)	Pilot scale	300	11.4	20	24	165	45	Altmann et al. (2016)
	Schonerlinde, Brandenburg, Germany	Pilot scale	400	12	5-100	-	80	80	Zietzschmann et al. (2014)
	Four different WWTPs, Germany	Lab scale	350 ^e	12.32	10-50	0.5	<315	>90	Altmann et al. (2014)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	171	7.3 ± 1.9 ^d	10-20 (12) ^f	0.7-0.3	61	64	Margot et al. (2013)
	Seine Centre WWTP (Colombes, France)	Pilot scale	50 ± 38 ^c	5.6 ± 0.9 ^d	5-10	0.4-0.8	15	70	Mailler et al. (2015)
Erythromycin	WWTP Kappala, Sweden	Pilot scale	54 ± 45 ^c	5.88	20	1	2.7	95	Karelid et al. (2017)
	Municipal WWTPs, Switzerland	Full and pilot scale	-	5-10	15	1	-	88	Boehler et al. (2012)
Clarithromycin	Municipal WWTP, Lausanne, Switzerland	Pilot scale	440	7.3 ± 1.9 ^d	10-20 (12) ^f	0.7-3.0	35	92	Margot et al. (2013)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	935	7.3 ± 1.9 ^d	10-20 (12) ^f	0.7-3.0	224	76	Margot et al. (2013)
Azithromycin	Municipal WWTP, Lausanne, Switzerland	Pilot scale	779	7.3 ± 1.9 ^d	10-20 (12) ^f	0.7-3.00	288	63	Margot et al. (2013)
	Municipal WWTP (Colombes, France)	Pilot scale	22 ± 17 ^c	5.6 ± 0.9 ^d	5-10	0.4-0.8	3.5	84	Mailler et al. (2015)
Diclofenac	WWTPs Ruhleben, Berlin, Germany	Lab scale	1,500	10.75	20-100	24	120	92	Streicher et al. (2016)
	Seine Centre WWTP (Colombes, France)	Pilot scale	52 ± 51 ^c	5.6 ± 0.9 ^d	5-10	0.4-0.8	12	76	Mailler et al. (2015)
	WWTPs Münchehofe (Berlin, Germany)	Pilot and Lab scale	6,800	5	3(+50) ^g	12	1,020	85	Altmann et al. (2015a)
	Schonerlinde, Brandenburg, Germany	Pilot scale	6,100	12	5-100	-	1,220	80	Zietzschmann et al. (2014)
	WWTP Kappala, Sweden	Pilot scale	287 ± 163 ^c	5.88	43	1	17	94	Karelid et al. (2017)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	1187	7.3 ± 1.9 ^d	10-20 (12) ^f	0.7-3.0	368	69	Margot et al. (2013)
Carbamazepine	Four different WWTPs, Germany	Lab scale	3,800 ^e	12.32	10-50	0.5	<3,420	>90	Altmann et al. (2014)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	2,100	12.48	10-50	24	<LOQ	99.99	Altmann et al. (2016)
	WWTPs Ruhleben, Berlin, Germany	Lab scale	800	10.75	20-100	24	16	98	Streicher et al. (2016)

	Seine Centre WWTP (Colombes, France)	Pilot scale	41 ± 43^c	5.6 ± 0.9^d	5-10	0.4-0.8	3.3	92	Mailler et al. (2015)
	WWTP Kappala, Sweden	Pilot scale	221 ± 125^c	5.88	20	1	22	90	Karelid et al. (2017)
	Municipal WWTPs	Pilot and full scale Lab scale	-	5-10	15	1	-	92	Boehler et al. (2012)
	Four different WWTPs, Germany	Lab scale	1675 ^e	12.32	10-50	0.5	<167	>90	Altmann et al. (2014)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	461	7.3 ± 1.9^d	10-20 (12) ^f	0.7-3.0	46	90	(Margot et al. 2013)
	Schonerlinde, Brandenburg, Germany	Pilot scale	2,500	12	5-100	-	500	80	Zietzschmann et al. (2014)
Metformin	Municipal WWTP, Lausanne, Switzerland	Pilot scale	>4,000	7.3 ± 1.9^d	10-20 (12) ^f	0.7-3.0	-	>55	Margot et al. (2013)
Metoprolol	WWTP Kappala, Sweden	Pilot scale	1203 ± 662^c	5.88	20	1	12	100	Karelid et al. (2017)
	WWTP HHSK, Rotterdam, Netherland	Lab scale	450	12	10-20 (12) ^e	48	<315	<30	Hu et al. (2016)
	WWTP Münchehofe (Berlin, Germany)	Pilot and Lab scale	5,400	5	3(+50) ^g	12	324	95	Altmann et al. (2015a)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	5,400	12.48	10-50	24	<LOQ	100	Altmann et al. (2016)
	Municipal WWTP of Lausanne, Switzerland	Pilot scale	653	7.3 ± 1.9^d	10-20 (12) ^t	0.7-3.0	32.6	95	Margot et al. (2013)
Bezafibrate	Four different WWTPs	Lab scale	650 ^e	12.32	10-50	0.5	<LOQ	100	Altmann et al. (2014)
	Municipal WWTP of Lausanne, Switzerland	Pilot scale	595	7.3 ± 1.9^d	10-20 (12) ^f	0.7-3.0	125	79	Margot et al. (2013)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	900	12.48	10-50	24	<LOQ	100	Altmann et al. (2016)
	WWTP Münchehofe (Berlin, Germany)	Pilot and Lab scale	900	5	3(+50) ^g	12	135	85	Altmann et al. (2015a)
	Seine Centre WWTP (Colombes, France)	Pilot scale	8 ± 9^c	5.6 ± 0.9^d	5-10	0.4-0.8	7.8	90	Mailler et al. (2015)
Primidone	Four different WWTPs, Germany	Lab scale	500 ^e	12.32	10-50	0.5	50	90	Altmann et al. (2014)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	97	7.3 ± 1.9^d	10-20 (12) ^t	0.7-3.0	47	51	Margot et al. (2013)
	WWTP Münchehofe (Berlin, Germany)	Pilot and Lab scale	700	5.0	3(+50) ^g	12	266	62	Altmann et al. (2015a)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	700	12.48	10-50	24	70	90	Altmann et al. (2016)
Iopromide	WWTP Münchehofe (Berlin, Germany)	Pilot and Lab scale	18,100	11.2	35	12	4,525	75	Altmann et al. (2015b)
	Municipal WWTPs, Switzerland	Full and pilot scale	-	5-10	15	1	-	70	Boehler et al. (2012)
	Schonerlinde, Brandenburg, Germany	Pilot scale	1,100	12	5-100	-	220	80	Zietzschmann et al. (2014)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	18,100	12.48	10-50	-	1,800	90	Altmann et al. (2016)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	4,141	7.3 ± 1.9^d	10-20 (12) ^e	-	-	47	Margot et al. (2013)

17-Alphaethylestradiol, EE2	Municipal WWTP, Lausanne, Switzerland	Pilot scale	<1.9	7.3 ± 1.9 ^d	10-20 (12) ^e	-	/	Margot et al. (2013)
	Municipal WWTP Wulongkou, Zhengzhou, China	Full scale	0.24 ± 0.07 ^c	-	20-160	0.78 ± 0.24 ^c	83.33	Sun et al. (2017)
17-Beta estradiol, E2	Municipal WWTP Wulongkou, Zhengzhou, China	Full scale	4.68 ± 0.89 ^c	-	20-160	<LOD	99.99	Sun et al. (2017)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	1.3	7.3 ± 1.9 ^d	5-10	35.5	61	Margot et al. (2013)
Mecoprop	Municipal WWTP, Lausanne, Switzerland	Pilot scale	245	7.3 ± 1.9 ^d	5-10	15	48	Margot et al. (2013)
	Municipal WWTPs, Switzerland	Full and pilot scale	-	5-10	15	-	65	Boehler et al. (2012)
Bisphenol A	Municipal WWTP Wulongkou, Zhengzhou, China	Full scale	12.60 ± 2.02 ^c	-	20-160	5.92 ± 0.02 ^c	53.01	Sun et al. (2017)
	Municipal WWTP, Lausanne, Switzerland	Pilot scale	338	7.3 ± 1.9 ^d	10-20 (12) ^t	57	83	Margot et al. (2013)
Benzotriazole	Seine Centre WWTP (Colombes, France)	Pilot scale	78 ± 24 ^c	5.6 ± 0.9 ^d	5-10	19.5	66	Mailler et al. (2015)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	11,600	12.48	10-50	<LOQ	100	Altmann et al. (2016)
Benzotriazole	WWTP Münchehofe (Berlin, Germany)	Pilot scale	11,600	5.0	3 (+50) ^g	1,740	85	Altmann et al. (2015a)
	WWTPs Ruhleben, Berlin, Germany	Lab scale	8,200	10.75	20-100	1000	82	Streicher et al. (2016)
Methylbenzotriazole	Municipal WWTP, Lausanne, Switzerland	Pilot scale	6,948	7.3 ± 1.9 ^d	10-20 (12) ^f	2.4	90	Margot et al. (2013)
	Four different WWTPs, Germany	Lab scale	12,025 ^e	12.32	10-50	1,203	>90	Altmann et al. (2014)
Acesulfame	Schonerlinde, Brandenburg, Germany	Pilot scale	34,000	12	5-100	6,800	80	Zietzschmann et al. (2014)
	Municipal WWTPs, Berlin, Germany	Pilot and Lab scale	6,200	12.48	10-50	124	98	Altmann et al. (2016)
Perfluoroctanoic acid; PFOA	Municipal WWTP, Lausanne, Switzerland	Pilot scale	4,201	7.3 ± 1.9 ^d	10-20 (12) ^t	168	96	Margot et al. (2013)
	WWTP Münchehofe (Berlin, Germany)	Pilot and Lab scale	5,900	11.2	35	4,956	16	Altmann et al. (2015b)
Perfluorooctanesulfonic acid, PFOS	Seine Centre WWTP (Colombes, France)	Pilot scale	7,525 ± 665 ^c	5.6 ± 0.9 ^d	5-10	6,396	15	Mailler et al. (2015)
	Seine Centre WWTP (Colombes, France)	Pilot scale	5,900	11.4	20	5,310	10	Altmann et al. (2016)

• ^a Lab and/or pilot plant receives conventionally treated wastewater from a full scale WWTP (real WW samples are further advanced treated by PAC)

• ^b When the advanced treatment efficiency was not presented in a study, it was calculated using the following equation: advanced treatment removal (%) = $(C_{eff} - C_{effa})/C_{eff} \times 100$. (C_{effa} is the effluent concentration of a compound after advanced treatment).

- ^cThe average concentration of tested samples (\pm standard deviation).
- ^dThe average DOC content of the wastewater (\pm standard deviation).
- ^eThe average value of the effluent concentrations from four different WWTPs.
- ^fMedian PAC dosage (mg/L).
- ^gContinuous PAC dosing (initial dosage of 3mg/L, plus 50 mg/L).

Table SI6. Removal of a selection of CEC from wastewater effluents by GAC adsorption

CEC	CEC source, WWTP	Scale ^a	Influent concentration (C_{eff}), ng/L	DOC, mg/L	EBCT, min	Bed volumes (BVs)	Effluent conc. after advanced treatment (C_{effa}), ng/L	GAC removal ^b , %	Reference
Sulfamethoxazole	WWTP Münchephofe (Berlin, Germany)	Pilot scale	300	11.4	14	<5,000	270	10	Altmann et al. (2016)
	South Caboolture Water Reclamation Plant, Australia	Full scale	-	4.2±0.1 ^c	18	68,000	-	90	Reungoat et al. (2011)
	WWTPs Neugut, Switzerland	Pilot scale	145	3.5-6.0	14	7,390	-	59	Bourgin et al. (2018)
Erythromycin	Municipal WWTP, Germany	Pilot scale	300 ± 200 ^d	-	-	25,000	<LOQ	99.99	Knopp et al. (2016)
	South Caboolture Water Reclamation Plant, Australia	Full scale		4.2±0.1 ^c	18	68,000		90	Reungoat et al. (2011)
Clarithromycin	WWTP Kappala, Sweden	Pilot scale	54	5.88	60	6,440	1	98	Karelid et al. (2017)
	WWTPs Neugut, Switzerland	Pilot scale	295 349 155	3.5-6.0	14	7,390 11,950 23,410	-	86 64 54	Bourgin et al. (2018)
Ciprofloxacin	WWTP Gwinnett County, GA, U.S.A.	Full scale	130	4.5	15	-	23	82.3	Yang et al. (2011)
Diclofenac	Municipal WWTP, Germany	Pilot scale	3900 ± 1200 ^d	5.3	34 ± 11 ^e	25,000	<LOQ	99.99	Knopp et al. (2016)
	WWTP Kappala, Sweden	Pilot scale	287	3.4 ± 1.1 ^c	60	6,440	17	94	Karelid et al. (2017)
	WWTP Münchephofe (Berlin, Germany)	Pilot scale	6,800	11.4	14	14,250	2,040	70	Altmann et al. (2016)
	WWTPs in Swindon, South-West England	Full scale	-	7.41 ^f		1,900	-	>98	Grover et al. (2011)
Carbamazepine	WWTPs Neugut, Switzerland	Pilot scale	1,396 1,293 1,008	3.5-6.0	14	7,390 11,950 23,410		91 69 72	Bourgin et al. (2018)
	WWTPs in Swindon, South-West England	Full scale	66	7.41 ^f		1,900	51	23	Grover et al. (2011)
	WWTP Münchephofe (Berlin, Germany)	Pilot scale	2,100	11.4	14	8,000-10,000	940	>80	Altmann et al. (2016)
	WWTP Kappala, Sweden	Pilot scale	221	5.88	60	6,440	11	95	Karelid et al. (2017)
Metoprolol	WWTPs Neugut, Switzerland	Pilot scale	190 230 110	3.5-6.0	14	7,390 11,950 23,410	-	95 75 72	Bourgin et al. (2018)
	South Caboolture Water Reclamation Plant, Australia	Full scale	-	4.2±0.1 ^c	18	68,000	-	90	Reungoat et al. (2011)
	WWTP Münchephofe (Berlin, Germany)	Pilot scale	5,400	11.4	14	14,250	972	82	Altmann et al. (2016)
	WWTPs Neugut, Switzerland	Pilot scale	304 292 191	3.5-6.0	14	7,390 11,950 23,410	-	99 85 85	Bourgin et al. (2018)
Bezafrilate	WWTP Kappala, Sweden	Pilot scale	1203	3.4 ± 1.1 ^c	60	6,440	12	100	Karelid et al. (2017)
	South Caboolture Water Reclamation Plant, Australia	Full scale	-	4.2±0.1 ^c	18	68,000	-	95	(2011)
Benzafrilate	WWTP Münchephofe (Berlin, Germany)	Pilot and	900	11.4	14	14,250	270	70	Altmann et al. (2016)

		Lab scale								
Primidone	WWTPs Neugut, Switzerland	Pilot scale	27 47 28	3.5-6.0	14	7,390 11,950 23,410	-	91 71 69	Bourgin et al. (2018)	
	Municipal WWTP Münchhofe (Berlin, Germany)	Pilot scale	700	11.4	14	<5,000	364	48	Altmann et al. (2016)	
	WWTPs Neugut, Switzerland	Pilot scale	157 132 91	3.5-6.0	14	7,390 11,950 23,410		79 48 37	Bourgin et al. (2018)	
Iopromide	WWTP Kappalaverket (Kappala, Sweden)	Pilot scale	1,200 ± 1,200 ^d	5.3	34 ± 11 ^e	25,000	50	96	Knopp et al. (2016)	
	Municipal WWTP Münchhofe (Berlin, Germany)	Pilot scale	18,100	11.4	14	14,250	2,715	85	Altmann et al. (2016)	
	South Caboolture Water Reclamation Plant, Australia	Full scale		4.2±0.1 ^c	18	68,000		>80	Reungoat et al. (2011)	
	WWTPs Neugut, Switzerland	Pilot scale	359 2,909 446	3.5-6.0	14	7,390 11,950 23,410		38 75 79	Bourgin et al. (2018)	
17-Alphaethylestradiol	Gwinnett County, GA, U.S.A.	Full scale	<20	4.5	15	-	<10	50	Yang et al. (2011)	
	WWTPs in Swindon, South-West England	Full scale	1	7.41 ^f	-	1,900	<LOD	>43	Grover et al. (2011)	
	WWTPs in Swindon, South-West England	Full scale	2	7.41 ^f	-	1,900	<LOD	>43	Grover et al. (2011)	
Mecoprop	Municipal WWTP, Germany	Pilot scale	<LOQ	5.3	34 ± 11 ^e	25,000	<LOQ	/	Knopp et al. (2016)	
	WWTPs Neugut, Switzerland	Pilot scale	16 19 71	3.5-6.0	14	7,390 11,950 23,410		38 40 53	Bourgin et al. (2018)	
Benzotriazole	WWTP Münchhofe (Berlin, Germany)	Pilot scale	11,600	11.4	14	8,000-10,000	4,060	65	(2016)	
	WWTPs Neugut, Switzerland	Pilot scale	2,484 2,886 2,310	3.5-6.0	14	7,390 11,950 23,410		99 88 84	Bourgin et al. (2018)	
	WWTP Münchhofe (Berlin, Germany)	Pilot and Lab scale	11,600	11.2	19	8,140	2,320	80	Altmann et al. (2015b)	
Methylbenzotriazole	WWTP Münchhofe (Berlin, Germany)	Pilot and Lab scale	6,200	11.2	19	8,140	620	90	Altmann et al. (2015b)	
	WWTP Münchhofe (Berlin, Germany)	Pilot scale	6,200	11.4	14	14,250	1,860	70	Altmann et al. (2016)	
	WWTPs Neugut, Switzerland	Pilot scale	1,216 1,346 838	3.5-6.0	14	7,390 11,950 23,410		99 91 88	Bourgin et al. (2018)	
Acesulfame	WWTP Münchhofe (Berlin, Germany)	Pilot scale	5,900	11.4	14	14,250	5,782	2	Altmann et al. (2016)	
	WWTPs Neugut, Switzerland	Pilot scale	7,762 11,831 9,290	3.5-6.0	14	7,390 11,950 23,410		59 31 66	Bourgin et al. (2018)	

• ^a Lab and/or pilot plant receives conventionally treated wastewater from a full scale WWTP (real WW samples are further treated by GAC)

- ^b When the GAC treatment efficiency was not presented in a study, it was calculated using the following equation: GAC adsorption (%) = $(C_{eff} - C_{effa})/C_{eff} \times 100$. (C_{effa} is the effluent concentration of a compound after GAC treatment).
- ^c The average DOC content of the wastewater (\pm standard deviation).
- ^d The average concentration of tested samples (\pm standard deviation).
- ^e The average EBCT (\pm standard deviation).
- ^f The average DOC content from four collected samples (seasonal variation).

Table SI7. Reported contaminant rejections by NF and RO membranes

CEC	Matrix	Membrane	Type	Scale	Rejection	Reference
Diclofenac	10mM NaCl	Dow NF270	NF	laboratory	84-86%	[Ge et al, 2017]
	Surface water	FM NP010	NF	laboratory	60-65%	[Vergili, 2013]
	Surface water	Dow BW30LE-440	RO	large pilot	>99%	[Radjenovic et al, 2008]
	Surface water	Dow NF90	NF	large pilot	>99%	[Radjenovic et al, 2008]
	5mM NaCl	Trisep TS-80 TSF	NF	laboratory	88-91%	[Verliefde et al, 2009]
	5mM NaCl	GE Desal HL	NF	laboratory	85-89%	[Verliefde et al, 2009]
Carbamazepine	10mM NaCl	Dow NF270	NF	laboratory	77-79%	[Ge et al, 2017]
	Surface water	FM NP010	NF	laboratory	32-40%	[Vergili, 2013]
	Surface water	Dow BW30LE-440	RO	large pilot	>99%	[Radjenovic et al, 2008]
	Surface water	Dow NF90	NF	large pilot	97-99%	[Radjenovic et al, 2008]
	10mM KCl	Dow NF90	NF	laboratory	90-98%	[Yangali-Quintanilla et al, 2010b]
	10mM KCl	Dow NF200	NF	laboratory	70-74%	[Yangali-Quintanilla et al, 2010b]
E2	5mM NaCl	Trisep TS-80 TSF	NF	laboratory	80-85%	[Verliefde et al, 2009]
	5mM NaCl	GE Desal HL	NF	laboratory	82-86%	[Verliefde et al, 2009]
	10mM NaCl	Dow NF270	NF	laboratory	63-67%	[Ge et al, 2017]
	20mM NaCl, 1mM NaHCO ₃	Koch TFC-S	RO	laboratory	80-90%	[Nghiem et al, 2004b]
	20mM NaCl, 1mM NaHCO ₃	Koch TFC-SR2	NF	laboratory	20-25%	[Nghiem et al, 2004b]
	Distilled water	Dow BW30	RO	laboratory	85-90%	[Semiao and Schäfer, 2013]
NDMA	Distilled water	Dow NF90	NF	laboratory	80-85%	[Semiao and Schäfer, 2013]
	Distilled water	Koch TFC-SR2	NF	laboratory	35-55%	[Semiao and Schäfer, 2013]
	Secondary effluent	3 commercial	RO	full-scale	10-75%	[Fujioka et al, 2013a]
	Secondary effluent	several commercial	RO	full-scale	10-86%	[Fujioka et al, 2012]
	20 mM NaCl, 1 mM NaHCO ₃ , 1 mM CaCl ₂	Dow NF 90	NF	laboratory	8%	[Fujioka et al, 2013b]
	20 mM NaCl, 1 mM NaHCO ₃ , 1 mM CaCl ₂	Hydranautics ESPA2	RO	laboratory	32-42%	[Fujioka et al, 2013b]
	20 mM NaCl, 1 mM NaHCO ₃ , 1 mM CaCl ₂	Hydranautics SWC5	RO	laboratory	79-85%	[Fujioka et al, 2013b]

Table SI8 Homogeneous advanced oxidation processes using CEC spiked wastewater and real wastewater.

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
Sulfamethoxazole	100 µg/L	Pilot	CEC spiked wastewater/ synthetic wastewater	DOC: 16.5 mg/L	Solar photo-Fenton	CPC; H ₂ O ₂ : 50 mg/L; Fe ³⁺ : 5 mg/L.	100%	Karolia et al., 2014
	100 µg/L	Pilot	CEC spiked wastewater	DOC: 42.7 mg/L COD: 122 mg/L	Solar photo-Fenton	CPC; H ₂ O ₂ : 50 mg/L; Fe ³⁺ : 5 mg/L.	100%	Karolia et al., 2017
	50 µM	Lab	CEC spiked wastewater	TOC: 50 mg/L	Photo-Fenton	Sulfate radical based homogeneous photo-Fenton involving peroxymonosulfate (PMS) as oxidant, Fe(II) as catalyst and simulated solar irradiation as a light source.	100%	Ahmed et al., 2014
	5 or 100 µg/L	Lab/Pilot	CEC spiked wastewater	COD: 60-62 mg/L; DOC: 11-15 mg/L	Solar photo-Fenton	Carbonate-bicarbonate removed; Solar simulator with a Xe Lamp; Mobile solar CPC; Solution of Fe:EDDS (molar ratio 1:2).	100%	Papoutsakis et al., 2015
	5 or 100 µg/L	Pilot	CEC spiked wastewater/ real wastewater	COD: 20-49 mg/L	Solar photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; Solution of Fe:EDDS (molar ratio 1:2 or 1:1).	84-95%	Klamerth et al., 2012
	5 or 100 µg/L	Pilot	CEC spiked wastewater/ real wastewater	COD: 26-53 mg/L DOC: 10-24 mg/L	Solar photo-Fenton	Modified solar photo-Fenton: 5 mg/L Fe(II), 50 mg/L H ₂ O ₂ ; pH ≈7; Other tested conditions: 35 mg/L oxalic acid or addition of humic acids or mixing 31% of WWTP influent and 69% effluent.	> 25%	Klamerth et al., 2011
	100 µg/L	Pilot	CEC spiked wastewater/ real wastewater	COD: 60 mg/L DOC: 36 mg/L	Solar photo-Fenton	CPC; H ₂ O ₂ : 50 mg/L; Iron: 5 mg/L; Unchanged pH.	100%	Klamerth et al., 2010
	282 ng/L	Pilot	real wastewater	COD: 19.4-26.2 mg/L DOC: 40-54 mg/L	Solar photo-Fenton	Raceway pond reactors; Continuous mode; Real secondary effluents treated at two liquid depths (5, 15 cm) and three HRTs (80, 40, 20 min); Iron: 5.5 mg/L; H ₂ O ₂ : 30 mg/L.	> 81%	Arzate et al., 2017
5.11-2330 ng/L	Lab	real wastewater	COD: 20-35 mg/L; BOD5: < 5 mg/L; TOC: 2-5 mg/L	Fenton Chemical precipitation with	Fenton: H ₂ O ₂ 25-250 mg/L at fixed iron dose (10 mg/L) and iron 10-40 mg/L at a constant H ₂ O ₂ dose (25 mg/L).	93-100% (Fenton)	Estrada-Arriaga et al., 2016	

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
FeCl_3 Coagulation with $\text{Al}_2(\text{SO}_4)_3$								
100 µg/L	Pilot	CEC spiked wastewater	COD: 122 mg/L DOC: 42.7 mg/L	Solar Fenton oxidation as post-treatment of MBR	CPC; Reactor recirculation time 15 min; Iron: 5 mg/L; H_2O_2 : 20-100 mg/L; pH 2.8.	100%	Karolia et al., 2017	
219-1879 µg/L	Pilot	real wastewater	COD: 20-29 mg/L; TOC: 16-18 mg/L	Solar photo-Fenton	Solar CPC; Fe(II): 5 mg/L; pH 3 and 10; H_2O_2 : 50 mg/L; Complexing agents (humic acid and ethylenediamine-N,N'-disuccinic acid).	> 56%	Klamerth et al., 2013	
209-487 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV $\text{UV}/\text{H}_2\text{O}_2$ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H_2O_2 : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L:	81-89% (UV/ H_2O_2); 79-82% (Photo-Fenton)	De la Cruz et al., 2013	
518 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H_2O_2 : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012	
1000-10000 ng/L	Pilot	CEC spiked wastewater	COD: 23 mg/L; DOC: 10.2 mg/L	Solar photo-Fenton	CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H_2O_2 : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a	
Erythromycin								
119 ng/L	Pilot	real wastewater	COD: 19.4-26.2 mg/L DOC: 40-54 mg/L	Solar photo-Fenton	Raceway pond reactors; Continuous mode; Real secondary effluents treated at two liquid depths (5, 15 cm) and three HRTs (80, 40, 20 min); Iron: 5.5 mg/L; H_2O_2 : 30 mg/L.	> 99.9%	Arzate et al., 2017	
100 µg/L	Pilot	CEC spiked wastewater	COD: 122 mg/L DOC: 42.7 mg/L	Photo-Fenton	Solar CPC; H_2O_2 : 50 mg/L; Fe^{3+} : 5 mg/L.	100%	Karolia et al., 2017	
648 ng/L	Lab	real wastewater	COD: 20-35 mg/L; BOD5: < 5 mg/L; TOC: 2-5 mg/L	Fenton Chemical precipitation with FeCl_3 Coagulation with $\text{Al}_2(\text{SO}_4)_3$	Fenton: H_2O_2 25-250 mg/L at fixed iron dose (10 mg/L) and iron 10-40 mg/L at a constant H_2O_2 dose (25 mg/L).	74% (Fenton)	Estrada-Arriaga et al., 2016	
100 µg/L	Lab	CEC spiked wastewater	DOC: 7.9 COD: 49	UV-C/ H_2O_2	Cylindrical reaction vessel with a total capacity of 600 mL, 9W low-pressure mercury monochromatic lamp	100%	Michael-Kordatou et al. (2015)	

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
Clarithromycin	146 ng/L	Lab	real wastewater	COD: 20 mg/L BOD: 3 mg/L	Fenton like reaction experiments (FLR-system Fe ⁰ /H ₂ O ₂ /H ₂ SO ₄)	Erlenmeyer flask of 300 mL, concentrated H ₂ SO ₄ (0.05 mL), optimized amount of activated iron shavings (3 g) and H ₂ O ₂ (0.8 mL, 30 w/w%) were added	100%	Mackulak et al., (2015)
	< 100 ng/L	Pilot	CEC spiked wastewater	COD: 23 mg/L; DOC: 10.2 mg/L	Photo-Fenton	Solar CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H ₂ O ₂ : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a
	100 µg/L	Pilot	CEC spiked wastewater/ synthetic wastewater	DOC: 16.5 mg/L	Solar photo-Fenton	CPC; H ₂ O ₂ : 50 mg/L; Fe ³⁺ : 5 mg/L.	77%	Karolia et al., 2017
	362 ng/L	Lab	real wastewater	COD: 20-35 mg/L; BOD5: < 5 mg/L; TOC: 2-5 mg/L	Fenton Chemical precipitation with FeCl ₃ Coagulation with Al ₂ (SO ₄) ₃	Fenton: H ₂ O ₂ 25-250 mg/L at fixed iron dose (10 mg/L) and iron 10-40 mg/L at a constant H ₂ O ₂ dose (25 mg/L).	77% (Fenton)	Estrada-Arriaga et al., 2016
	100 µg/L	Pilot	CEC spiked wastewater	COD: 122 mg/L DOC: 42.7 mg/L	Solar photo Fenton oxidation as post-treatment of MBR	CPC; Reactor recirculation time 15 min; Iron: 5 mg/L; H ₂ O ₂ : 20-100 mg/L; pH 2.8.	84%	Karolia et al., 2017
	209-487 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L;	81-89% (UV/H ₂ O ₂); 79-82% (Photo-Fenton)	De la Cruz et al., 2013
	363-490 ng/L	Lab	real wastewater	COD: 35-90 mg/L; TOC: 20.2-57.2 mg/L	UV UV/H ₂ O ₂ Solar irradiation Fenton Solar photo-Fenton	UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 25 mg/L; Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II); Photo-Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II).	> 79% (UV-based AOPs)	Giannakis et al., 2015
	518 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
Azithromycin	< 100 ng/L	Pilot	CEC spiked wastewater	COD: 23 mg/L; DOC: 10.2 mg/L	Solar photo-Fenton	CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H ₂ O ₂ : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a
	82.2 ng/L	Lab	real wastewater	COD: 20-35 mg/L; BOD5: < 5 mg/L; TOC: 2-5 mg/L	Fenton Chemical precipitation with FeCl ₃ Coagulation with	Fenton: H ₂ O ₂ 25-250 mg/L at fixed iron dose (10 mg/L) and iron 10-40 mg/L at a constant H ₂ O ₂ dose (25 mg/L).	72% (Fenton)	Estrada-Arriaga et al., 2016

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
$\text{Al}_2(\text{SO}_4)_3$								
Ciprofloxacin	295 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H_2O_2 : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
	100 $\mu\text{g L}^{-1}$	Lab scale, batch mode	Spiked WW (CAS effluent)	DOC: 6.4 COD: 32	UV-C/ H_2O_2	Cylindrical reaction glass vessel with a total capacity of 600 mL, 9W low-pressure mercury monochromatic lamp, 10 mg H_2O_2 /L	100%	Boudriche et al. (2016)
	209-487 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV $\text{UV}/\text{H}_2\text{O}_2$ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H_2O_2 : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L;	81-89% (UV/ H_2O_2); 79-82% (Photo-Fenton)	De la Cruz et al., 2013
Diclofenac	50 μM	Lab	CEC spiked wastewater	TOC: 50 mg/L	Photo-Fenton	Sulfate radical based homogeneous photo-Fenton involving peroxymonosulfate (PMS) as oxidant, Fe(II) as catalyst and simulated solar irradiation as a light source.	100%	Ahmed et al., 2014
	5, 100 $\mu\text{g/L}$	Pilot	CEC spiked wastewater/ real wastewater	COD: 20-49 mg/L	Solar Photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; Solution of Fe:EDDS (molar ratio 1:2 or 1:1).	-	Klamerth et al., 2012
	5 or 100 $\mu\text{g/L}$	Pilot	CEC spiked wastewater/ real wastewater	COD: 26-53 mg/L DOC: 10-24 mg/L	Solar Photo-Fenton	Modified solar photo-Fenton: 5 mg/L Fe(II), 50 mg/L H_2O_2 ; pH \approx 7; Other tested conditions: 35 mg/L oxalic acid or addition of humic acids or mixing 31% of WWTP influent and 69% effluent.	> 89%	Klamerth et al., 2011
	100 $\mu\text{g/L}$	Pilot	CEC spiked wastewater/ real wastewater	COD: 60 mg/L DOC: 36 mg/L	Solar Photo-Fenton	Solar CPC; H_2O_2 : 50 mg/L; Iron: 5 mg/L; Unchanged pH.	100%	Klamerth et al., 2010
	110-3577 $\mu\text{g/L}$	Pilot	real wastewater	COD: 20-29 mg/L; TOC: 16-18 mg/L	Solar photo-Fenton	Solar CPC; Fe(II): 5 mg/L; pH 3 and 10; H_2O_2 : 50 mg/L; Complexing agents (humic acid and ethylenediamine-N,N'-disuccinic acid).	100%	Klamerth et al., 2013
	1254-1579 ng/L	Lab	real wastewater	COD: 35-90 mg/L; TOC: 20.2-57.2 mg/L	UV $\text{UV}/\text{H}_2\text{O}_2$ Solar irradiation Fenton Solar photo-Fenton	UV-C irradiation (λ_{\max} 254 nm); H_2O_2 : 25 mg/L; Fenton: 25 mg/L H_2O_2 and 5 mg/L Fe (II); Solar photo-Fenton: 25 mg/L H_2O_2 and 5	> 79% (UV-based AOPs)	Giannakis et al., 2015

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
mg/L Fe (II).								
	494-1247 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L.	99-100% (UV/H ₂ O ₂); 100% (Photo-Fenton)	De la Cruz et al., 2013
	518 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
	1000-10000 ng/L	Pilot	CEC spiked wastewater	COD: 23 mg/L; DOC: 10.2 mg/L	Photo-Fenton	Solar CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H ₂ O ₂ : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a
Carbamazepine	50 µM	Lab	CEC spiked wastewater	TOC: 50 mg/L	Photo-Fenton	Sulfate radical based homogeneous photo-Fenton involving peroxymonosulfate (PMS) as oxidant, Fe(II) as catalyst and simulated solar irradiation as a light source.	100%	Ahmed et al., 2014
	5 or 100 µg/L	Lab/Pilot	CEC spiked wastewater	COD: 60-62 mg/L; DOC: 11-15 mg/L	Solar Photo-Fenton	Carbonate-bicarbonate removed; Solar simulator with a Xe Lamp; Mobile solar CPC; Solution of Fe:EDDS (molar ratio 1:2).	-	Papoutsakis et al., 2015
	5, 100 µg/L	Pilot	CEC spiked wastewater/ real wastewater	COD: 20-49 mg/L	Solar Photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; Solution of Fe:EDDS (molar ratio 1:2 or 1:1).	97%	Klamerth et al., 2012
	5 or 100 µg/L	Pilot	CEC spiked wastewater/ real wastewater	COD: 26-53 mg/L DOC: 10-24 mg/L	Solar Photo-Fenton	Modified solar photo-Fenton: 5 mg/L Fe(II), 50 mg/L H ₂ O ₂ ; pH ≈7; Other tested conditions: 35 mg/L oxalic acid or addition of humic acids or mixing 31% of WWTP influent and 69% effluent.	> 24%	Klamerth et al., 2011
	100 µg/L	Pilot	CEC spiked wastewater/ real wastewater	COD: 60 mg/L DOC: 36 mg/L	Solar Photo-Fenton	Solar CPC; H ₂ O ₂ : 50 mg/L; Iron: 5 mg/L; Unchanged pH.	100%	Klamerth et al., 2010
	422 ng/L	Pilot	real wastewater	COD: 19.4-26.2 mg/L DOC: 40-54 mg/L	Solar photo-Fenton	Raceway pond reactors; Continuous mode; Real secondary effluents treated at two liquid depths (5, 15 cm) and three HRTs (80, 40, 20 min); Iron: 5.5 mg/L; H ₂ O ₂ : 30 mg/L.	> 86%	Arzate et al., 2017

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
	29.5-244 ng/L	Lab	real wastewater	COD: 20-35 mg/L; BOD5: < 5 mg/L; TOC: 2-5 mg/L	Fenton Chemical precipitation with FeCl ₃ Coagulation with Al ₂ (SO ₄) ₃	Fenton: H ₂ O ₂ 25-250 mg/L at fixed iron dose (10 mg/L) and iron 10-40 mg/L at a constant H ₂ O ₂ dose (25 mg/L).	29.5-100% (Fenton)	Estrada-Arriaga et al., 2016
	220-349 ng/L	Lab	real wastewater	COD: 35-90 mg/L; TOC: 20.2-57.2 mg/L	UV UV/H ₂ O ₂ Solar irradiation Fenton Solar photo-Fenton	UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 25 mg/L; Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II); Photo-Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II).	> 79% (UV-based AOPs)	Giannakis et al., 2015
	237-476 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L;	92-97% (UV/H ₂ O ₂); 92-94% (Photo-Fenton)	De la Cruz et al., 2013
	263 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
	< 100 ng/L	Pilot	CEC spiked wastewater	COD: 23 mg/L; DOC: 10.2 mg/L	Photo-Fenton	Solar CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H ₂ O ₂ : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a
Metoprolol	7.76-205 ng/L	Lab	real wastewater	COD: 20-35 mg/L; BOD5: < 5 mg/L; TOC: 2-5 mg/L	Fenton Chemical precipitation with FeCl ₃ Coagulation with Al ₂ (SO ₄) ₃	Fenton: H ₂ O ₂ 25-250 mg/L at fixed iron dose (10 mg/L) and iron 10-40 mg/L at a constant H ₂ O ₂ dose (25 mg/L).	84-100% (Fenton)	Estrada-Arriaga et al., 2016
	579-855 ng/L	Lab	real wastewater	COD: 35-90 mg/L; TOC: 20.2-57.2 mg/L	UV UV/H ₂ O ₂ Solar irradiation Fenton Solar photo-Fenton	UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 25 mg/L; Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II); Photo-Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II).	> 79% (UV-based AOPs)	Giannakis et al., 2015
	175-308 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L;	89-93% (UV/H ₂ O ₂); 84-90% (Photo-Fenton)	De la Cruz et al., 2013
	179 ng/L	Lab	real wastewater	COD: 126.9 mg/L;	UV	LP Hg lamp (λ_{\max} 254 nm);	97-98% (Photo-Fenton)	De la Cruz et al., 2012

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
Bezafibrate	< 100 ng/L	Pilot	CEC spiked wastewater	TOC: 18.8 mg/L	Dark Fenton Photo-Fenton	Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	Fenton)	2012
				COD: 23 mg/L; DOC: 10.2 mg/L	Photo-Fenton	Solar CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H ₂ O ₂ : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a
	426 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
	< 100 ng/L	Pilot	CEC spiked wastewater	COD: 23 mg/L; DOC: 10.2 mg/L	Photo-Fenton	Solar CPC; Carbonate-bicarbonate removed; Fe(II): 9.7 mg/L; H ₂ O ₂ : 68 mg/L; 34 °C.	> 80%	Prieto-Rodríguez et al., 2013a
Primidone	339 ng/L	Pilot	real wastewater	COD: 19.4-26.2 mg/L DOC: 40-54 mg/L	Solar photo-Fenton	Raceway pond reactors; Continuous mode; Real secondary effluents treated at two liquid depths (5, 15 cm) and three HRTs (80, 40, 20 min); Iron: 5.5 mg/L; H ₂ O ₂ : 30 mg/L.	> 66%	Arzate et al., 2017
						Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20, 30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L.		
	52-84 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	72-82% (UV/H ₂ O ₂); 76-77% (Photo-Fenton)	De la Cruz et al., 2013	
EE2	49 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
						Ozone: 3.15 g/h; 5% of ozone in gas mixture.		
	2.15 – 3.59 µg/L	Pilot	CEC spiked wastewater	COD: 30 mg/L; BOD5: 2.5 mg/L	O ₃ O ₃ /UV O ₃ /H ₂ O ₂ O ₃ /UV/H ₂ O ₂	> 99.7%	Pesoutova et al., 2014	
E2	0.2 to 2 µg L ⁻¹	Pilot	CEC spiked wastewater (post MF and post RO)	[DOC] ₀ = 4.85-7.7	UV-C/H ₂ O ₂	Flow-through UV reactor equipped with 12 low-pressure amalgam lamps with nominal output power from the lamps varies from 60% to 100%	>99	James et al. (2014)
	1.72 – 2.88 µg/L	Pilot	CEC spiked wastewater	COD: 30 mg/L; BOD5: 2.5 mg/L	O ₃ O ₃ /UV O ₃ /H ₂ O ₂ O ₃ /UV/H ₂ O ₂	Ozone: 3.15 g/h; 5% of ozone in gas mixture.	> 99.7%	Pesoutova et al., 2014
	0.2 to 2 µg L ⁻¹	Pilot	CEC spiked wastewater (post MF and post RO)	[DOC] ₀ = 4.85-7.7	UV-C/H ₂ O ₂	Flow-through UV reactor equipped with 12 low-pressure amalgam lamps with nominal output power from the lamps	>99	James et al. (2014)

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
varies from 60% to 100%								
Mecoprop	102-618 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L.	93-99% (UV/H ₂ O ₂); 93% (Photo-Fenton)	De la Cruz et al., 2013
	34 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
Bisphenol A	5 or 100 µg/L	Lab/Pilot	CEC spiked wastewater	COD: 60-62 mg/L; DOC: 11-15 mg/L	Solar Photo-Fenton	Carbonate-bicarbonate removed; Solar simulator with a Xe Lamp; Mobile solar CPC; Solution of Fe:EDDS (molar ratio 1:2).	-	Papoutsakis et al., 2015
Benzotriazole	4199-7244 ng/L	Lab	real wastewater	COD: 35-90 mg/L; TOC: 20.2-57.2 mg/L	UV UV/H ₂ O ₂ Solar irradiation Fenton Solar photo-Fenton	UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 25 mg/L; Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II); Photo-Fenton: 25 mg/L H ₂ O ₂ and 5 mg/L Fe (II).	> 79% (UV-based AOPs)	Giannakis et al., 2015
	5363-7545 ng/L	Pilot	real wastewater	TOC: 5.16-7.27 mg/L	UV UV/H ₂ O ₂ Photo-Fenton	Continuous mode; UV-C irradiation (λ_{\max} 254 nm); H ₂ O ₂ : 20,30, 40 and 50 mg/L; Fe(II): 0, 2 or 4 mg/L.	94-98% (UV/H ₂ O ₂); 93-95% (Photo-Fenton)	De la Cruz et al., 2013
	10 mg L ⁻¹	Lab scale, batch mode	Spiked WW (MBR effluent)	[TOC] ₀ = 4.8-6.8 [COD] ₀ =13.7-24.7	UV, UV/H ₂ O ₂	Glass reactor with 350 mL reaction volume. Controlled temperature. Polychromatic mercury lamp	<LOQ	Borowska et al. (2016)
Methylbenzotriazole	2781 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
	1535 ng/L	Lab	real wastewater	COD: 126.9 mg/L; TOC: 18.8 mg/L	UV Dark Fenton Photo-Fenton	LP Hg lamp (λ_{\max} 254 nm); Solar simulator; H ₂ O ₂ : 25, 50 mg/L; Fe(II): 5 mg/L; natural pH.	97-98% (Photo-Fenton)	De la Cruz et al., 2012
Acesulfame	741 ng/L	Pilot	real wastewater	COD: 19.4-26.2 mg/L DOC: 40-54 mg/L	Solar photo-Fenton	Raceway pond reactors; Continuous mode; Real secondary effluents treated at two liquid depths (5, 15 cm) and three HRTs (80, 40, 20 min); Iron: 5.5 mg/L; H ₂ O ₂ : 30 mg/L.	> 76%	Arzate et al., 2017

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
	75 µM	Lab	CEC spiked wastewater	TOC: 13.2 mg/L	UVA/H ₂ O ₂ /Fe ²⁺ , UVA/S ₂ O ₈ ²⁻	Ambient room temperature, 1 L cylindrical glass reactor with permanent agitation.	<LOD	Kattel et al. (2017)
2-ethylhexyl-4-methoxycinnamate (EHMC)	ng L ⁻¹ to µg L ⁻¹ levels	Lab-scale	Mixture of urban and industrial WW	[COD] ₀ =28	UV, Simulated solar irradiation	UV: 15 W LP Hg vapor lamp 254 nm, Xe 150 Xe-arc lamp with spectral emission in the visible region	EHMC: <50	Santiago-Morales et al. (2013)

AOP, advanced oxidation process; CEC, compound of emerging concern; CPC, compound parabolic collector; E2, 17 β -estradiol; EE2, 17 α -ethinylestradiol; EDDS, ethylenediamine-N,N'-disuccinic acid; LP, low pressure; MBR, membrane bioreactor; MP, medium pressure; PMS, peroxyomonosulfate; SS, stainless steel; WWTP, wastewater treatment plant.

Table SI9 Perspective processes using synthetic wastewater, CEC spiked wastewater and real wastewater.

CEC	CEC initial concentration ¹	Scale of study ²	Water matrix ³	Organic matter ⁴ (mg/L)	AOP ⁵	Operating conditions	CEC removal (%)	Reference
Sulfamethoxazole	100 µg/L	Pilot	synthetic wastewater	-	Photo-Fenton TiO ₂ /UV	Solar CPC A: Photo-Fenton (pH 2; 5 mg/L Fe(II); 50 mg/L H ₂ O ₂ ; 5 mg/L TiO ₂); B: no pH adjustment; 50 mg/L H ₂ O ₂ ; 5, 15, 55 mg/L Fe(II).	100% (145 min by solar TiO ₂ photocatalysis and 10 min by photo-Fenton)	Klamerth et al., 2009
	4 µg/L	Lab	synthetic wastewater	COD: 442 mg/L	Combined O ₃ /US as pretreatment prior to MBR	US device: 750 W, 20 kHz; power density 370 W/L; Ozone: 3.3 g/h; Reaction time: 40 min.	69%	Prado et al., 2017
	10 mg/L	Lab	CEC spiked wastewater	COD: 64 ± 15 mg/L; BOD5: 15 ± 3 mg/L; TOC: 8 ± 2 mg/L	Catalytic ozonation	Ozone: 20 mg/L; Catalysts: 5 g commercial γ-Al ₂ O ₃ or synthesized Co ₃ O ₄ /Al ₂ O ₃ .	100% (<10 min)	Pocostales et al., 2011
	100 mg/L	Lab	synthetic wastewater	-	Sonolysis	200 W; 24 kHz; 600 min	0%	de Vidales et al., 2017
0.5 mg/L	0.5 mg/L	Lab	CEC spiked wastewater	COD: 18.9 mg/L; TOC: 6.2 mg/L	CWPO	Catalyst: 20, 80 mg/L carbon xerogel with cobalt and iron (CX/CoFe); Cylindrical jacketed glass reactor stirred at 500 rpm; 25 °C, 60 °C; pH 3; 500 mg/L H ₂ O ₂ .	96.8-97.8% (6 h)	Ribeiro et al., 2016
0.5 mg/L	0.5 mg/L	Lab	CEC spiked wastewater	COD: 44 mg/L; BOD5: 28 mg/L; TOC: 14.2 mg/L	Photocatalytic ozonation	Carbonate-bicarbonate removed and pH restored; Simulated solar light radiation; Ozone: concentration 10 mg/L and flow rate 20 L/h; Catalyst: WO ₃ prepared by thermodecomposition of commercial tungstate.	100% (< 10 min)	Rey et al., 2015
0.2 mg/L	Lab	CEC spiked wastewater	COD: 195-296 mg/L	Heterogeneous photocatalysis Photo-Fenton Ozonation Photocatalytic ozonation	Aerobic biodegradation followed by different AOPs; Solar irradiation; Catalyst: TiO ₂ .	> 81%	Gimero et al., 2016	
0.2 mg/L	Lab	CEC spiked wastewater	-	Photocatalytic oxidation Photocatalytic ozonation Ozonation	Combinations of ozone, UV-A black-light and 2.8 mg/L Fe(III) or 150 mg/L Fe ₃ O ₄ .	100% (< 10 min, O ₃ -based AOPs)	Espejo et al., 2014	
50 µg/L	Lab	CEC spiked wastewater	COD: 40 mg/L; TOC: 25-30 mg/L	Photocatalytic oxidation Photocatalytic ozonation Ozonation	15-W black-light lamps (350–410 nm); TiO ₂ : 250 mg/L; Ozone: flow rate 30 L/h.	100% (< 5 min, O ₃ -based AOPs)	Encinas et al., 2013	
10 mg/L	Lab	CEC spiked wastewater	COD: 58-84 mg/L;	TiO ₂ catalytic ozonation	HP Hg lamp (238–579 nm emitting	99% (< 10 min,	Beltran et al., 2012	

			BOD5: 30-60 mg/L; TOC: 35 mg/L	TiO ₂ photocatalysis TiO ₂ photocatalytic ozonation Ozonation Photolytic ozonation	mainly at 254, 313 and 366 nm and with UV-B cut-off); Catalyst: 1.5 mg/L TiO ₂ .	O ₃ -based AOPs)	
0.2 mg/L	Lab	synthetic wastewater	COD: 592 mg/L	Electrochemical oxidation with a sequential activated sludge process	FM01-LC reactor, BDD as anode and SS as counter electrode; Conditions: pH 7; 1.2 L/s and current density 1.56 mA/cm ² .	> 50% (20 min)	
1-100 mg/L	Lab	synthetic wastewater	-	Conductive-diamond electrochemical oxidation	Anode: diamond-based material (p-Si-BDD); Cathode: SS; Current density: 15 mA/cm ² .	100%	
15 µg/L	Pilot	CEC spiked wastewater	COD: 30-40 mg/L; DOC: 10-30 mg/L	NF/solar Photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; H ₂ O ₂ : < 2 mM; Fe(III): < 0.1 mM; Iron complexing agents: EDDS and citrate.	> 90%	
100 µg/L	Pilot	CEC spiked wastewater	DOC: 13 mg/L	Heterogeneous photocatalysis	Catalyst: TiO ₂ on glass substrate; pH unchanged.	70-78 min (t30 W, 90%)	
5 mg/L	Lab	CEC spiked wastewater	COD: 137-774 mg/L; BOD5: 60-89 mg/L	Photocatalysis	Preliminary filtration and coagulation; Catalyst: 0.5 g/L TiO ₂ or 1 mM FeCl ₃ ; 4 UV lamps (λ_{\max} 366 nm).	76.9%	
15 µg/L	Pilot	CEC spiked wastewater	COD: 74 mg/L; DOC: 30 mg/L	NF/solar photo-Fenton Photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; 1.5 mM H ₂ O ₂ ; 0.1 mM Fe(III) for effluents and 0.2 mM Fe(III) for concentrate.	93%	
Erythromycin	27 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis λ > 300 nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation)
	78 ng/L	Lab/Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Heterogeneous photocatalysis	Solar CPC; Catalyst: 20 mg/L TiO ₂ .	> 85 %
41-78 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	-	
0.03 µg/L	Pilot	real wastewater	COD: 60-120 mg/L; DOC: 15-50 mg/L	Heterogeneous photocatalysis	Solardetox Acadus-2006 CPCs with 3.0 m ² irradiated surface and 24 L irradiated volume; Catalyst: 0.2 g/L TiO ₂ .	-	

	37.6-280 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	> 95% (photocatalytic ozonation)	Moreira et al., 2016
Clarithromycin	116 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis $\lambda > 300$ nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation)	Moreira et al., 2015
	54 ng/L	Lab/Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Heterogeneous photocatalysis	Solar CPC; Catalyst: 20 mg/L TiO ₂ .	> 85 %	Prieto-Rodríguez et al., 2012
	24-54 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	-	Prieto-Rodríguez L., 2013b
Azithromycin	0.07 µg/L	Pilot	real wastewater	COD: 60-120 mg/L; DOC: 15-50 mg/L	Heterogeneous photocatalysis	Solardetox Acadus-2006 CPCs with 3.0 m ² irradiated surface and 24 L irradiated volume; Catalyst: 0.2 g/L TiO ₂ .	30-55%	Bernabeu et al., 2011
	25.5-729 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	> 98% (photocatalytic ozonation)	Moreira et al., 2016
	~ 1 µg/L	Lab/pilot	real wastewater/CEC spiked wastewater	-	Hydrodynamic cavitation with addition of H ₂ O ₂	Shear induced hydrodynamic cavitation reactor; 50 °C; 30 min; H ₂ O ₂ dose: 3.4 g/L.	37%	Dular et al., 2016
Azithromycin	140 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis $\lambda > 300$ nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation)	Moreira et al., 2015
	69 ng/L	Lab/Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Heterogeneous photocatalysis	Solar CPC; Catalyst: 20 mg/L TiO ₂ .	> 85 %	Prieto-Rodríguez et al., 2012
	35-161 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	-	Prieto-Rodríguez L., 2013bprieto-
	233-870 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	100% (photocatalytic ozonation)	Moreira et al., 2016

Diclofenac	1 µg/L	Lab	CEC spiked wastewater	COD: 92-131 mg/L	Pulsating hydrodynamic cavitation-H ₂ O ₂ process	Initial pressure: 6 bar; H ₂ O ₂ 30%: 20 mL; 30 min.	35%	Zupanc et al., 2013
	4 µg/L	Lab	synthetic wastewater	COD: 442 mg/L	Combined O ₃ /US as pretreatment prior to MBR	US device: 750 W, 20 kHz; power density 370 W/L; Ozone: 3.3 g/h; Reaction time: 40 min.	79%	Prado et al., 2017
	100 µg/L	Pilot	synthetic wastewater	-	Photo-Fenton TiO ₂ /UV	Solar CPC; A: Photo-Fenton (pH 2; 5 mg/L Fe(II); 50 mg/L H ₂ O ₂ ; 5 mg/L TiO ₂); B: no pH adjustment; 50 mg/L H ₂ O ₂ ; 5, 15, 55 mg/L Fe(II).	100% (60 min by solar TiO ₂ photocatalysis and 10 min by photo-Fenton)	Klamerth et al., 2009
	10 mg/L	Lab	CEC spiked wastewater	COD: 64 ± 15 mg/L; BOD5: 15 ± 3 mg/L; TOC: 8 ± 2 mg/L	Catalytic ozonation	Ozone: 20 mg/L; Catalysts: 5 g of commercial γ-Al ₂ O ₃ or synthesized Co ₃ O ₄ /Al ₂ O ₃ .	100% (<10 min)	Pocostales et al., 2011
	0.1 mM	Lab	CEC spiked wastewater	TOC: 37 mg/L	Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis λ > 300 nm); Catalyst: 0.5 mg/L TiO ₂ .	100% (< 2 min)	Moreira et al., 2015
	30 mg/L	Lab	CEC spiked wastewater	COD: 60 mg/L; BOD5: 33 mg/L; TOC: 33 mg/L	Photocatalytic ozonation	Ozone: 10 mg/L, 30 dm ³ /h; HP Hg lamp (UV-A); Catalyst: 1.5 g/L TiO ₂ .	100% (6 min)	Aguinaco et al., 2012
	5 mg/L	Lab	CEC spiked wastewater	COD: 67 mg/L; BOD5: 12.7 mg/L	Heterogeneous photocatalysis	Simulated solar irradiation (96 h); Stirring at 75 rpm; Catalyst: 25 g immobilized TiO ₂ .	100%	He et al., 2016
	2.5 mg/L	Lab	CEC spiked wastewater	TOC: 14.1 mg/L	Heterogeneous photocatalysis	125 W black-light fluorescent lamp (300–420 nm); Catalyst: 0.2–0.8 g/L TiO ₂ .	-	Rizzo et al., 2009
	5-20 mg/L	Lab	CEC spiked wastewater	TOC: 5.15 mg/L	Heterogeneous photocatalysis	9 W UV-A lamp (350–400 nm); Catalyst: 50–1600 mg/L of TiO ₂ ; H ₂ O ₂ : 0.07–1.4 mM.	-	Achilleos et al., 2010
	5 mg/L	Lab	CEC spiked wastewater	DOC: 4.65 mg/L; TOC: 5.15 mg/L	Heterogeneous photocatalysis	XX-15 BLB UV lamp (365 nm), Catalysts: single-phase hydroxyapatite-based materials of marine origin (Hap) and Hap-titania (TiHAp) multicomponent materials (1 wt% TiO ₂); Catalyst load: 4 g/L.	60%	Marquez et al., 2016
2,4-dichlorophenoxyacetic acid	1 µg/L	Lab	CEC spiked wastewater	TOC: 100 mg/L	Shear-induced Hydrodynamic cavitation/H ₂ O ₂	50 °C; 15 min; H ₂ O ₂ : 340 mg/L.	79%	Zupanc et al. 2014
	2.5 mg/L	Lab	CEC spiked wastewater	COD: 10.5 mg/L; BOD5: 4 mg/L; TOC: 4.4 mg/L	US irradiation	200 mL of wastewater spiked at different concentrations of single CECs and their mixtures; pH 3.0, 7.5, 11; Frequency 20 kHz; electrical power	50%	Naddeo et al., 2009

						100 W/L; 60 min.		
4, 40, 80 mg/L	Lab	CEC spiked wastewater	COD: 8.6 mg/L; BOD5: 7 mg/L; TOC: 4.51 mg/L	Sonolysis Ozonation Sonolysis/Ozonation	Ozone: concentration 5–15 mg/L and flow rate 2.4–31 g/h; Electrical power: 100–400 W/L; Combined treatment: ozone flow rate 31 g/h and electrical power 400 W/L.	36% 22% 39%	Naddeo et al., 2012	
40 mg/L	Lab	CEC spiked wastewater	-	Sonolysis	Experiments at mg/L: frequency 20 kHz and electrical power 100–400 W/L; Experiments at 1 µg/L: frequency 45 kHz and variable electrical power up to 800 W.	55%	Naddeo et al., 2013	
0.5 mg/L	Lab	CEC spiked wastewater	COD: 44 mg/L; BOD5: 28 mg/L; TOC: 14.2 mg/L	Photocatalytic ozonation	Carbonate-bicarbonate removed and pH restored; Simulated solar light radiation; Ozone: concentration 10 mg/L and flow rate 20 L/h; Catalyst: WO_3 prepared by thermodecomposition of commercial tungstate.	100% (< 10 min)	Rey et al., 2015	
0.2 mg/L	Lab	CEC spiked wastewater	COD: 195–296 mg/L	Heterogeneous photocatalysis Photo-Fenton Ozonation Photocatalytic ozonation	Aerobic biodegradation followed by different AOPs; Solar irradiation; Catalyst: TiO_2 .	> 54%	Gimero et al., 2016	
0.2 mg/L	Lab	CEC spiked wastewater	-	Photocatalytic oxidation Photocatalytic ozonation Ozonation	Combinations of ozone, UV-A black-light and 2.8 mg/L Fe(III) or 150 mg/L Fe_3O_4 .	100% (< 10 min, O_3 -based AOPs)	Espejo et al., 2014	
50 µg/L	Lab	CEC spiked wastewater	COD: 40 mg/L; TOC: 25–30 mg/L	Photocatalytic oxidation Photocatalytic ozonation Ozonation	15-W black-light lamps (350–410 nm); TiO_2 : 250 mg/L; Ozone: flow rate 30 L/h.	100% (< 5 min, O_3 -based AOPs)	Encinas et al., 2013	
10–1000 µg/L	Lab	CEC spiked wastewater	COD: 119 mg/L; BOD5: 250 mg/L	Heterogeneous photocatalysis Photo-Fenton Ozonation	<i>Heterogeneous photocatalysis</i> TiO_2 : 200 mg/L. <i>Photo-Fenton</i> 3 4 W near-UV-A (black light) fluorescent lamps, λ_{\max} 352 nm; Iron: 10 mg/L; H_2O_2 : 100 mg/L. <i>Ozone/H_2O_2</i> Inlet ozone concentration 0.36 mg/L and flow rate 3.0 L/min; H_2O_2 : 20 mg/L. 25 °C and pH 7.0 for all processes (except pH 2.8 for photo-Fenton).	-	Tokumura et al., 2016	

10 mg/L	Lab	CEC spiked wastewater	COD: 58-84 mg/L; BOD5: 30-60 mg/L; TOC: 35 mg/L	TiO ₂ catalytic ozonation TiO ₂ photocatalysis TiO ₂ photocatalytic ozonation Ozonation Photolytic ozonation	HP Hg lamp (238-579 nm emitting mainly at 254, 313 and 366 nm and with UV-B cut-off); Catalyst: 1.5 mg/L TiO ₂ .	99% (< 10 min, O ₃ -based AOPs)	Beltran et al., 2012
20 mg/L	Lab	CEC spiked wastewater	COD: 85 mg/L	Electrochemical oxidation	Graphite-PVC (anode) and Pt (cathode); Applied voltage: 10 V, using 4 g/L NaCl; pH 3, 7 and 11.	96.9% (30 min)	Mussa et al., 2017
100 µg/L	Pilot	CEC spiked wastewater	DOC: 13 mg/L	Heterogeneous photocatalysis	Catalyst: TiO ₂ on glass substrate; natural pH.	33-78 min (t30 W, 90%)	Miranda-García et al., 2011
150 µg/L	Lab	CEC spiked wastewater	DOC: 10-12 mg/L	Photocatalysis-DCMD process	Photoreactor equipped with an UV-C germicidal lamp (λ_{max} 254 nm) located between a feed tank and a membrane module; Catalyst: 1.5 g/L TiO ₂ . Module: hydrophobic polypropylene membranes, with an area of 0.014 m ² and nominal pore size of 0.2 µm; Feed (60 °C), distillate (20 °C).	100%	Tokumura et al., 2016
465 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis λ > 300 nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation)	Moreira et al., 2015
4425 ng/L	Lab/Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Heterogeneous photocatalysis	Solar CPC; Catalyst: 20 mg/L TiO ₂ .	> 85 %	Prieto-Rodríguez et al., 2012
414-1466 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	100% 100% 100%	Dular et al., 2016
0.87 µg/L	Pilot	real wastewater	COD: 60-120 mg/L; DOC: 15-50 mg/L	Heterogeneous photocatalysis	Solardetox Acadus-2006 CPCs with 3.0 m ² irradiated surface and 24 L irradiated volume; Catalyst: 0.2 g/L TiO ₂ .	80-88%	Bernabeu et al., 2011
121-652 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	100% (photocatalytic ozonation)	Moreira et al., 2016
≈ 1 µg/L	Lab/pilot	real wastewater/CEC spiked wastewater	-	Hydrodynamic cavitation with addition of H ₂ O ₂	Shear induced hydrodynamic cavitation reactor; 50 °C; 30 min; H ₂ O ₂ dose: 3.4 g/L.	79%	Dular et al., 2016

Carbamazepine	1 µg/L	Lab	CEC spiked wastewater	COD: 92-131 mg/L	Pulsating hydrodynamic cavitation–H ₂ O ₂ process	Initial pressure: 6 bar; H ₂ O ₂ 30%: 20 mL; 30 min.	15%	Zupanc et al., 2013
	4 µg/L	Lab	synthetic wastewater	COD: 442 mg/L	Combined O ₃ /US as pretreatment prior to MBR	US device: 750 W, 20 kHz; power density 370 W/L; Ozone 3.3 g/h; Reaction time: 40 min.	76%	Prado et al., 2017
	5 mg/L	Lab	CEC spiked wastewater	COD: 67 mg/L; BOD5: 12.7 mg/L	Heterogeneous photocatalysis	Simulated solar irradiation (96 h); Stirring at 75 rpm; Catalyst: 25 g immobilized TiO ₂ .	76%	He et al., 2016
	5 mg/L	Lab	CEC spiked wastewater	TOC: 14.1 mg/L	Heterogeneous photocatalysis	125 W black-light fluorescent lamp (300–420 nm); Catalyst: 0.2–0.8 g/L TiO ₂ .	-	Rizzo et al., 2009
	1 µg/L	Lab	CEC spiked wastewater	TOC: 100 mg/L	Shear-induced Hydrodynamic cavitation/H ₂ O ₂	50 °C; 15 min; H ₂ O ₂ : 340 mg/L.	62%	Zupanc et al., 2014
	2.5 mg/L	Lab	CEC spiked wastewater	COD: 10.5 mg/L; BOD5: 4 mg/L; TOC: 4.4 mg/L	US irradiation	200 mL of wastewater spiked at different concentrations of single CECs and their mixtures; pH 3.0, 7.5, 11; Frequency 20 kHz; electrical power 100 W/L; 60 min.	50%	Naddeo et al., 2009
	5 mg/L	Lab	CEC spiked wastewater	-	Sonolysis	Experiments at mg/L: frequency 20 kHz and electrical power 100-400 W/L; Experiments at 1 µg/L: frequency 45 kHz and variable electrical power up to 800 W.	55%	Naddeo et al., 2013
	0.5 mg/L	Lab	CEC spiked wastewater	COD: 44 mg/L; BOD5: 28 mg/L; TOC: 14.2 mg/L	Photocatalytic ozonation	Carbonate-bicarbonate removed and pH restored; Simulated solar light radiation; Ozone: concentration 10 mg/L and flow rate 20 L/h; Catalyst: WO ₃ prepared by thermodecomposition of commercial tungstate.	100% (< 10 min)	Rey et al., 2015
	0.2 mg/L	Lab	CEC spiked wastewater	COD: 195-296 mg/L	Heterogeneous photocatalysis Photo-Fenton Ozonation Photocatalytic ozonation	Aerobic biodegradation followed by different AOPs; Solar irradiation; Catalyst: TiO ₂ .	> 77%	Gimero et al., 2016
	0.2 mg/L	Lab	CEC spiked wastewater	-	Photocatalytic oxidation Photocatalytic ozonation Ozonation	Combinations of ozone, UV-A black-light and 2.8 mg/L Fe(III) or 150 mg/L Fe ₃ O ₄ .	100% (< 10 min, O ₃ -based AOPs)	Espejo et al., 2014
	10-1000 µg/L	Lab	CEC spiked wastewater	COD: 119 mg/L; BOD5: 250 mg/L	Heterogeneous photocatalysis	<i>Heterogeneous photocatalysis</i> TiO ₂ : 200 mg/L.	-	Tokumura et al., 2016

				Photo-Fenton Ozonation	<i>Photo-Fenton</i> 3.4 W near-UV-A (black light) fluorescent lamps, λ_{max} 352 nm; Iron: 10 mg/L; H ₂ O ₂ : 100 mg/L. <i>Ozone/H₂O₂</i> Inlet ozone concentration 0.36 mg/L and flow rate 3.0 L/min; H ₂ O ₂ : 20 mg/L. 25 °C and pH 7.0 for all processes (except pH 2.8 for photo-Fenton).		
22.91 µg/L	Lab	synthetic wastewater	COD: 394 mg/L	Electrochemical oxidation as post-treatment (after MBR)	Electrochemical system (post- treatment) coupled to the MBR system: Ti/PbO ₂ anode and Ti electrode as cathode; Optimal conditions: current intensity 1.37 A during 101 min, recycling flow rate 232 mL/min, 25 °C.	99.99%	García-Gómez et al., 2016
15 µg/L	Pilot	CEC spiked wastewater	COD: 30-40 mg/L; DOC: 10-30 mg/L	NF/solar Photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; H ₂ O ₂ : < 2 mM; Fe(III): < 0.1 mM; Iron complexing agents: EDDS and citrate.	> 90%	Miralles-Cuevas et al., 2014
100 µg/L	Pilot	CEC spiked wastewater	DOC: 13 mg/L	Heterogeneous photocatalysis	Catalyst: TiO ₂ on glass substrate; pH unchanged.	-	Miranda-García et al., 2011
5 mg/L	Lab	CEC spiked wastewater	COD: 13.5-22.0 mg/L	Photocatalysis	Sequential batch annular slurry photoreactor; Low-intensity 11 W UV-C lamp; Catalysts: immobilized TiO ₂ , namely anatase titanate nanofiber and mesoporous TiO ₂ impregnated kaolinite; Presence of effluent organic matter and inorganic ions;	< 61%	Chong et al., 2011
60-70 µg/L	Lab	CEC spiked wastewater	TOC: 8.86 mg/L	Electro-Fenton	Anode: Ti/Pt, Ti/SnO ₂ and Nb/BDD; Cathode: titanium or carbon felt electrode; pH 3, 5, 7.	100% (< 30 min, pH 3)	Komtchou et al., 2015
50 µM	Lab	CEC spiked wastewater	TOC: 16.1 mg/L	Sulfate radical oxidation Fenton	Carbamazepine/ peroxymonosulfate (PMS) molar ratio: from 1 to 30; Cobalt salts tested: CoCl ₂ .6H ₂ O and Co(NO ₃) ₂ .6H ₂ O.	50% (PMS/Co) 7% (Fenton)	Matta et al., 2010
15 µg/L	Pilot	CEC spiked wastewater	COD: 74 mg/L; DOC: 30 mg/L	NF/solar photo-Fenton Photo-Fenton	Carbonate-bicarbonate removed; Solar CPC; 1.5 mM H ₂ O ₂ ; 0.1 mM Fe(III) for effluents and 0.2 mM Fe(III) for concentrate.	100%	Miralles-Cuevas et al., 2015

111 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis $\lambda > 300$ nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation)	Moreira et al., 2015	
553-1160 ng/L	Pilot	real wastewater	BOD5: 1-13 mg/L; DOC: 6.0-14.8 mg/L	Heterogeneous Fenton's Catalytic Process	Catalyst: polyacrylonitrile; Room temperature; Natural pH.	46-84.5%	Chi et al., 2013	
133 ng/L	Lab	real wastewater	DOC: 10 mg/L	Heterogeneous photocatalysis	21-25 °C; 100 mg/L TiO ₂ ; pH 7.3; Presence and absence of PAC.	0%	Gulyas et al., 2016	
1.29 µg/L	Lab	real wastewater	COD: 37 mg/L; BOD5: 4 mg/L	Heterogeneous photocatalysis	UVA radiation: six 8W Hg fluorescent lamps (365 nm); Catalyst load: 1 g/L TiO ₂ or ZnO.	> 50% (TiO ₂) 100% (ZnO)	Teixeira et al., 2016	
0.07 µg/L	Pilot	real wastewater	COD: 60-120 mg/L; DOC: 15-50 mg/L	Heterogeneous photocatalysis	Solardetox Acadus-2006 CPCs with 3.0 m ² irradiated surface and 24 L irradiated volume; Catalyst: 0.2 g/L TiO ₂ .	80%	Bernabeu et al., 2011	
8.02-312 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	100% (photocatalytic ozonation)	Moreira et al., 2016	
≈ 1 µg/L	Lab/pilot	real wastewater/CEC spiked wastewater	-	Hydrodynamic cavitation with addition of H ₂ O ₂	Shear induced hydrodynamic cavitation reactor; 50 °C; 30 min; H ₂ O ₂ dose: 3.4 g/L.	62%	Dular et al., 2016	
Metoprolol	0.5 mg/L	Lab	CEC spiked wastewater	COD: 44 mg/L; BOD5: 28 mg/L; TOC: 14.2 mg/L	Photocatalytic ozonation	Carbonate-bicarbonate removed and pH restored; Simulated solar light radiation; Ozone: concentration 10 mg/L and flow rate 20 L/h; Catalyst: WO ₃ prepared by thermodecomposition of commercial tungstate.	100% (< 60 min)	Rey et al., 2015
	0.2 mg/L	Lab	CEC spiked wastewater	COD: 195-296 mg/L	Heterogeneous photocatalysis Photo-Fenton Ozonation Photocatalytic ozonation	Aerobic biodegradation followed by different AOPs; Solar irradiation; Catalyst: TiO ₂ .	> 62%	Gimero et al., 2016
	0.2 mg/L	Lab	CEC spiked wastewater	-	Photocatalytic oxidation Photocatalytic ozonation Ozonation	Combinations of ozone, UV-A black-light and 2.8 mg/L Fe(III) or 150 mg/L Fe ₃ O ₄ .	100% (< 10 min, O ₃ -based AOPs)	Espejo et al., 2014
	50 µg/L	Lab	CEC spiked wastewater	COD: 40 mg/L; TOC: 25-30 mg/L	Photocatalytic oxidation Photocatalytic ozonation Ozonation	15-W black-light lamps (350-410 nm); TiO ₂ : 250 mg/L; Ozone: flow rate 30 L/h.	100% (< 5 min, O ₃ -based AOPs)	Encinas et al., 2013
	0.2 mg/L	Pilot	CEC spiked wastewater	COD: 58.6 mg/L; BOD5: 10 mg/L; TOC: 20 mg/L	Photocatalytic oxidation Photocatalytic ozonation Ozonation	Solar CPC operating in semi-batch mode; Catalysts: Fe(III), Fenton reagent and TiO ₂ .	100% (20 min, photocatalytic ozonation)	Quiñones et al., 2015

					Semi-batch mode; Simulated solar light; Catalysts: different TiO_2 - WO_3 composites; Ozone: concentration 10 mg/L and flow rate 20 L/h.			
2 mg/L	Lab	CEC spiked wastewater	COD: 51 mg/L; BOD5: 32 mg/L; TOC: 35.3 mg/L	Photocatalytic ozonation		100% (< 45 min, O ₃ -based AOPs)	Rey et al., 2014	
0-21 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	-	Prieto-Rodríguez L., 2013b	
100 mg/L	Lab	synthetic wastewater	-	Sonolysis	200 W; 24 kHz; 600 min	20-25	de Vidales et al., 2017	
Bezafibrate	0.2 mg/L	Lab	synthetic wastewater	COD: 592 mg/L	Electrochemical oxidation with a sequential activated sludge process	FM01-LC reactor, BDD as anode and SS as counter electrode; Conditions: pH 7; 1.2 L/s and current density 1.56 mA/cm ² .	> 50% (20 min)	Rodriguez-Nava et al., 2016
	44 ng/L	Lab/Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Heterogeneous photocatalysis	Solar CPC; Catalyst: 20 mg/L TiO ₂ .	> 85 %	Prieto-Rodríguez et al., 2012
44-57 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	-	Prieto-Rodríguez L., 2013b	
0.48 µg/L	Lab	real wastewater	COD: 37 mg/L; BOD5: 4 mg/L	Heterogeneous photocatalysis	UVA radiation: six 8W Hg fluorescent lamps (365 nm); Catalyst load: 1 g/L TiO ₂ or ZnO.	≈ 45% (TiO ₂) 100% (ZnO)	Teixeira et al., 2016	
Primidone	50 ng/L	Lab/Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Heterogeneous photocatalysis	Solar CPC; Catalyst: 20 mg/L TiO ₂ .	> 85 %	Prieto-Rodríguez et al., 2012
50-57 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	-	Prieto-Rodríguez L., 2013b	
EE2	10 mg/L	Lab	CEC spiked wastewater	COD: 64 ± 15 mg/L; BOD5: 15 ± 3 mg/L;	Catalytic ozonation	Ozone: 20 mg/L; Catalysts: 5 g of commercial γ -Al ₂ O ₃	100% (<10 min)	Pocostales et al., 2011

TOC: 8 ± 2 mg/L or synthesized Co ₃ O ₄ /Al ₂ O ₃ .							
391 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis $\lambda > 300$ nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation) Moreira et al., 2015	
0.23-1.72 ng/L	Pilot	real wastewater	BOD5: 1-13 mg/L; DOC: 6.0-14.8 mg/L	Heterogeneous Fenton's Catalytic Process	Catalyst: polyacrylonitrile; Room temperature; Natural pH.	> 80% Chi et al., 2013	
1667-4021 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	> 95% (photocatalytic ozonation) Moreira et al., 2016	
E2	110 ng/L	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis $\lambda > 300$ nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation) Moreira et al., 2015
<0.05-6.52 ng/L	Pilot	real wastewater	BOD5: 1-13 mg/L; DOC: 6.0-14.8 mg/L	Heterogeneous Fenton's Catalytic Process	Catalyst: polyacrylonitrile; Room temperature; Natural pH.	> 80% Chi et al., 2013	
0-66.3 ng/L	Lab	real wastewater	TOC: 25 mg/L	Ozonation Photocatalysis Photocatalytic ozonation	Continuous mode; LEDs; Catalyst: TiO ₂ -coated Raschig glass rings.	100% (photocatalytic ozonation) Moreira et al., 2016	
Bisphenol A	0.2 mg/L	Pilot	CEC spiked wastewater	COD: 58.6 mg/L; BOD5: 10 mg/L; TOC: 20 mg/L	Photocatalytic oxidation Photocatalytic ozonation Ozonation	Solar CPC operating in semi-batch mode; Catalysts: Fe(III), Fenton reagent and TiO ₂ .	100% (20 min, photocatalytic ozonation) Quiñones et al., 2015
1 mg/L	Lab	CEC spiked wastewater	COD: 70 mg/L	Electrochemical oxidation	Anode: Ti/SnO ₂ , Ti/IrO ₂ and Ti/PbO ₂ ; Cathode: SS; Current intensity: 2.0 A.	99.9% (100 min)	Zaviska et al., 2012
0-3495 ng/L	Pilot	real wastewater	COD: 43-63 mg/L; DOC: 13-23 mg/L	Solar photo-Fenton Heterogeneous photocatalysis Ozonation	Solar CPC; Photo-Fenton: 5 mg/L Fe(II), 60 mg/L H ₂ O ₂ and pH 2.8; Carbonate-bicarbonate removed; Heterogeneous photocatalysis: pH ₀ 6 and 20 mg/L TiO ₂ ; Ozone: concentration 6.9 mg/L, flow rate 100 L/h; pH 8 (natural).	100% 100% 100%	Prieto-Rodríguez L., 2013b
PFOS	ng/L levels	Lab	real wastewater	-	Heterogeneous photocatalysis Ozonation Photocatalytic ozonation	O ₃ : 50, 70 or 90 g/Nm ³ ; 150 Ncm ³ /min; MP Hg vapor lamp (UV-Vis $\lambda > 300$ nm); Catalyst: 0.5 mg/L TiO ₂ .	100 % (photocatalytic ozonation) Moreira et al., 2015
BHT	164.6 ng/L	Lab	real wastewater	COD: 28 mg/L; DOC: 8.1 mg/L	Photolysis Heterogeneous photocatalysis Ozonation	15 W LP Hg vapour lamp (λ_{max} 254 nm); Xe-arc lamp with spectral emission in the visible region;	50% (visible light irradiation) 60% Santiago-Morales et al., 2013

					Photocatalyst: Ce-doped TiO ₂ at 0.5 g/L; Ozone: 22 g/Nm ³ .	(photocatalysis) 66% (ozonation)		
EHMC	23.6 ng/L	Lab	real wastewater	COD: 28 mg/L; DOC: 8.1 mg/L	Heterogeneous photocatalysis Ozonation	15 W LP Hg vapour lamp (λ_{\max} 254 nm); Xe-arc lamp with spectral emission in the visible region; Photocatalyst: Ce-doped TiO ₂ at 0.5 g/L; Ozone: 22 g/Nm ³ .	23% (visible light irradiation) 50% (photocatalysis) 0% (ozonation)	Santiago-Morales et al., 2013

AOP, advanced oxidation process; BHT, butyl hydroxytoluene; BDD, boron-doped diamond; CEC, comtaminants of emerging concern; CPC, compound parabolic collector; CWPO, catalytic wet peroxide oxidation; DCMD, direct contact membrane distillation; E2, 17 β -estradiol; EE2, 17 α -ethinylestradiol; EHMC, 2-ethylhexyl-4-methoxycinnamate; HP, high pressure; LED, Light Emitting Diode; LP, low pressure; MBR, membrane bioreactor; MP, medium pressure; NF, nanofiltration; PAC, powdered activated carbon; PFOS, perfluorooctane sulfonic acid; UF, ultrafiltration; US, ultrasound; WWTP, wastewater treatment plant.

Table SI10: Costs of ozonation and treatment with PAC in Switzerland for an 80% abatement of CECs (after Abegglen et al. 2012). The costs are calculated for a small (14'400 p.e.) and a large (590'000 p.e.) WWTP and include amortization of investment and operation.

	Costs, 14'400 p.e.		Costs, 590'000 p.e.	
	CHF/m ³	Euro/m ³	CHF/m ³	Euro/m ³
Ozonation (5 g/m ³)	0.15–0.19	0.13–0.16	0.04–0.06	0.034–0.052
PAC (10 g/m ³)	0.25–0.3	0.21–0.26	0.1–0.15	0.086–0.13

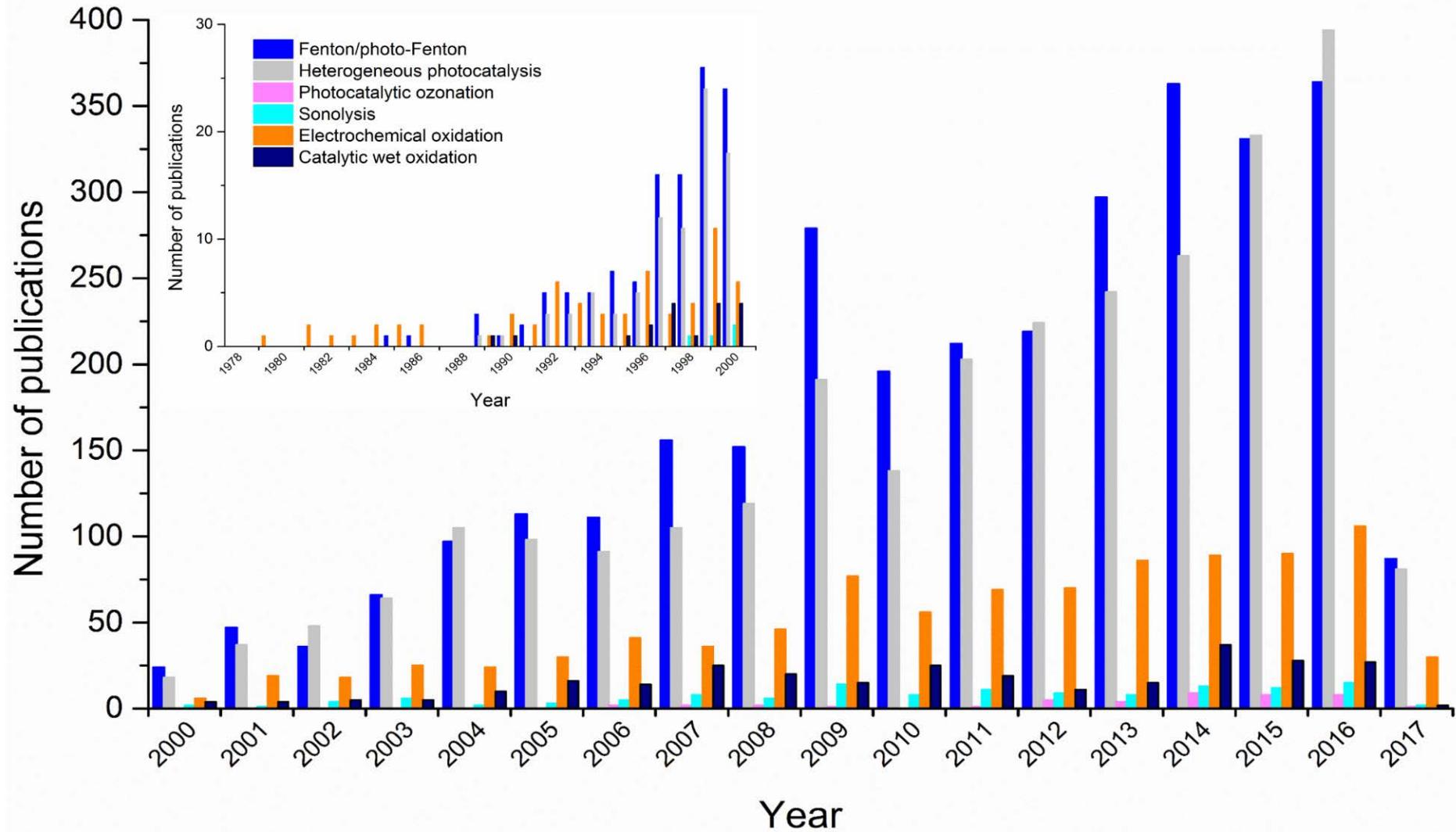


Figure. SI1 Number of publications displayed by searching all type of papers in Scopus database, using as keywords: “Fenton” or “photocatalysis” or “photocatalytic ozonation” or “sonolysis” or “electrochemical oxidation” or “catalytic wet (air or peroxide) oxidation” and “wastewater”. Source: Scopus; March 2017.

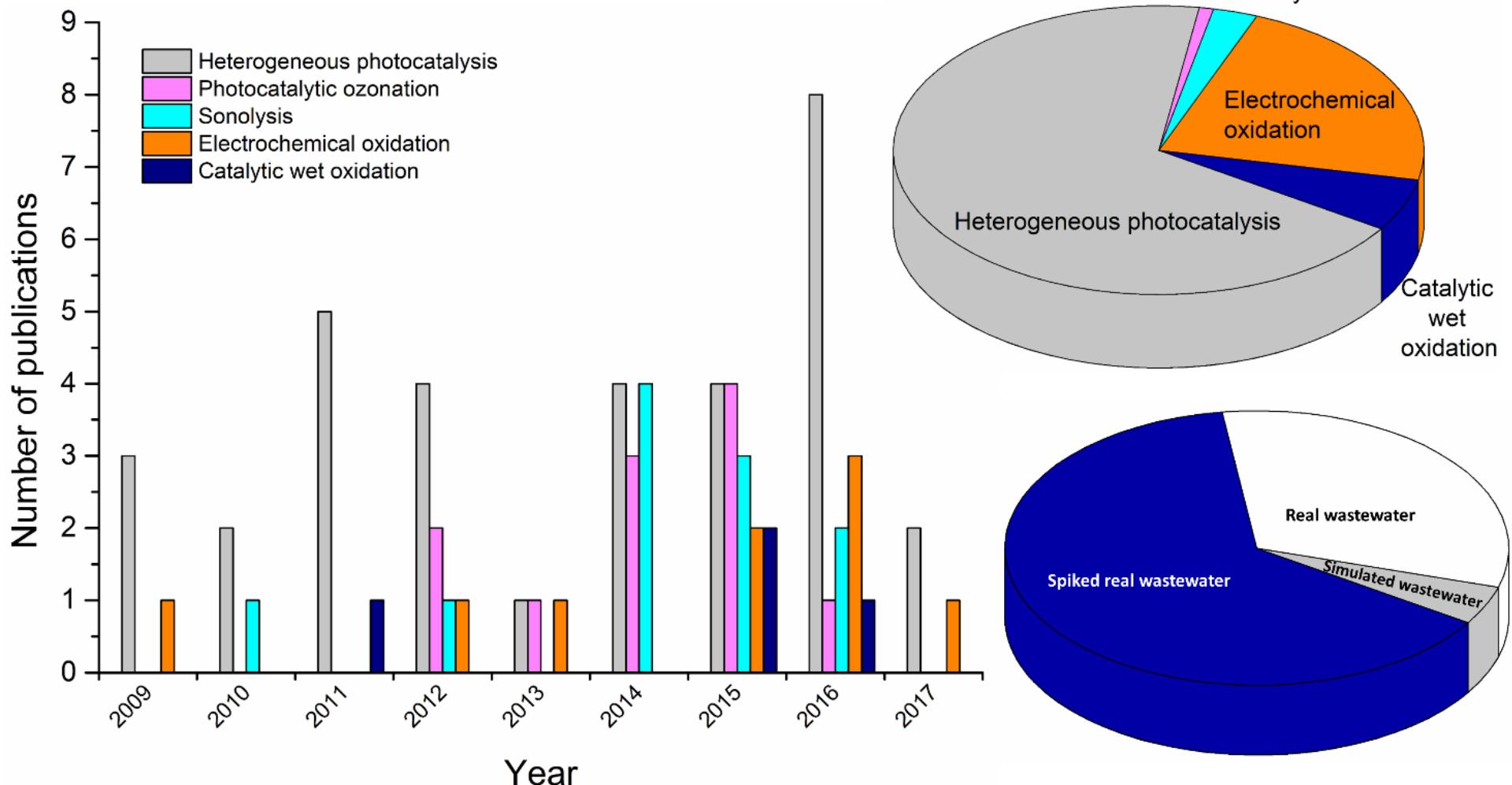


Figure. SI2 Number of publications displayed by searching solely publications dealing with simulated and real urban wastewaters (spiked or not) treated by perspective methods, describing the removal of CECs rather than other parameters, such as COD and TOC. Source: Scopus; March 2017.

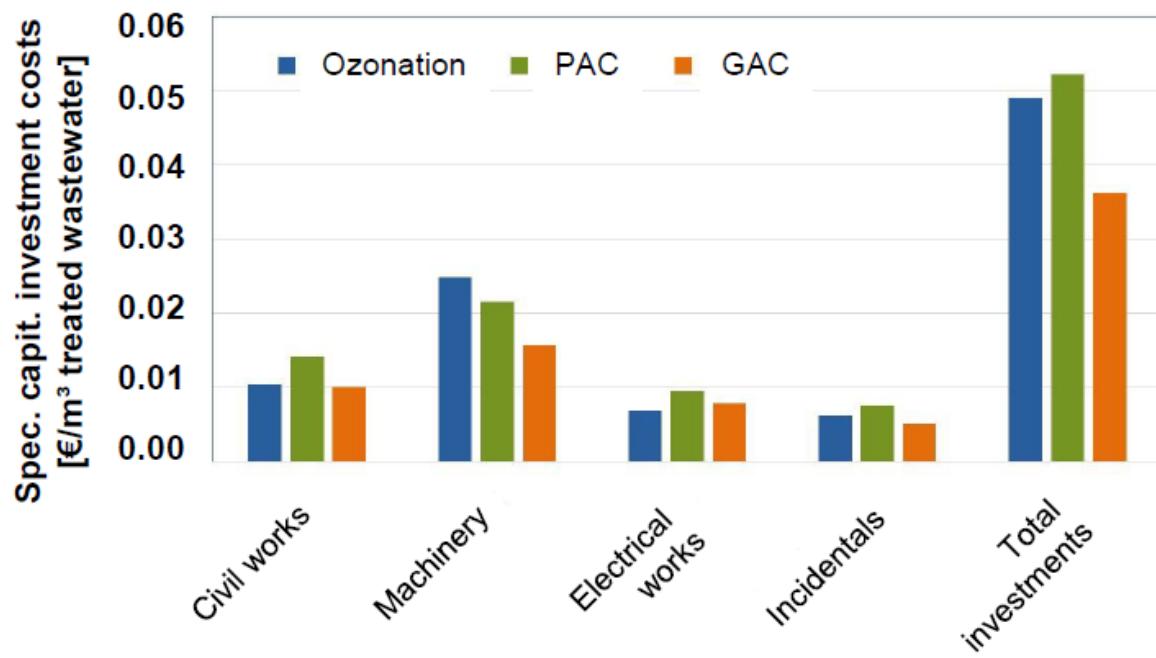


Figure SI3. Specific capitalized investment costs of different consolidated advanced wastewater treatment processes (selected process options only)
(Antakyali 2016)

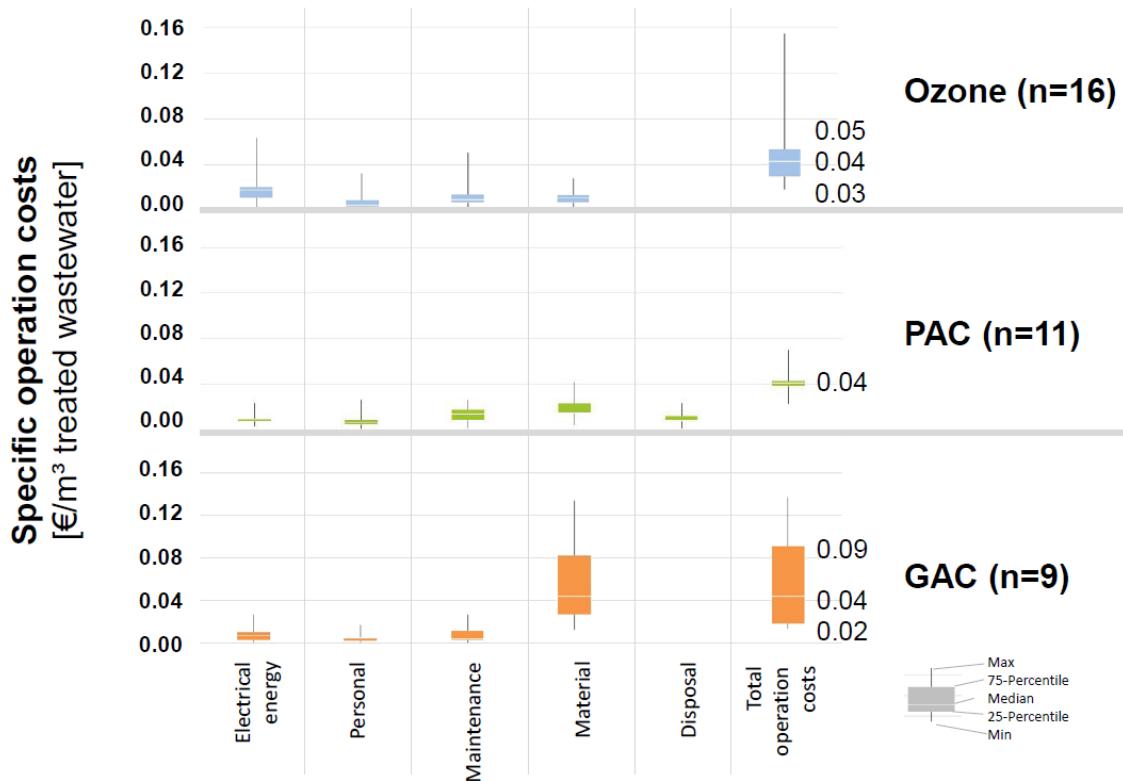


Figure SI4. Specific operation costs of different processes for CECs removal (selected process options only) (Antakyali 2017)

References Supporting information

- Abegglen, C., Siegrist, H., 2012. Mikroverunreinigungen aus kommunalem Abwasser: Verfahren zur weitergehenden Elimination auf Kläranlagen. Umwelt-Wissen Nr. 1214. www.bafu.admin.ch/uw-1214-d.
- Achilleos A., Hapeshi E., Xekoukoulotakis N.P., Mantzavinos D., Fatta-Kassinos D., Chemical Engineering Journal 161 (2010) 53.
- Aguinaco A., Beltrán F.J., García-Araya J.F., Oropesa A., Chemical Engineering Journal 189-190 (2012) 275.
- Ahmed M.M., Brienza M., Goetz V., Chiron S., Chemosphere 117 (2014) 256.
- Altmann, J., Ruhl, A.S., Zietzschmann, F. and Jekel, M. (2014) Direct comparison of ozonation and adsorption onto powdered activated carbon for micropollutant removal in advanced wastewater treatment. Water Research 55, 185-193.
- Altmann, J., Ruhl, A.S., Sauter, D., Pohl, J. and Jekel, M. (2015a) How to dose powdered activated carbon in deep bed filtration for efficient micropollutant removal. Water Res 78, 9-17.
- Altmann, J., Massa, L., Sperlich, A., Gnrss, R. and Jekel, M. (2016a) UV254 absorbance as real-time monitoring and control parameter for micropollutant removal in advanced wastewater treatment with powdered activated carbon. Water Res 94, 240-245.
- Altmann, J., Rehfeld, D., Trader, K., Sperlich, A. and Jekel, M. (2016b) Combination of granular activated carbon adsorption and deep-bed filtration as a single advanced wastewater treatment step for organic micropollutant and phosphorus removal. Water Res 92, 131-139.
- Antakyali, D., 2016. Sanierung und gleichzeitige Ertüchtigung zur Mikroschadstoffelimination – Betriebswirtschaftliche Bewertung (transl. as: Restoration and simultaneous retrofitting for micropollutant removal – a financial evaluation). Presentation at the conference "Arzneimittel und Mikroschadstoffe in Gewässern", Düsseldorf.
- Antakyali, D., 2017. Machbarkeitsstudien– Eine Hilfestellung für Betreiber und Ingenieurbüros– (transl. as: Feasibility studies – A support for plant operators and designers). Presentation at the conference "5 Jahre Kompetenzzentren Spurenstoffe", Friedrichshafen.
- Arzate S., García Sánchez J.L., Soriano-Molina P., Casas López J.L., Campos-Mañas M.C., Agüera A., Sánchez Pérez J.A., Chemical Engineering Journal 316 (2017) 1114.
- Bahr, C., Ernst, M., Reemtsma, T., Heinzmann, B., Luck, F. and Jekel, M. (2005) Pilot scale ozonation of treated Municipal effluent for removal of pharmaceutical compounds and pathogens - The Berlin study, Strasbourg.
- Beltran, F.J., Gonzalez, M., Rivas, J. and Marin, M. (1994) Oxidation of mecoprop in water with ozone and ozone combined with hydrogen peroxide. Industrial & Engineering Chemistry Research 33(1), 125-136.
- Beltrán F.J., Aguinaco A., García-Araya J.F., Ozone: Science & Engineering 34 (2012) 3
- Benner, J., Salhi, E., Ternes, T.A. and von Gunten, U. (2008) Ozonation of reverse osmosis concentrate: Kinetics and efficiency of beta blocker oxidation. Water Research 42(12), 3003-3012.
- Bernabeu A., Vercher R.F., Santos-Juanes L., Simón P.J., Lardín C., Martínez M.A., Vicente J.A., González R., Llosá C., Arques A., Amat A.M., Catalysis Today 161 (2011) 235.
- Boehler, M., Zwickenpflug, B., Hollender, J., Ternes, T., Joss, A. and Siegrist, H. (2012) Removal of micropollutants in Municipal wastewater treatment plants by powder-activated carbon. Water Sci Technol 66(10), 2115-2121.
- Borowska, E., Felis, E., & Kalka, J. (2016). Oxidation of benzotriazole and benzothiazole in photochemical processes: Kinetics and formation of transformation products. Chemical Engineering Journal, 304, 852–863.
- Boudriche, L., Michael-Kordatou, I., Michael, S., Karaolia, P., & Fatta-Kassinos, D. (2016). UV-C-driven oxidation of ciprofloxacin in conventionally treated urban wastewater: Degradation kinetics, ecotoxicity and phytotoxicity assessment and inactivation of ciprofloxacin-resistant *Escherichia coli*. Journal of Chemical Technology and Biotechnology, (October 2016), 1380–1388.
- Bourgin, M., Beck, B., Boehler, M., Borowska, E., Fleiner, J., Salhi, E., Teichler, R., von Gunten, U., Siegrist, H. and McArdell, C.S. (2018) Evaluation of a full-scale wastewater treatment plant upgraded with ozonation and biological post-treatments: Abatement of micropollutants, formation of transformation products and oxidation by-products. Water Research 129, 486-498.

- Chi G.T., Churchley J., Huddersman K.D., International Journal of Chemical Engineering 2013 (2013) 1.
- Chong M.N., Jin B., Laera G., Saint C.P., Chemical Engineering Journal 174 (2011) 595.
- De la Cruz N., Gimenez J., Esplugas S., Grandjean D., de Alencastro L.F., Pulgarin, C. Water Res 46 (2012) 1947.
- De la Cruz N., Esquius L., Grandjean D., Magnet A., Tungler A., de Alencastro L.F., Pulgarin C., Water Res 47 (2013) 5836.
- Dodd, M.C., Buffle, M.-O. and von Gunten, U. (2006) Oxidation of Antibacterial Molecules by Aqueous Ozone: moiety-Specific reaction kinetics and application to ozone-based wastewater treatment. Environ. Sci. Technol. 40, 1969-1977.
- Dular M., Griessler-Bulc T., Gutierrez-Aguirre I., Heath E., Kosjek T., Krivograd Klemencic A., Oder M., Petkovsek M., Racki N., Ravnikar M., Sarc A., Sirok B., Zupanc M., Zitnik M., Kompare B., Ultrason Sonochem 29 (2016) 577.
- Encinas A., Rivas F.J., Beltrán F.J., Oropesa A., Chemical Engineering & Technology 36 (2013) 492.
- Espejo A., Aguinaco A., Amat A.M., Beltran F.J., Journal of environmental science and health. Part A, Toxic/hazardous substances & environmental engineering 49 (2014) 410.
- Estrada-Arriaga E.B., J.E. Cortes-Munoz, A. Gonzalez-Herrera, C.G. Calderon-Molgora, M. de Lourdes Rivera-Huerta, E. Ramirez-Camperos, L. Montellano-Palacios, S.L. Gelover-Santiago, S. Perez-Castrejon, L. Cardoso-Vigueros, A. Martin-Dominguez, L. Garcia-Sanchez, The Science of the total environment 571 (2016) 1172.
- Fujioka, T., Khan, S.J., Poussade, Y., Drewes, J.E., Nghiem, L.D. (2012). N-nitrosamine removal by reverse osmosis for indirect potable water reuse - A critical review based on observations from laboratory-, pilot- and full-scale studies. Separ. Purif. Technol. 98, 503-515.
- Fujioka, T., Khan, S.J., McDonald, J.A., Roux, A., Poussade, Y., Drewes, J.E., Nghiem, L.D. (2013a). N-nitrosamine rejection by reverse osmosis membranes: A full-scale study. Water Res. 47, 6141-6148.
- Fujioka, T., Khan, S.J., McDonald, J.A., Roux, A., Poussade, Y., Drewes, J.E., Nghiem, L.D. (2013b). N-nitrosamine rejection by nanofiltration and reverse osmosis membranes: The importance of membrane characteristics. Desalination 316, 67-75.
- Fux, C., Kienle, C., Joss, A., Wittmer, A. and Frei, R. (2015) Ausbau der ARA Basel mit 4. Reinigungsstufe - Pilotstudie: Elimination Mikroverunreinigungen udn ökotoxikologische Wirkungen. Aqua & Gas 7/8, 10-17.
- García-Gómez C., Drogui P., Seyhi B., Gortáres-Moroyoqui P., Buelna G., Estrada-Alvgarado M.I., Álvarez L.H., Journal of the Taiwan Institute of Chemical Engineers 64 (2016) 211.
- Ge, S., Feng, L., Zhang, L., Xu, Q., Yang, Y., Wang, Z., Kim, K.-H. (2017). Rejection rate and mechanisms of drugs in drinking water by nanofiltration technology. Environ. Eng. Res. 22(3), 329-338.
- Giannakis S., Gamarra Vives F.A., Grandjean D., Magnet A., De Alencastro L.F., Pulgarin C., Water Research 84 (2015) 295.
- Gimeno O., J.F. García-Araya, F.J. Beltrán, F.J. Rivas, A. Espejo, Chemical Engineering Journal 290 (2016) 12.
- Götz, C., Otto, J. and Singer, H. (2015) Überprüfung Des Reinigungseffekts - Auswahl Geeigneter Organischer Spurenstoffe. Aqua & Gas 2, 34-40.
- Grover, D.P., Zhou, J.L., Frickers, P.E. and Readman, J.W. (2011) Improved removal of estrogenic and pharmaceutical compounds in sewage effluent by full scale granular activated carbon: impact on receiving river water. J Hazard Mater 185(2-3), 1005-1011.
- Gulyas H., Ogun M.K., Meyer W., Reich M., Otterpohl R., The Science of the total environment 542 (2016) 612.
- He Y., Sutton N.B., Rijnaarts H.H.H., Langenhoff A.A.M., Applied Catalysis B: Environmental 182 (2016) 132.
- Hollender, J., Zimmermann, S.G., Koepke, S., Krauss, M., McArdell, C.S., Ort, C., Singer, H., von Gunten, U. and Siegrist, H. (2009) Elimination of Organic Micropollutants in a Municipal Wastewater Treatment Plant Upgraded with a Full-Scale Post-Ozonation Followed by Sand Filtration. Environmental Science & Technology 43(20), 7862-7869.
- Hu, J., Aarts, A., Shang, R., Heijman, B. and Rietveld, L. (2016) Integrating powdered activated carbon into wastewater tertiary filter for micro-pollutant removal. J Environ Manage 177, 45-52.

- Huber, M.M., Canonica, S., Park, G.-Y. and von Gunten, U. (2003) Oxidation of Pharmaceuticals during Ozonation and Advanced Oxidation Processes. *Environmental Science & Technology* 37(5), 1016-1024.
<http://doi.org/10.1016/j.watres.2007.09.020>
- James, C. P., Germain, E., & Judd, S. (2014). Micropollutant removal by advanced oxidation of microfiltered secondary effluent for water reuse. *Separation and Purification Technology*, 127, 77–83.
- Jin, X., Peldszus, S. and Huck, P.M. (2012) Reaction kinetics of selected micropollutants in ozonation and advanced oxidation processes. *Water Research* 46(19), 6519-6530.
- Kaiser, H.-P., Köster, O., Gresch, M., Périsset, P.M.J., Jäggi, P., Salhi, E. and von Gunten, U. (2013) Process Control For Ozonation Systems: A Novel Real-Time Approach. *Ozone: Science & Engineering* 35(3), 168-185.
- Karaolia, P., Michael, I., García-Fernández, I., Agüera, A., Malato, S., Fernández-Ibáñez, P., Fatta-Kassinos, D. (2014). Reduction of clarithromycin and sulfamethoxazole-resistant Enterococcus by pilot-scale solar-driven Fenton oxidation. *The Science of the Total Environment*, 468–469, 19–27.
- Karaolia, P., Michael, I., Hapeshi E., Alexander J., Schwartz T., Fatta-Kassinos D., Chemical Engineering Journal 310 (2017) 491.
- Karelid, V., Larsson, G. and Bjorlenius, B. (2017) Pilot-scale removal of pharmaceuticals in Municipal wastewater: Comparison of granular and powdered activated carbon treatment at three wastewater treatment plants. *J Environ Manage* 193, 491-502.
- Kattel, E., Trapido, M., & Dulova, N. (2017). Oxidative degradation of emerging micropollutant acesulfame in aqueous matrices by UVA-induced H₂O₂/Fe²⁺ and S₂O₈²⁻/Fe²⁺ processes. *Chemosphere*, 171, 528–536.
- Klamerth N., N. Miranda, S. Malato, A. Agüera, A.R. Fernández-Alba, M.I. Maldonado, J.M. Coronado, *Catalysis Today* 144 (2009) 124.
- Klamerth N., L. Rizzo, S. Malato, M.I. Maldonado, A. Aguera, A.R. Fernandez-Alba, *Water Research* 44 (2010) 545.
- Klamerth N., S. Malato, M.I. Maldonado, A. Agüera, A. Fernández-Alba, *Catalysis Today* 161 (2011) 241.
- Klamerth N., S. Malato, A. Aguera, A. Fernandez-Alba, G. Mailhot, *Environ Sci Technol* 46 (2012) 2885.
- Klamerth N., S. Malato, A. Aguera, A. Fernandez-Alba, *Water Research* 47 (2013) 833.
- Knopp, G., Prasse, C., Ternes, T.A. and Cornel, P. (2016) Elimination of micropollutants and transformation products from a wastewater treatment plant effluent through pilot scale ozonation followed by various activated carbon and biological filters. *Water Research* 100, 580-592.
- Komtchou S., Dirany A., Drogui P., Bermond A., *Environ Sci Pollut Res Int* 22 (2015) 11513.
- Kazner C., Lehnberg K., Kovalova L., Wintgens T., Melin T., Hollender J., Dott W., *Water Science and Technology* 58 (2008) 1699.
- Kovalova, L., Siegrist, H., von Gunten, U., Eugster, J., Hagenbuch, M., Wittmer, A., Moser, R. and McArdell, C.S. (2013) Elimination of Micropollutants during Post-Treatment of Hospital Wastewater with Powdered Activated Carbon, Ozone, and UV. *Environmental Science & Technology* 47(14), 7899-7908.
- Kreuzinger, N., Haslinger, J., Kornfeind, L., Schaar, H., Saracevic, E., Winkelbauer, A., Hell, F., Walder, C., Müller, M., Wagner, A. and Wieland, A. (2015) KomOzAk Endbericht: Weitergehende Reinigung kommunaler Abwässer mit Ozon sowie Aktivkohle für die Entfernung organischer Spurenstoffe, Wien.
- Lange, F., Cornelissen, S., Kubac, D., Sein, M.M., von Sonntag, J., Hannich, C.B., Gollock, A., Heipieper, H.J., Möder, M. and von Sonntag, C. (2006) Degradation of macrolide antibiotics by ozone: A mechanistic case study with clarithromycin. *Chemosphere* 65(1), 17-23
- Lee, Y., Gerrity, D., Lee, M., Bogeat, A.E., Salhi, E., Gamage, S., Trenholm, R.A., Wert, E.C., Snyder, S.A. and von Gunten, U. (2013) Prediction of Micropollutant Elimination during Ozonation of Municipal Wastewater Effluents: Use of Kinetic and Water Specific Information. *Environmental Science & Technology* 47(11), 5872-5881.
- Lee, Y., Kovalova, L., McArdell, C.S. and von Gunten, U. (2014) Prediction of micropollutant elimination during ozonation of a Hospital wastewater effluent. *Water Research* 64, 134-148.
- Leitner, N.K.V. and Roshani, B. (2010) Kinetic of benzotriazole oxidation by ozone and hydroxyl radical. *Water Research* 44(6), 2058-2066.

- Löwenberg J., Zenker A., Baggenstos M., Koch G., Kazner C., Wintgens T., Water Research 56 (2014) 26.
- Mackuľák, T., Nagyová, K., Faberová, M., Grabcík, R., Koba, O., Gál, M., & Birošová, L. (2015). Utilization of Fenton-like reaction for antibiotics and resistant bacteria elimination in different parts of WWTP. Environmental Toxicology and Pharmacology, 40(2), 492–497
- Mailler, R., Gasperi, J., Coquet, Y., Deshayes, S., Zedek, S., Cren-Olive, C., Cartiser, N., Eudes, V., Bressy, A., Caupos, E., Moilleron, R., Chebbo, G. and Rocher, V. (2015) Study of a large scale powdered activated carbon pilot: Removals of a wide range of emerging and priority micropollutants from wastewater treatment plant effluents. Water Res 72, 315-330.
- Margot, J., Kienle, C., Magnet, A., Weil, M., Rossi, L., de Alencastro, L.F., Abegglen, C., Thonney, D., Chevre, N., Scharer, M. and Barry, D.A. (2013) Treatment of micropollutants in Municipal wastewater: ozone or powdered activated carbon? Sci Total Environ 461-462, 480-498.
- Marquez Brazon E., Piccirillo C., Moreira I.S., Castro P.M., J Environ Manage 182 (2016) 486.
- Matta R., Tlili S., Chiron S., Barbat S., Environmental Chemistry Letters 9 (2010) 347.
- Michael-Kordatou, I., Iacovou, M., Frontistis, Z., Hapeshi, E., Dionysiou, D. D., & Fatta-Kassinos, D. (2015). Erythromycin oxidation and ERY-resistant Escherichia coli inactivation in urban wastewater by sulfate radical-based oxidation process under UV-C irradiation. Water Research, 85, 346–358.
- Miralles-Cuevas S., Oller I., Sanchez Perez J.A., Malato S., Water Res 64 (2014) 23.
- Miranda-García N., Suárez S., Sánchez B., Coronado J.M., Malato S., Maldonado M.I., Applied Catalysis B: Environmental 103 (2011) 294.
- Miralles-Cuevas S., I. Oller, A. Agüera, L. Ponce-Robles, J.A.S. Pérez, S. Malato, Catalysis Today 252 (2015) 78.
- Moreira N.F., C.A. Orge, A.R. Ribeiro, J.L. Faria, O.C. Nunes, M.F. Pereira, A.M. Silva, Water Research 87 (2015) 87.
- Moreira N.F., Sousa J.M., Macedo G., Ribeiro A.R., Barreiros L., Pedrosa M., Faria J.L., Pereira M.F., Castro-Silva S., Segundo M.A., Manaia C.M., Nunes O.C., Silva A.M., Water Res 94 (2016) 10.
- Mussa Z.H., Al-Qaim F.F., Othman M.R., Abdullah M.P., Latip J., Zakria Z., Journal of the Taiwan Institute of Chemical Engineers 72 (2017) 37.
- Naddeo V., S. Meric, D. Kassinos, V. Belgiorio, M. Guida, Water Res 43 (2009) 4019.
- Naddeo V., D. Ricco, D. Scannapieco, V. Belgiorio, International Journal of Photoenergy 2012 (2012) 7.
- Naddeo V., M. Landi, D. Scannapieco, V. Belgiorio, Desalination and Water Treatment 51 (2013) 6601.
- Nakada, N., Shinohara, H., Murata, A., Kiri, K., Managaki, S., Sato, N. and Takada, H. (2007) Removal of selected pharmaceuticals and personal care products (PPCPs) and endocrine-disrupting chemicals (EDCs) during sand filtration and ozonation at a Municipal sewage treatment plant. Water Research 41(19), 4373-4382.
- Nghiem, L.D., Manis, A., Soldenhoff, K., Schäfer, A.I. (2004b). Estrogenic hormone removal from wastewater using NF/RO membranes. J. Memb. Sci. 242, 37-45.
- Nöthe, T., Fahnenkamp, H. and Sonntag, C.v. (2009) Ozonation of Wastewater: Rate of Ozone Consumption and Hydroxyl Radical Yield. Environmental Science & Technology 43(15), 5990-5995.
- Papoutsakis S., Miralles-Cuevas S., Oller I., Garcia Sanchez J.L., Pulgarin C., Malato S., Catalysis Today 252 (2015) 61.
- Pesoutova R., Stritesky L., Hlavinek P., Water Science and Technology 70 (2014) 70.
- Pocostales P., Álvarez P., Beltrán F.J., Chemical Engineering Journal 168 (2011) 1289.
- Prado M., Borea L., Cesaro A., Liu H., Naddeo V., Belgiorio V., Ballesteros F., International Biodeterioration & Biodegradation 119 (2017) 577.
- Prieto-Rodríguez L., S. Miralles-Cuevas, I. Oller, P. Fernández-Ibáñez, A. Agüera, J. Blanco, S. Malato, Applied Catalysis B: Environmental 128 (2012) 119.
- Prieto-Rodríguez L., Spasiano D., Oller I., Fernández-Calderero I., Agüera A., Malato S., Catalysis Today 209 (2013a) 188.

- Prieto-Rodríguez L., Oller I., Klamerth N., Aguera A., Rodriguez E.M., Malato S., *Water Res* 47 (2013b) 1521.
- Quiñones D.H., Álvarez P.M., Rey A., Beltrán F.J., *Separation and Purification Technology* 149 (2015) 132.
- Radjenovic, J., Petrovic, M., Ventura, F., Barceló, D. (2008). Rejection of pharmaceuticals in nanofiltration and reverse osmosis membrane drinking water treatment. *Water Res.* 42, 3601-3610.
- Real, F.J., Benítez, F.J., Acero, J.L., Sagasti, J.J.P. and Casas, F. (2009) Kinetics of the Chemical Oxidation of the Pharmaceuticals Primidone, Ketoprofen, and Diatrizoate in Ultrapure and Natural Waters. *Industrial & Engineering Chemistry Research* 48(7), 3380-3388.
- Reungoat, J., Macova, M., Escher, B.I., Carswell, S., Mueller, J.F. and Keller, J. (2010) Removal of micropollutants and reduction of biological activity in a full scale reclamation plant using ozonation and activated carbon filtration. *Water Research* 44(2), 625-637.
- Reungoat, J., Escher, B.I., Macova, M. and Keller, J. (2011) Biofiltration of wastewater treatment plant effluent: effective removal of pharmaceuticals and personal care products and reduction of toxicity. *Water Res* 45(9), 2751-2762.
- Rey A., García-Muñoz P., Hernández-Alonso M.D., Mena E., García-Rodríguez S., Beltrán F.J., *Applied Catalysis B: Environmental* 154-155 (2014) 274.
- Rey A., Mena E., Chávez A.M., Beltrán F.J., Medina F., *Chemical Engineering Science* 126 (2015) 80.
- Ribeiro R.S., Frontistis Z., Mantzavinos D., Venieri D., Antonopoulou M., Konstantinou I., Silva A.M.T., Faria J.L., Gomes H.T., *Applied Catalysis B: Environmental* 199 (2016) 170.
- Rizzo L., Meric S., Guida M., Kassinos D., Belgiorno V., *Water Research* 43 (2009) 4070.
- Rodrigo M.A., Cañizares P., Buitrón C., Sáez C., *Electrochimica Acta* 55 (2010) 8160
- Rodriguez-Nava O., Ramirez-Saad H., Loera O., Gonzalez I., *Environ Technol* 37 (2016) 2964.
- Rosenfeldt, E.J. and Linden, K.G. (2004) Degradation of Endocrine Disrupting Chemicals Bisphenol A, Ethinyl Estradiol, and Estradiol during UV Photolysis and Advanced Oxidation Processes. *Environmental Science & Technology* 38(20), 5476-5483.
- Santiago-Morales, J., Gómez, M. J., Herrera-López, S., Fernández-Alba, A. R., García-Calvo, E., & Rosal, R. (2013). Energy efficiency for the removal of non-polar pollutants during ultraviolet irradiation, visible light photocatalysis and ozonation of a wastewater effluent. *Water Research*, 47(15), 5546–5556.
- Schaar, H., Clara, M., Gans, O. and Kreuzinger, N. (2010) Micropollutant removal during biological wastewater treatment and a subsequent ozonation step. *Environmental Pollution* 158(5), 1399-1404.
- Scheurer, M., Michel, A., Brauch, H.-J., Ruck, W. and Sacher, F. (2012) Occurrence and fate of the antidiabetic drug metformin and its metabolite guanylurea in the environment and during drinking water treatment. *Water Research* 46(15), 4790-4802.
- Semiao, A.J.C., Schäfer, A.I. (2013). Removal of adsorbing estrogenic micropollutants by nanofiltration membranes. Part A—Experimental evidence. *J. Memb. Sci.* 431, 244-256.
- Streicher, J., Ruhl, A.S., Gnirss, R. and Jekel, M. (2016) Where to dose powdered activated carbon in a wastewater treatment plant for organic micro-pollutant removal. *Chemosphere* 156, 88-94.
- Sun, J., Wang, J., Zhang, R., Wei, D., Long, Q., Huang, Y., Xie, X. and Li, A. (2017) Comparison of different advanced treatment processes in removing endocrine disruption effects from Municipal wastewater secondary effluent. *Chemosphere* 168, 1-9.
- Teixeira S., Gurke R., Eckert H., Kühn K., Fauler J., Cuniberti G., *Journal of Environmental Chemical Engineering* 4 (2016) 287.
- Tokumura M., Sugawara A., Raknuzzaman M., Habibullah-Al-Mamun M., Masunaga S., *Chemosphere* 159 (2016) 317.
- Vecitis, C.D., Park, H., Cheng, J., Mader, B.T. and Hoffmann, M.R. (2008) Kinetics and Mechanism of the Sonolytic Conversion of the Aqueous Perfluorinated Surfactants, Perfluoroctanoate (PFOA), and Perfluoroctane Sulfonate (PFOS) into Inorganic Products. *The Journal of Physical Chemistry A* 112(18), 4261-4270.

- Vecitis, C.D., Park, H., Cheng, J., Mader, B.T. and Hoffmann, M.R. (2009) Treatment technologies for aqueous perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA). *Frontiers of Environmental Science & Engineering in China* 3(2), 129-151.
- Verliefde, A.R.D., Cornelissen, E.R., Heijman, S.G., Hoek, E.M.V., Amy, G.L., Van der Bruggen, B., Van Dijk, J.C. (2009). Influence of solute-membrane affinity on rejection of uncharged organic solutes by nanofiltration membranes. *Env. Sci. Technol.* 43(7), 2400-2406.
- Vergili, I. (2013). Application of nanofiltration for the removal of carbamazepine, diclofenac and ibuprofen from drinking water sources. *J. Environ. Management* 127, 177-187.
- de Vidales M.J.M., Sáez C., Pérez J.F., Cotillas S., Llanos J., Cañizares P., Rodrigo M.A., *Journal of Applied Electrochemistry* 45 (2015) 799.
- Wenk, J., von Gunten, U. and Canonica, S. (2011) Effect of Dissolved Organic Matter on the Transformation of Contaminants Induced by Excited Triplet States and the Hydroxyl Radical. *Environmental Science & Technology* 45(4), 1334-1340.
- Yang, X., Flowers, R.C., Weinberg, H.S. and Singer, P.C. (2011) Occurrence and removal of pharmaceuticals and personal care products (PPCPs) in an advanced wastewater reclamation plant. *Water Res* 45(16), 5218-5228.
- Yangali-Quintanilla, V., Sadmani, A., McConville, M., Kennedy, M., Amy, G. (2010b). A QSAR model for predicting rejection of emerging contaminants (pharmaceuticals, endocrine disruptors) by nanofiltration membranes. *Water Res.* 44(2), 373-384.
- Zaviska F., Drogu P., Blais J.-F., Mercier G., *Journal of Applied Electrochemistry* 42 (2012) 95.
- Ziemianska J., Adamek E., Sobczak A., Lipska I., Makowski A., Baran, W. *Physicochem. Probl. Miner. Process* 45 (2010) 127.
- Zietzschmann, F., Altmann, J., Ruhl, A.S., Dunnbier, U., Dommisch, I., Sperlich, A., Meinel, F. and Jekel, M. (2014) Estimating organic micro-pollutant removal potential of activated carbons using UV absorption and carbon characteristics. *Water Res* 56, 48-55.
- Zupanc M., T. Kosjek, M. Petkovšek, M. Dular, B. Kompare, B. Širok, Ž. Blažeka, E. Heath, *Ultrasonics Sonochemistry* 20 (2013) 1104.
- Zupanc M., T. Kosjek, M. Petkovšek, M. Dular, B. Kompare, B. Širok, M. Stražar, E. Heath, *Ultrasonics Sonochemistry* 21 (2014) 1213.