Supporting Information

Per- and polyfluoroalkyl substances in the environment and their removal by advanced oxidation processes

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Text S1. PFAS research hotspots.

Currently, they can be divided into four main categories. The first is degradation methods mainly involving redox reactions (green section), among which AOPs and ARPs are primarily used, due to their strong degradation, defluorination, and mineralization capabilities(Lei et al., 2020). The second is the adsorption method (purple section), where various adsorbents (such as activated carbon, ion exchange resin, and biochar) have been developed, but their application have been limited by relatively pronounced adsorption saturation, high cost and low efficiency(Wang et al., 2023a). The third method is the biodegradation (red section), which has been little studied due to the poor biodegradability of PFAS(Zhang et al., 2022; Berhanu et al., 2023). The fourth type are other methods (blue section), which mainly include nanofiltration, reverse osmosis, etc. These methods have high cost, low removal rate, and are not ideal for removing PFAS(Johnson et al., 2022; Chaudhary et al., 2023).

Table S1 Comparison between PS-AOP, H_2O_2-Fenton, electrocatalytic and catalytic ozone technologies

Type	Reaction conditions	Main active substances	PFAS degradation efficiency	Cost	Environmental impact	References
PS-AOPs	Mild conditions (ambient temperature and pressure), wide pH range (acidic to alkaline)	$SO_4 \bullet^-$, $\bullet OH$, $O_2 \bullet^-$, $^1O_2$, etc.	High (efficiently breaks C-F bonds), especially effective against long-chain PFAS	Moderate, no complex equipment required	Fewer by-products	(Lee et al., 2020; Ding et al., 2024)
H_2O_2-Fenton	Acidic conditions (pH 2-4), iron catalyst required	$\bullet OH$, $O_2 \bullet^-$, $^1O_2$, etc.	Lower (less effective for long chain PFAS)	Low (low cost of H_2O_2 and iron salts), but requires pH adjustment	Possible generation of iron-containing sludge and toxic intermediates	(Schlesinger et al., 2022; Quiroz-Vela et al., 2024)
Electrocatalysis	Requires applied current and electrode material (e.g., boron-doped diamond electrode)	$\bullet OH$, H_2O_2, $O_2 \bullet^-$, $^1O_2$, etc.	Medium (dependent on electrode activity and current density), high energy consumption	High (high equipment and energy costs)	No chemical additives, but electrode loss and energy consumption are significant issues	(Chen et al., 2023; Meng et al., 2024)
Catalytic ozonation technologies	Neutral to alkaline conditions (pH 7-9), ozone generator and catalyst are required.	$\bullet OH$, $O_2 \bullet^-$, $^1O_2$, etc.	Medium (short chain PFAS are more easily degraded), ozone mass transfer efficiency limits overall effectiveness	Higher (high energy consumption for ozone generation, possible catalyst deactivation)	Risk of ozone leakage with possible by-products such as aldehydes	(Wu et al., 2018; Lashuk et al., 2022)

Text S2. PFAS in environment

Generally, F is derived from the mining of fluorite (CaF_2) ores, during which fluorite is digested to form hydrofluoric acid (HF). Production of starting materials for synthesizing PFAS through direct fluorination or oligomerization, HF, and other non-PFAS based chemicals, and further conversion into PFAS with C-F bonds(Schwichtenberg et al., 2020). During product processing, PFAS gradually enter the environment through sewage, exhaust gas and solid waste. More insidiously and importantly, PFAS can also slowly leach out through the use of everyday products(e.g. clothes, bags, non-stick pans)(Holder et al., 2023). With further transport and transformation, PFAS will be found in a variety of environmental media. Due to its toxicity and cumulative nature, the food chain can become a chain of transmission of PFAS to biological health hazards(Sadia et al., 2023). Prolonged exposure to PFOS, even at low doses, can result in negative human health effects such as cancer, neurotoxicity, thyroid disorders, and developmental and reproductive disorders(Curtzwiler et al., 2021; Loganathan and Wilson, 2022; Vendl et al., 2022; Yang et al., 2023).

Table S2 Current PS-AOPs and sulfite-ARPs methods for PFAS removal and their efficiencies

Type	Method	Reaction conditions	Reaction time(h)	Initial concentration	Degradation rate (%)	Defluorination rate (%)	Mineralization rate (%)	Degradation efficiency(μmol/h)	Defluoridation efficiency(μmol/h)	References
PS-AOPs-PFAS	UV/PS	PS= 15 mmol/L 254 nm UV 16 W	8	150 μmol/L (62.11 mg/L) PFOA (1 L)	85.6	41.29	28.97	16.05	116.13	(Qian et al., 2016)
	BC activated PMS	60℃ PMS= 10 mmol/L 1 g/L ISBC pH=6.4	2	4.8 μmol/L (2 mg/L) PFOA (0.25 L)	99.6	90.8	89.4	0.60	8.172	(Fu et al., 2022)
	In_2O_3/PS/sun light	Light (320-780nm) PS= 10 mmol/L pH=3.7 In_2O_3=0.05 g/L	10	12 μmol/L (5 mg/L) PFOA (0.05 L)	98.6	94.2	-	0.059	0.8478	(Yuan et al., 2022)

In_2O_3/PS	PS= 10 mmol/L pH=3.7 In_2O_3 = 0.05 g/L	4	12 µmol/L (5 mg/L) PFOA (0.05 L)	-	50	-	-	1.125	
Carbon haerogel/PS	pH=3.8 PS= 50 mmol/L Carbonaerogel= 0.1 g/L 60 ℃	8	241.8 µmol/L (100 mg/L) PFOA (1 L)	85.7	34.5	-	25.90	156.41	(Lee et al., 2022)
PS	pH=3 PS= 50 mmol/L 60 ℃	8	241.8 µmol/L (100 mg/L) PFOA (1 L)	58.2	23.1	-	17.59	104.73	
UV/PS	PS= 50 mmol/L 200 W	4 12	1350 µmol/L (559 mg/L) PFOA (0.022 L)	100 (4)	73.8 (12)	-	7.43	27.40	(Hori et al., 2005)
UV/PS	253.7 nm 8.0 mW/cm^2 pH=10 PDS= 20 mmol/L	3	168.2 µmol/L (55.53 mg/L) GenX	<5	-	-	0.13	-	(Bao et al., 2018)

			(0.045 L)						
UV/PS	253.7 nm PS= 20 mmol/L pH=6	0.167	160 µmol/L (68.2 mg/L) 6:2 FTS (0.045 L)	100	20	40(480 min)	43.11	112.1	(Bao et al., 2021)
ZVI/PS/ Microwave	PS= 5 mmol/L 3.6 mmol/L ZVI 90℃	2	240.7 µmol/L (99.6 mg/L) PFOA (0.05 L)	67.6	22.5	-	4.07	20.31	(Lee et al., 2010a)
Heat/PS	PS= 20 mmol/L 60℃	48	5 µmol/L (1.65 mg/L) GenX (0.04 L)	97	83	-	0.004	0.038	(Ding et al., 2022)
UV/PS	PS= 10mmol/L 253.7 nm 8.0 mW/cm^2	0.1 5	160 µmol/L (100 mg/L) OBS (0.04 L)	100 (0.1)	≈27 (5)	-	64	5.875	(Liu et al., 2022c)
US/PS	PS= 4.2 mmol/L pH= 3.69 20 kHz 550 W	6	10 µmol/L (4.14 mg/L) PFOA	100	99	-	1.67	24.75	(Lei et al., 2020)

	+ 43 kHz 250 W		(1 L)						
US/PS	PS= 4.2 mmol/L pH= 3.69 20 kHz 550 W + 43 kHz 250 W	6	5.79 µmol/L (0.0057 mg/L) PFOS (1 L)	100	47	-	0.965	6.80	
US/PS	PS= 4.2 mmol/L pH= 3.69 20 kHz 550 W + 43 kHz 250 W	6	~7 µmol/L (3.15 mg/L) 6:2FTS (1 L)	100	87	-	1.17	13.20	
US/PS	PS= 1 mmol/L 20.00 ±0.20 kHz 900 W	2	1.207 µmol/L (0.5 mg/L) PFOA (0.05L)	~92	84.54	-	0.03	0.38	(Xiong et al., 2023)
PS	PS= 50mmol/L 27℃	12	253.8 µmol/L (105.1 mg/L) PFOA (0.05 L)	12.7	27.1	2.64	0.134	0.023	(Lee et al., 2009)
mol/Licrowave/PS	PS= 50mmol/L	6	253.8 µmol/L	100	79.9	-	2.12	25.35	

	70W 90℃		(105.1 mg/L) PFOA (0.05 L)						
mol/Licrowave/PS	PS= 50mmol/L 45 W 60℃	8	253.8 μmol/L (105.1 mg/L) PFOA (0.05 L)	100	81.9	-	1.586	19.48	
mol/Licrowave/PS	PS= 50 mmol/L 140 W 130℃	1	253.8 μmol/L (105.1 mg/L) PFOA (0.05 L)	92.4	40	-	11.726	76.14	
Heat/zeolite/PS	PS= 100 mmol/L pH =3.0 70℃ 50 g/L zeolite	1.5	240 μmol/L (100 mg/L) PFOA (0.03 L)	99.8	71	-	4.790	51.12	(Qian et al., 2022)
Al_2O_3 /PS	2.58g Al_2O_3 1.37g PS 350 r/min 100℃	2	240 μmol/L (100 mg/L) PFOA (0.25 L)	99	96	98	28.8	432	(Wang et al., 2019)

		mixed with H_2								
	UV/PS	253.7 nm 8.0 mW/cm^2 PS= 10 mmol/L pH=10	0.1 5 -	160 μmol/L (100 mg/L) OBS (0.04 L)	46.9 (0.1)	27.6 (5)	9.8	30.015	6.006	(Liu et al., 2022b)
	UV/PS	253.7/184.9 nm 8.0 mW/cm^2 pH=12 PS= 20 mmol/L	8	100μmol/L HFPO-TA (0.04 L)	65	30.3	-	0.325	2.87	(Gu et al., 2023)
Other AOPs-PFAS	BDD anode	0.0070 m^2 50 mA/cm^2	10	37.2 mg/L PFOA	99.7	-	>90	-	-	(Ruiz et al., 2017)
	CrNi-foam/BDD Electro-Fenton	16 mA/cm^2 pH=3	4	82 mg/L GenX	-	-	92.2	-	-	(Olvera-Vargas et al., 2022)
	Photocatalytic BiOCl	0.5g/L BiOCl	3	8.3 mg/L PFOA	100	59.3	-	-	-	(Song et al., 2017)
	BDD anodic oxidation	Nb/BDD anod stainless-steel cathode50 mA cm^{2}	5	4.98 mg /L GenX	60	45	-	-	-	(Pica et al., 2019)

	pH=7								
TiO_2 /UV	UV lamp 254 nm 400W	12	20.7 mg/L PFOA	18.6	0	-	-	-	(Chen et al., 2016)
Pb-TiO_2 /UV	UV lamp 254 nm 400W	12	20.7 mg/L PFOA	99.9	22.4	-	-	-	
BDD	Room temperature	43	2 mg/L PFBS	45	-	-	-	-	(Trautmann et al., 2015)
BDD	Room temperature	43	2 mg/L PFHxS	91	-	-	-	-	
BDD	Room temperature	43	2 mg/L PFOS	98	-	-	-	-	
UV irradiation	Low pressure,254 nm, 32 W	240	16.6 mg/L PFOS	27.2	-	-	-	-	(Yamamoto et al., 2007)
UV-irradiation	LP UV lamp 254 nm, 20W	4	20.7-27.8 mg/L PFCA	98.6	69	88.9	-	-	(Giri et al., 2014)
Photocatalytic BiOF	50 % EG-BiOF	6	15 mg/L PFOA	100	26	56.8	-	-	(Wang et al., 2021)
Photocatalytic Ga/ TNTs@AC	3 g/L Ga/TNTs@AC pH=7.0 UV=210W/m^2	2	0.1mg/L PFOS	75	66	-	-	-	(Zhu et al., 2021)
H_2O_2/UV	O_2 0.48mol/Lpa	72	12.25 mg/L PFOA	26.5	-	-	-	-	(Hori et al., 2004)
UV-visible light	O_2 0.48mol/Lpa	24	12.25 mg/L	13.3	-	-	-	-	

				PFOA						
	BDD electrodes	10 mA cm^{-2} pH= 3 10 mmol/L NaClO4 T= 25 ±1 ℃	3	116 mg/L PFNA PFDA	98.7 96.0	88 50.7	88.0 81.1	-	-	(Lin et al., 2013)
	PbO2 electrodes	10 mA cm^{-2} pH= 3, 10 mmol/L L–1 NaClO$_4$25 ± 1 ℃	3	116 mg/L PFNA PFDA	97.1 92.2	78.1 40.9	92.6 87.2	-	-	(Lin et al., 2013)
	SnO2 electrodes	10 mA cm^{-2} pH= 3 10 mmol/L NaClO25 ±1 ℃	3	116 mg/L PFNA PFDA	95.8 88.7	72.4 32.0	95.4 91.9	-	-	(Lin et al., 2013)
	UV–vis/ZnxCu1-xFe2O4/oxalic acid	20 mW/cm^2 50 mg Zn$_x$Cu$_{1-x}$Fe$_2$O$_4$ 0.1mol/L oxalic acid N^2 pH=1.73	12	100mg/L PFOA	86.7	-	-	-	-	(Verma et al., 2021)
	Biochar hydrothermal degradation	240℃ 1 g BC-ZVI	192	10 mg/L PFOA	100	63.2	-	-	-	(Yang et al., 2022)
Sulfite-ARPs-PFAS	VUV/Sulfite	253.7/184.9 nm 8.0 mW/cm^2 pH=12 Sulfite= 2 mmol/L	8	100 μmol/L (51.21 mg/L) HFPO-TA	91.1	56.6	-	0.456	5.377	(Gu et al., 2023)

				(0.04 L)						
	UV/Sulfite	253.7/184.9 nm 8.0 mW/cm^2 pH=12 Sulfite= 2 mol/L	8	100 µmol/L (51.21 mg/L) HFPO-TA (0.04 L)	99.9	81.5	-	0.499	7.74	(Gu et al., 2023)
	UV/Sulfite	253.7 nm Sulfite= 20 mmol/L pH=10	2 4	160 µmol/L (68.2 mg/L) 6:2 FTS (0.045 L)	60 (2)	90 (4)	-	2.16	21.06	(Bao et al., 2021)
	Sulfite	Na_2SO_3= 20 mmol/L 60 °C	3	4.8 µmol/L (2.0 mg/L) PFOA (0.15 L)	3	-	-	0.0072	-	(Zhang et al., 2021)
	AlC$_{Ni}$/Na_2SO_3	AlC$_{Ni}$ = 7 g/L Sulfite = 20 mmol/L 60 °C	3	2.4 µmol/L (1.0 mg/L) PFOA (0.15 L)	44.6	-	-	0.5352	-	
	Na_2SO_3/AlC$_{Ni}$/UV	245 nm AlC$_{Ni}$] = 7 g/L Sulfite = 20 mmol/L	3	2.4 µmol/L (1.0 mg/L)	70	-	-	0.084	-	

		60 °C		PFOA (0.15 L)						
	UV/Sulfite	253.7 nm 8.0 mW/cm^2 Sulfite= 20 mmol/L pH=10	0.33 5	160 μmol/L (100 mg/L) OBS (0.04 L)	100 (0.33)	87.7 (5)	-	19.39	19.08	(Liu et al., 2022b)
	UV/Sulfite	Sulfite= 10 mmol/L pH=10 21℃	-	24.15 μmol/L (10 mg/L) PFOA (0.013L)	100(1h)	89(24)	-	0.314	0.35	(Ren et al., 2021)
	UV/ Sulfite	Sulfite= 10 mmol/L pH = 9.5 20℃ 254 nm	12	25 μmol/L (2.85 mg/L) TFA (0.6 L)	100	100	-	1.25	3.75	(Bentel et al., 2019)
	UV/ Sulfite	Sulfite =10 mmol/L pH = 9.5 20℃ 254nm	8	25 μmol/L (11.60 mg/L) PFNA (0.6 L)	100	58	-	1.875	18.49	
	UV/ Sulfite	Sulfite =10 mmol/L	48	25 μmol/L	90	37	-	0.28	1.97	

		pH = 9.5 20℃ 254 nm		(10.30 mg/L)\ 8:2 FTCA 0.6 L						
	UV/diamond catalytic system	Sulfite =10 mmol/L pH =3	3	20.0 µmol/L (8.28 mg/L) PFOA 0.01 L	100	60	-	0.067	0.6	(Liu et al., 2022a)
	UV/ Sulfite	pH =9.2 25℃ Sulfite =10 mmol/L	0.5	32 µmol/L (16 mg/L) PFOS (0.025 L)	98	60	-	1.568	14.4	(Gu et al., 2016)
	UV/ Sulfite	253.7 nm 8.0 mW/cm^2 pH =10 Sulfite =20 mmol/L	6	168.2 µmol/L (50 mg/L) GenX (0.045 L)	100	90(2)	-	1.26	51.09	(Bao et al., 2018)
	UV/Sulfite + Iodide	5 mmol/L $NaHCO_3$ 10 mmol/L Na_2SO_3 20℃ 18 W pH=12	24	25 µmol/L PFBS (7503 mg/L) (0.6 L)	99	78	-	0.619	4.388	(Liu et al., 2022d)

	UV/Sulfite	5 mmol/L $NaHCO_3$ 10 mmol/L Na_2SO_3 20℃ 18 W pH=12	24	25 µmol/L (7503 mg/L) PFBS (0.6 L)	48	42	-	0.3	2.363	
	VUV/Sulfite	185 nm/254 nm pH =10 0.65 mW/cm^2 30min N_2	3	3 µmol/L (1mg/L) GenX (2 L)	90(3h)	67(6)	-	1.8	7.37	(Kim et al., 2024)
Other ARPs-PFAS	UV/DIHA	36 W，254 nm 25℃ pH=6-7 121µmol/L DIHA	12	10 mg/L PFNA	100	90	-	-	-	(Wang et al., 2023b)
	UV/DIHA	36 W，254 nm 25℃ pH=6-7 121µmol/L DIHA		10 mg/L PFOA PFOS	100	79 79	-	-	-	
	UV/DIHA	36 W，254 nm 25℃ pH=6-7 121µmol/L DIHA		10 mg/L PFHpA	100	72	-	-	-	
	UV/DIHA	36 W，254 nm 25℃ pH=6-7 121µmol/L DIHA		10 mg/L PFHxA PFHxS	100	65 62	-	-	-	

UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L PFPeA	100	62	-	-	-	
UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L PFBA PFBS	100	56 51	-	-	-	
UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L PFPrA	100	37	-	-	-	
UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L TFA	100	9	-	-	-	
UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L 6:3-FTCA	100(4h)	66	-	-	-	
UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L HFPO-DA	100(4h)	47	-	-	-	
UV/DIHA	36 W，254 nm 25℃ pH=6-7 121μmol/L DIHA		10 mg/L HFPO-TA	100(4h)	45	-	-	-	
UV/electrochemical method	UV/-2V pH=11.5 N_2 50 mmol/L $NaClO_4$	2	5 mg/L PFHpA	-	98.7	-	-	-	(Rao et al., 2020)
UV/electrochemical method	UV/-2V pH=11.5 N_2 50 mmol/L $NaClO_4$		5 mg/L PFOA	-	98	-	-	-	

UV/electrochemical method	UV/-2V pH=11.5 N_2 50 mmol/L $NaClO_4$		5 mg/L PFNA	-	98.8	-	-	-	
UV/electrochemical method	UV/-2V pH=11.5 N_2 50 mmol/L $NaClO_4$		5 mg/L PFNA	-	99.2	-	-	-	
UV/electrochemical method	UV/-2V pH=11.5 N_2 50 mmol/L $NaClO_4$		5 mg/L PFHxS	-	95.2	-	-	-	
UV/electrochemical method	UV/-2V pH=11.5 2h N_2 50 mmol/L $NaClO_4$		5 mg/L PFOS	-	87.4	-	-	-	
UV/KI	254nm 10mmol/L KI pH=6-8	2.5	10 mg/L PFBA	18	22.8	-	-	-	(Park et al., 2009)
UV/KI	254nm 10mmol/L KI pH=6-8		10 mg/L PFOA	16	29.2	-	-	-	
UV/KI	254nm 10mmol/L KI pH=6-8		10 mg/L PFOS	32	88.7	-	-	-	
UV/KI	254nm 10mmol/L KI pH=6-8		10 mg/L PFBS	5	24.3	-	-	-	
ZVI reduction in subcritical water	350℃ Iron powder	5	0.5 mg/L PFOS	100	30	-	-	-	(Lee et al., 2010b)
titanium(III) citrate	Cu^{00} 2 g L−1 , 45mmol/L	20	50 mg/L	65	20.6	-	-	-	(Lee et al.,

	with vitamin B$_{12}$, copper nanoparticles Reduction	titanium(III) citrate, 0.2 mmol/L vitamin B12, pH=9.0 70℃		PFOA						2017)
ARPs+AOPs	UV/Sulfite–Heat/PS Treatment	10 mmol/L Na_2SO_3 20 ℃ 5 mmol/L $NaHCO_3$ pH=12.0 + 5 mmol/L $K_2S_2O_8$ 120℃ pH=12	24+0.67	250 μmol/L ω-HPFPrA (0.03 L)	100	94	-	0.304	2.57	(Gao et al., 2021)
	Heat/PS–UV/Sulfite Treatment	10 mmol/L $K_2S_2O_8$ 50 mmol/L NaOH pH=12 120℃ +10 mmol/L Na_2SO_3 5 mmol/L pH =12 20 ℃ 18 W	1+8	500 μmol/L ω-HPFPrA (0.03 L)	100	100	-	1.67	15	
	UV/Sulfite+•OH oxidation	120℃ pH< 2/>12 10 mmol/L Na_2SO_3 5 mmol/L $NaHCO_3$ 18 W UV 5 mmol/L $K_2S_2O_8$	16	500 μmol/L PFHxS 0.03 L	99	72	-	0.928	2.57 8.775	(Liu et al., 2021)
	UV/Sulfite+ BDD electroc emical	254 nm UV 12 mmol/L Na_2SO_3	0.5 14	120.75 μmol/L 50 mg/L	100 (0.5 h)	100 (14)	100 (15 h)	24.15	12.94	(Zhang et al., 2023)

	oxidation	pH ＝11 55mA/cm^2	15	PFOA (0.1 L)						

Degradation efficiency (μmol/h) =$(\mathrm{C(PFAS)} \times \mathrm{V} \times \mathrm{Degradation\ \ rate})/\mathrm{Time(h)}$

Defluorination efficiency (μmol/h) = $\mathrm{C(PFAS)} \times \mathrm{V} \times \mathrm{Defluorination\ \ rate} \times \mathrm{N}_{\mathrm{C-F}}/\mathrm{Time(h)}$

C(PFAS): Concentration of PFAS (μmol/L)

V: Reaction volume(L)

$\mathrm{N}_{\mathrm{C\text{-}F}}$: The number of C-F bonds in PFAS

Table S3 Reactive oxygen radicals and their properties (Wang and Wang, 2018; Yi et al., 2019; Zhu et al., 2019; Yu et al., 2022)

Types	Reactive species	Redox potential	Lifetime (s)	Main Scavengers
Main free radicals	•OH	1.8-2.7 V	10^{-9}	Methanol N-butanol Ethanol Isopropanol Tert butanol
	$O_2•^-$	2.4 V	10^{-5}	Benzoquinone Chloroform L-histidine
	$SO_4•^-$	2.5-3.1 V	3-4 x 10^{-5}	Methanol 1-Octanol Ethanol Butanol
Non-radical species	$^1O_2$	2.2-2.4 V	1-10 x 10^{-6}	Sodium azide L-histidine Furfuryl

Direct electron transfer	-	-	Potassium dichromate
Surface active species	-	-	Dimethyl sulfoxide
High-valent metal species	Fe^{IV} 1.8-2 V	-	Dimethyl sulfoxide
	Co^{IV} 1.8-1.92 V	-	Methyl phenyl sulfoxide
	Cu^{III} 1.57-2.3 V	-	Methyl p-tolyl sulfoxide

Text S3. Differences, similarities, and disadvantages between AOPs and ARPs in removing PFAS

As shown in **Table S4**, we summarize the applicable conditions for AOPs and ARPs. The AOPs system degrades PFAS more effectively under acidic conditions, while ARPs are more suitable for alkaline conditions. This may be because as pH increases, less H^+ participates in the elimination of e_{aq}^-, which leads to more effective degradation of PFAS. In ARP system experiments for PFCAs degradation, it was found that several PFCAs have similar pseudo first order rate constants ($\sim 1.3 \times 10^{-3}$ min^{-1}) indicating a chain length independent degradation mechanism. ARPs may react with matrix components such as humic acids in water, and with the increase of dissolved oxygen, the degradation rate will decrease. ARPs may only be suitable for use in groundwater environments or artificially controlled hypoxic environments, which would also increase costs (Cui et al., 2020; Zhang et al., 2021; Alalm and Boffito, 2022; Zango et al., 2023).

Table S4 Differences, similarities, and disadvantages between AOPs and ARPs in removing PFAS

Types	**Difference**	**Similarities**	**Disadvantage**
AOPs	● Diversity of active species ● Optimal pH: Acidity ● HA reduces degradation rate	● Temperature rise degradation rate increases ● Removal effect depends on typeand quantity of active species and PFAS type ● 100% removed after regulating conditions ● Removal in homogeneous and heterogeneous systems	● Low defluorination rate ● high mineralization cost ● Unstable use in pilot and industrial scale
ARPs	● Optimal pH: Alkaline ● HA inerease the degradation rate ● High defluorination rate		● Chain length decreases, degradation rate and defluorination rate decrease ● Dissolved oxygen increases, degradation and defluorination rate decrease ● Poor mineralization effect

Reference

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