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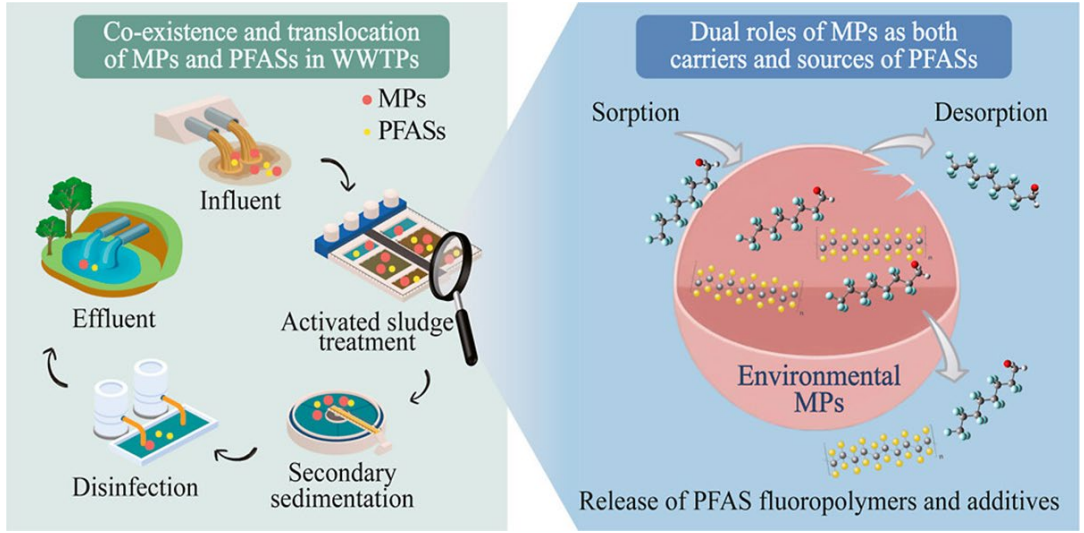
Article

Unveiling the Truth of Interactions between Microplastics and Per- and Polyfluoroalkyl Substances (PFASs) in Wastewater Treatment Plants: Microplastics as a Carrier of PFASs and Beyond

Min Ma, Frederic Coulon, Zhiwen Tang, Zhiyuan Hu, Ye Bi, Mingxin Huo,* and Xin Song*

Published on
6th January, 2025



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Atrayee Datta
3rd May 2025

Background

Interaction and combined toxicity of microplastics and per- and polyfluoroalkyl substances in aquatic environment

Yanhui Dai[1], Jian Zhao (✉)[1,2], Chunxiao Sun[1], Diying Li[1], Xia Liu[1], Zhenyu Wang[3], Tongtao Yue[1], Baoshan Xing (✉)[4]

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Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Adsorption of PFAS onto secondary microplastics: A mechanistic study

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Article

Occurrence, Fate, and Removal of Per- and Polyfluoroalkyl Substances (PFAS) in Small- and Large-Scale Municipal Wastewater Treatment Facilities in the United States

Juhee Kim, Xiaoyue Xin, Gary L. Hawkins, Qingguo Huang, and Ching-Hua Huang*

ACS ES&T Water

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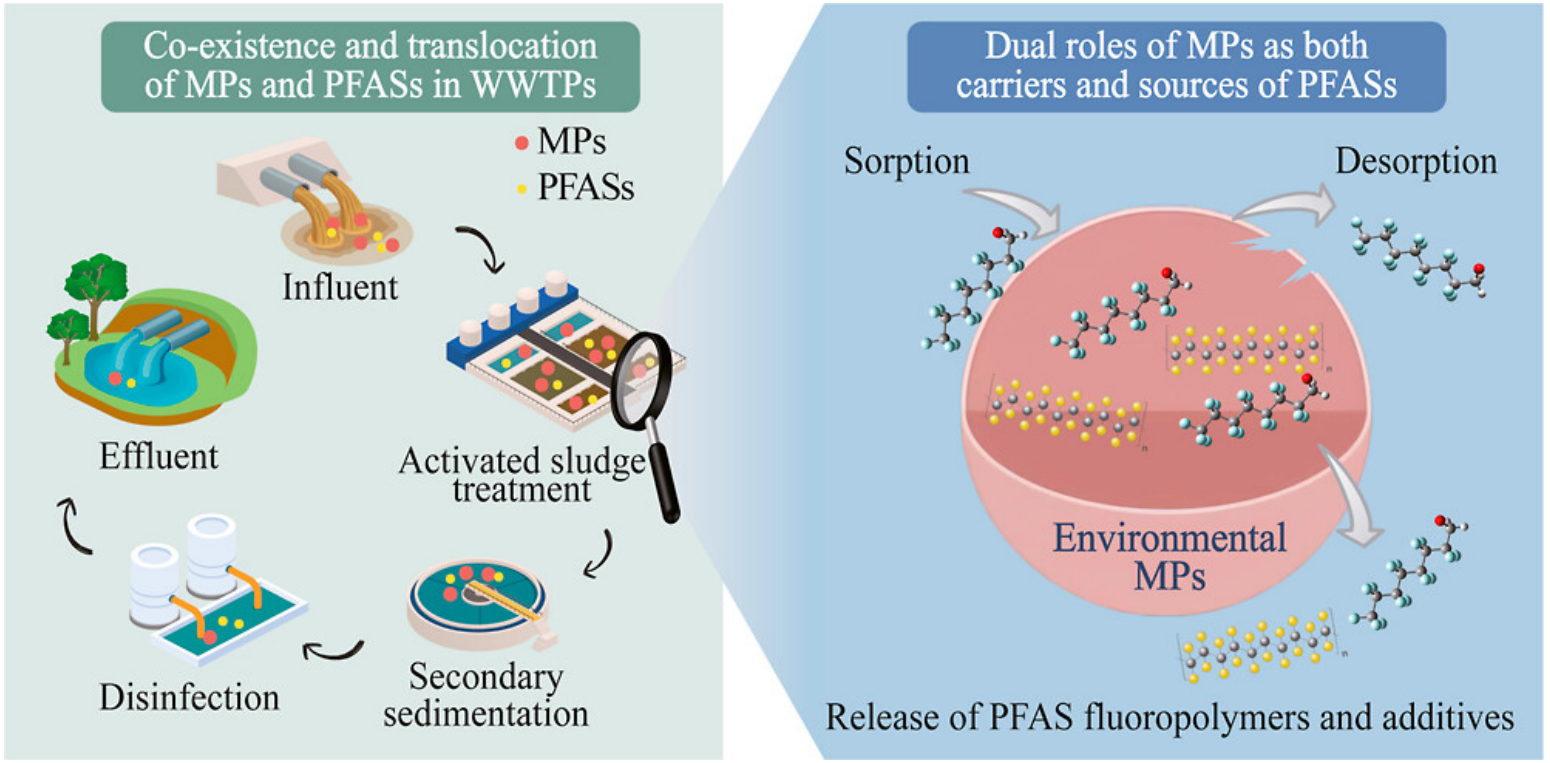
Article

Machine Learning-Assisted Insights into Sources and Fate of Microplastics in Wastewater Treatment Plants

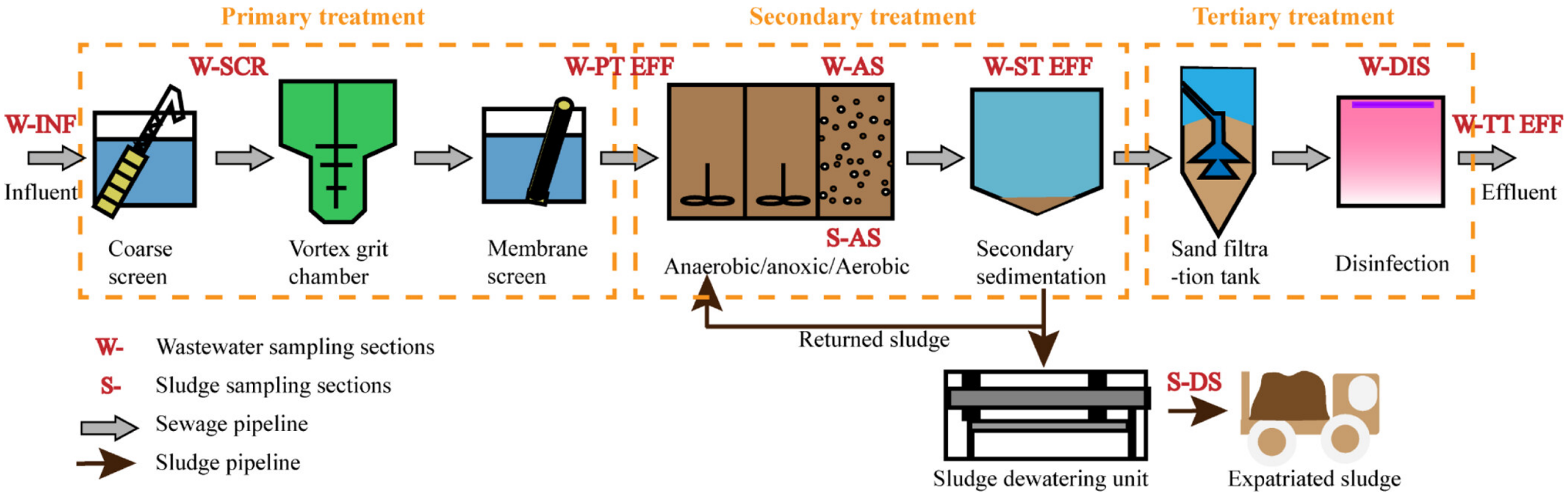
Pengfei Wu, Bolun Wang, Yi Lu, Guodong Cao, Peisi Xie, Wei Wang, Duoli Chen, Gefei Huang, Hangbiao Jin, Zhu Yang, and Zongwei Cai*

Aim of the work

This study investigates the co-occurrence and interaction mechanisms between microplastics (MPs) and per- and polyfluoroalkyl substances (PFASs) in wastewater treatment plants (WWTPs), revealing MPs' dual role as carriers and sources of PFASs.



Sample collection and pre-treatment



1 L of wastewater sample was collected in glass bottle for microplastic analysis

1 L of wastewater sample was collected in PP bottles for PFAS analysis

10 L of activated sludge sample was collected in PP bottle

1 kg of dewatered sludge sample was collected in a stainless steel container

Microplastics from wastewater

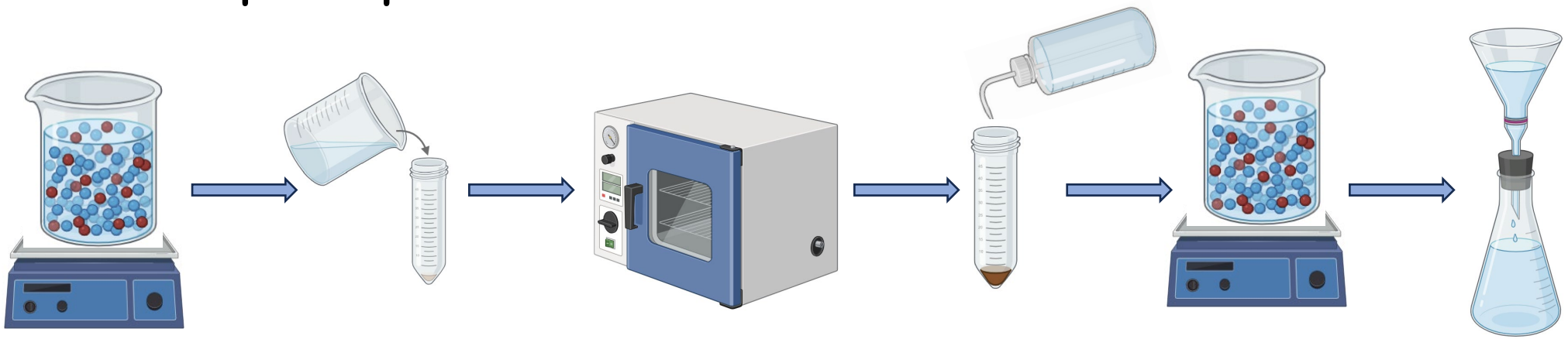
Microplastics from sludge samples

PFAS from wastewater samples

PFAS from sludge samples

PFAS from leaching microplastics

Sorption and desorption experiments



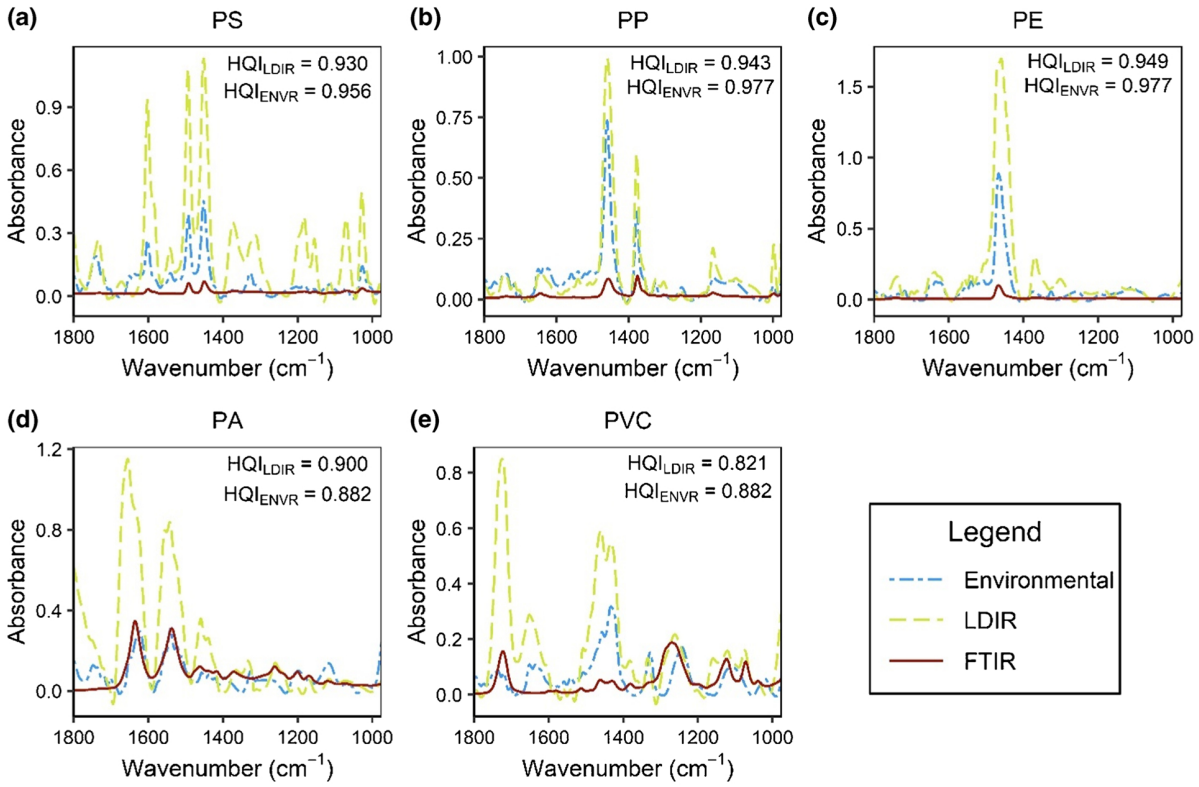
0.2 g of MPs was added to 10 mL PFAS stock solution consisting of PFBA, PFOA, PFBS, PFOS, and F-53B at 100 μg/L in concentration each. The mixture was mechanically agitated at 250 rpm using a thermostatic oscillator incubated at a constant temperature of 25 °C for 48 h. The supernatant samples were collected and underwent drying. Subsequently, ultrapure water was introduced into the tubes for the desorption experiment. The bottles were mechanically agitated at 250 rpm at a constant temperature of 25 °C for 48 h. All aqueous samples were then collected and filtered through 0.22μm PP filters and stored at 4 °C until analysis.

Instrumentation

The laser direct infrared imaging system (8700 LDIR, Chemical Imaging System, Agilent, USA) was used to identify the MPs

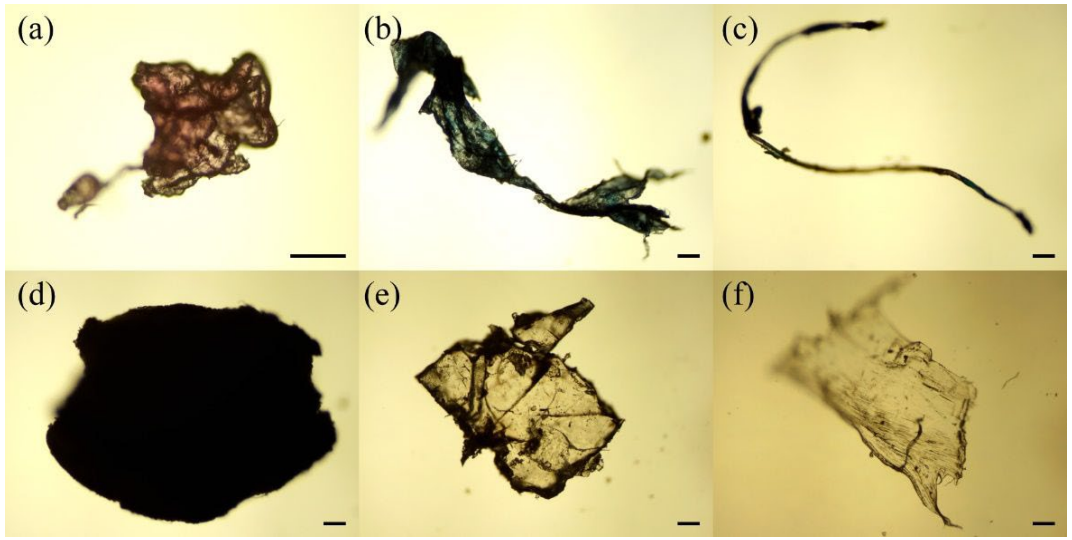
Triple quadrupole high-performance liquid chromatography tandem mass spectrometry (UPLC-MS/MS) system (AB SCIEX 5500, USA)

Results



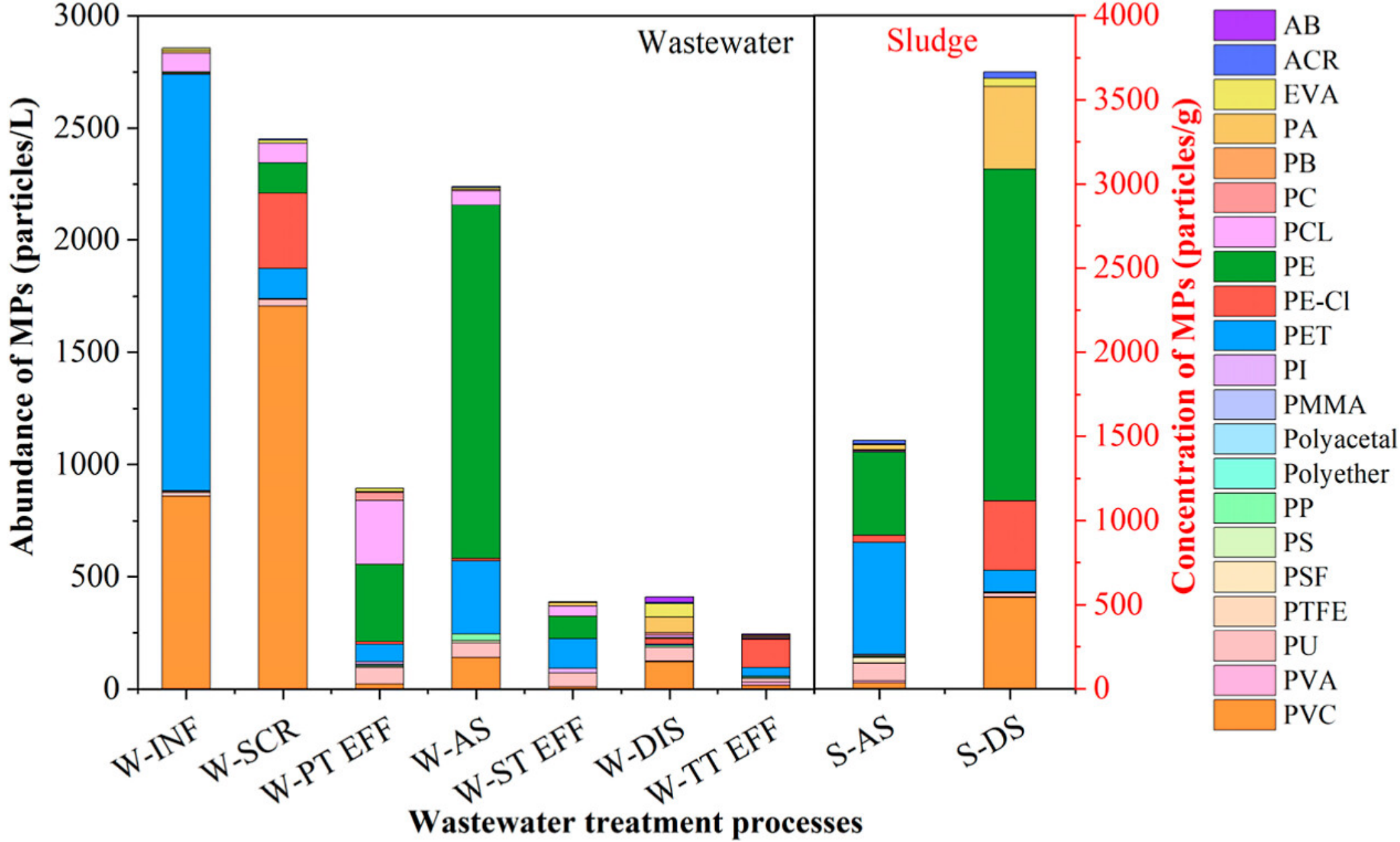
Comparison of LDIR to FTIR spectra and polymer standards to environmental particles' spectra. Polystyrene (PS), polypropylene (PP), polyethylene (PE), polyamide (PA), and polyvinylchloride (PVC) spectra are compared in plots a–e. FTIR (red) is the Center for Marine Debris Research (CMDR) Polymer Kit 1.0 spectra, LDIR (green) is the spectra measured of the CMDR polymers by the LDIR, and Environmental (blue) is a polymer identified within an environmental sample.

Fig. S3. Photographs of MPs taken under an optical microscope platform: influent (a), aqueous activated sludge (b) and effluent (c).

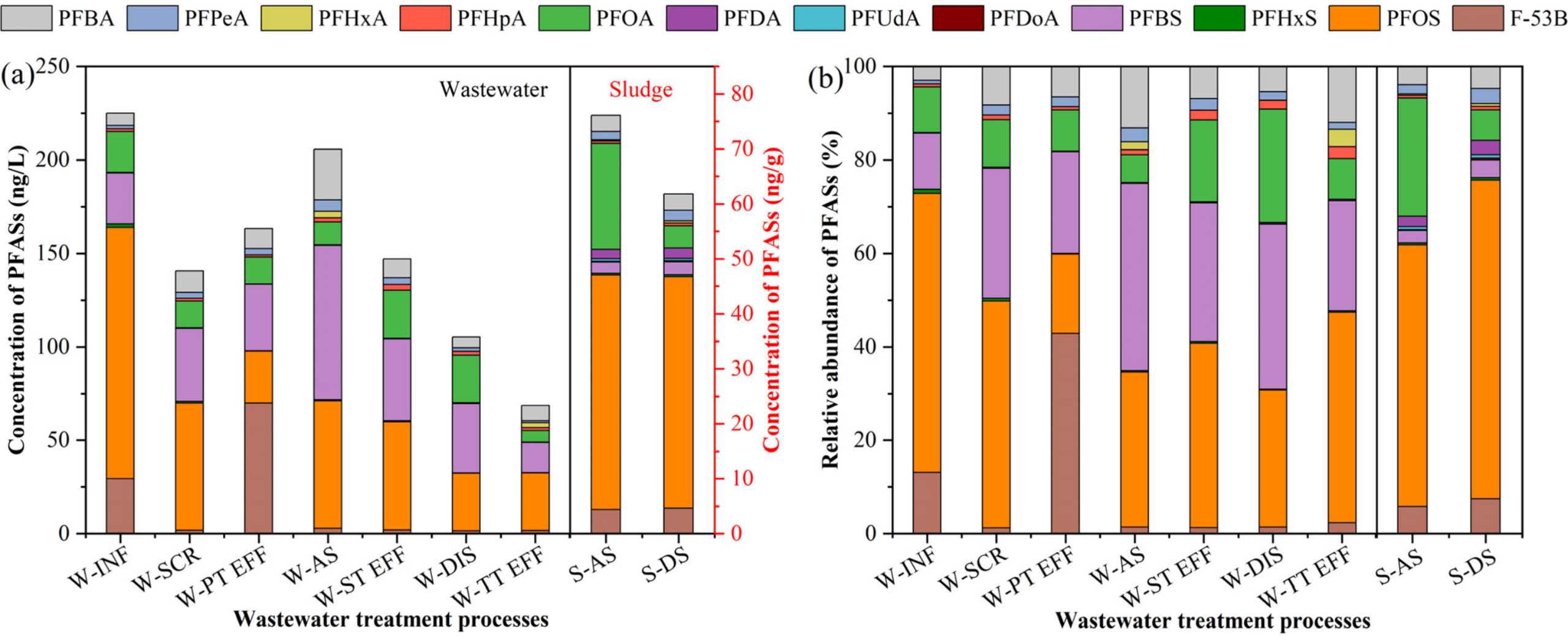


Photographs of MPs: granule (a), line (b), fiber (c), foam (d), flake (e), and film (f). The scale bars in all the photographs are 200 μm.

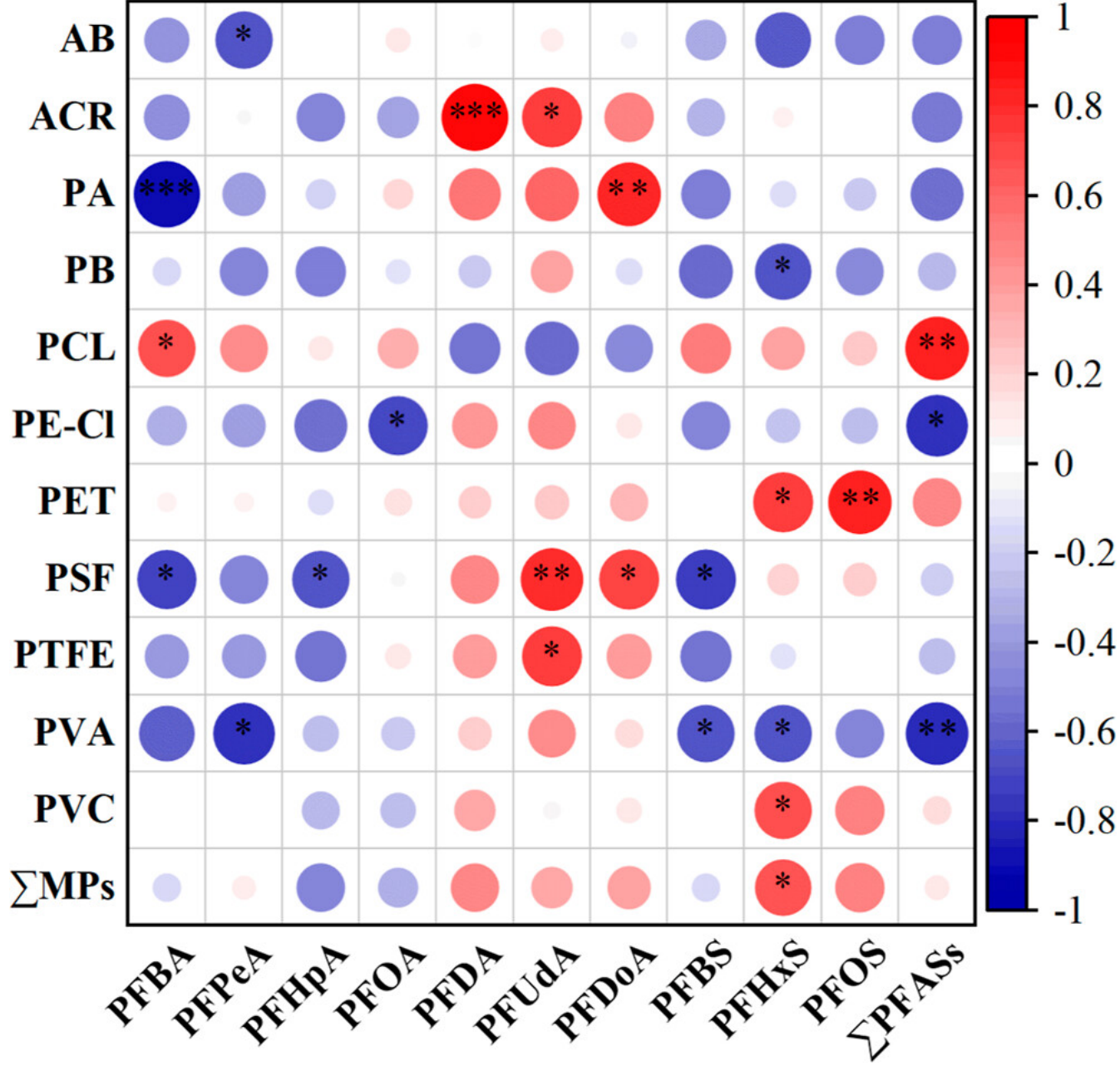
Whiting, Q. T. et al., Anal. Bioanal. Chem. 2022, 414 (29), 8353–8364.



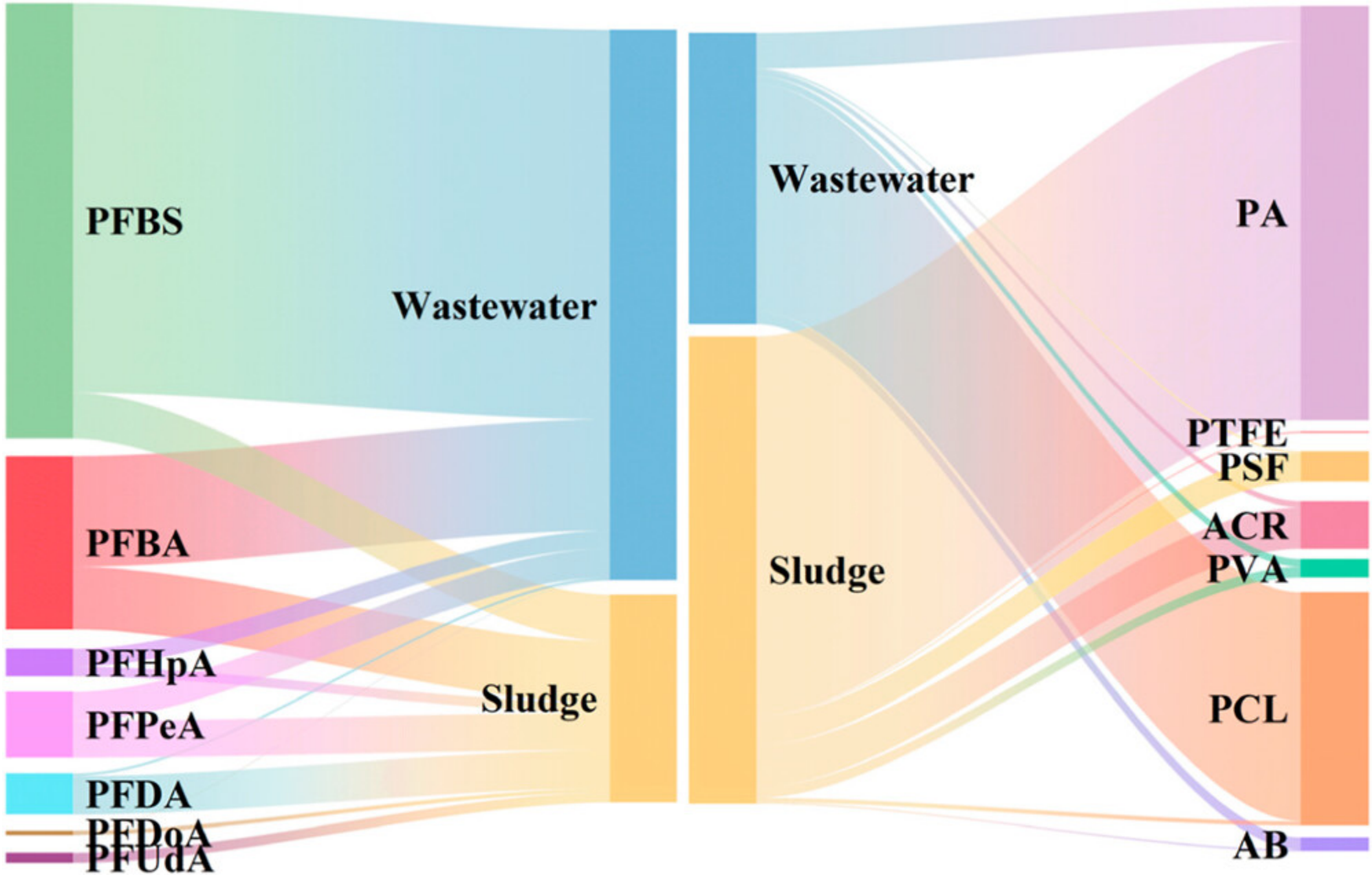
Abundance of MPs and the accumulated abundance of each type of polymer in wastewater samples and sludge samples in the target WWTP.

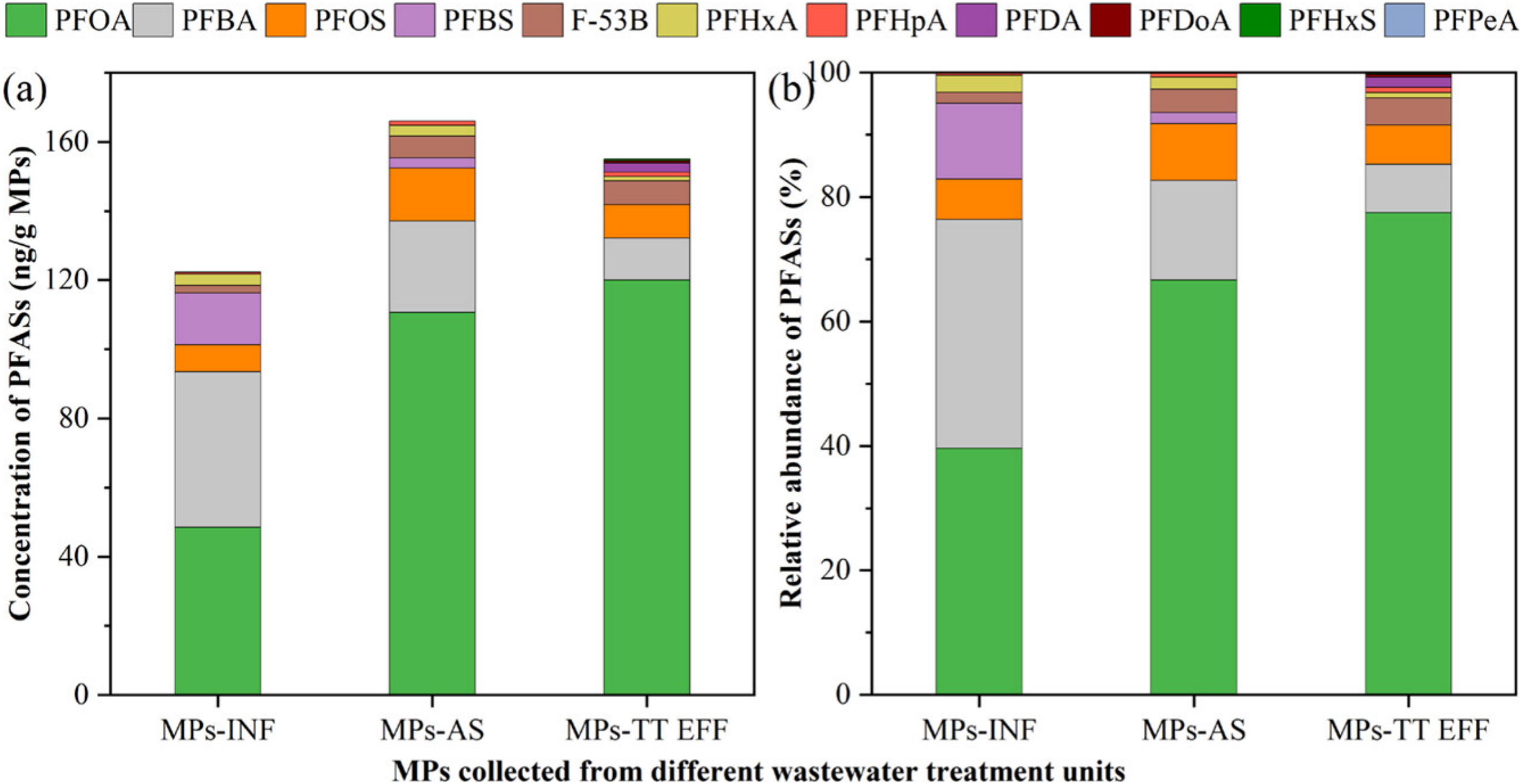


Concentration (a) and relative abundance (b) of PFASs in different wastewater treatment units

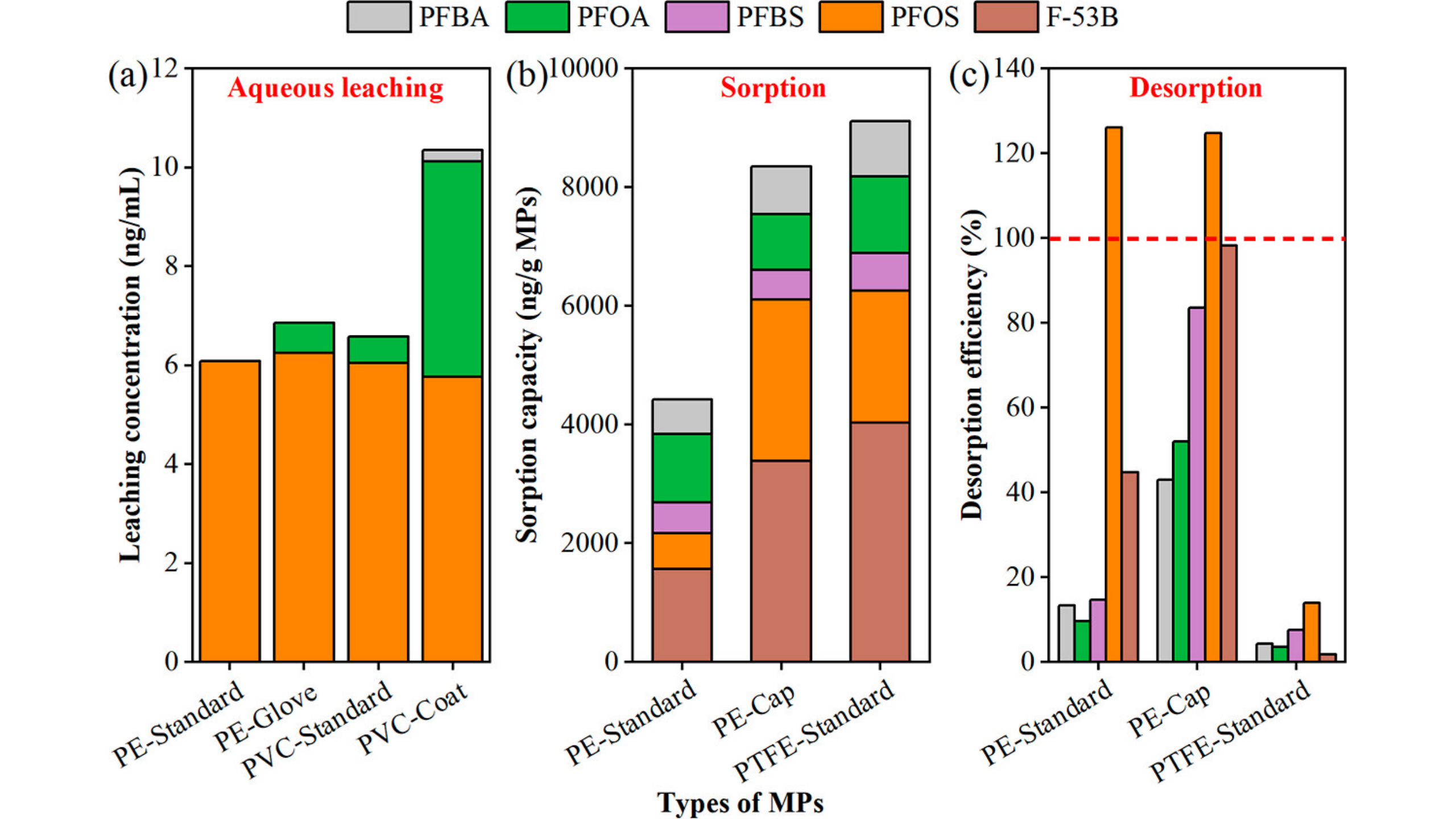


Spearman rank correlation matrix of PFASs and MPs in the WWTP. ***$p \leq 0.001$; ** $0.001 < p \leq 0.01$; * $0.01 < p \leq 0.05$.


PFBS
PFBA
PFHpA
PFPeA
PFDA
PFDoA
PFUdA
Wastewater
Sludge
Wastewater
Sludge
PA
PTFE
PSF
ACR
PVA
PCL
AB



Concentrations (a) and relative abundance (b) of PFASs associated with MPs.


PFBA
PFOA
PFBS
PFOS
F-53B
(a)
Aqueous leaching
Leaching concentration (ng/mL)
0
2
4
6
8
10
12
PE-Standard
PE-Glove
PVC-Standard
PVC-Coat
(b)
Sorption
Sorption capacity (ng/g MPs)
0
2000
4000
6000
8000
10000
PE-Standard
PE-Cap
PTFE-Standard
(c)
Desorption
Desorption efficiency (%)
0
20
40
60
80
100
120
140
PE-Standard
PE-Cap
PTFE-Standard
Types of MPs

Conclusions

1. MPs carry PFASs by both incorporating additives during production and sorbing contaminants from the environment.
2. Simultaneously, they can release PFASs into the environment through desorption and intrinsic leaching.
3. These findings revealed the dual roles of MPs as both carriers and sources of PFASs, providing crucial insights into the dynamic behavior of the two emerging pollutants.
4. The strong correlations between specific polymer types and PFAS congeners underscore the need for material-specific regulations in plastic production.