Microplastics in Chiang Mai University wastewater treatment plant: distribution and removal efficiencies

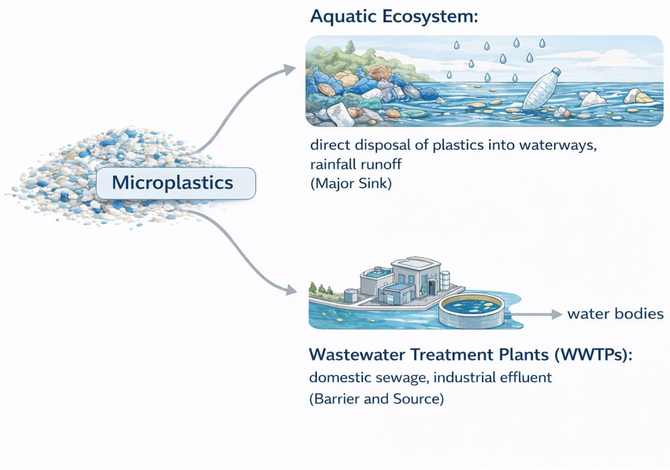
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INTRODUCTION



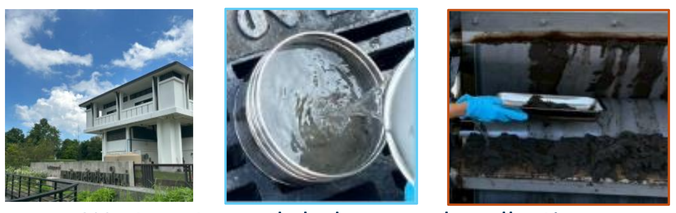
- **Microplastics (MPs)** are plastic particles < 5 mm, categorized into primary and secondary, and are persistent environmental contaminants. [1]
- **Wastewater Treatment Plants (WWTPs)** can act as both barriers and source of MPs. [2]
- Most studies focus on overall removal efficiency but limited information across different stages.
- The **Chiang Mai University (CMU) WWTP** still lacking detailed investigation of MPs distribution and removal efficiency across treatment stages.

OBJECTIVE

To assess the distribution and removal efficiencies of MPs across three major treatment stages (preliminary treatment, secondary treatment, and tertiary treatment) of the CMU wastewater treatment system

METHODS

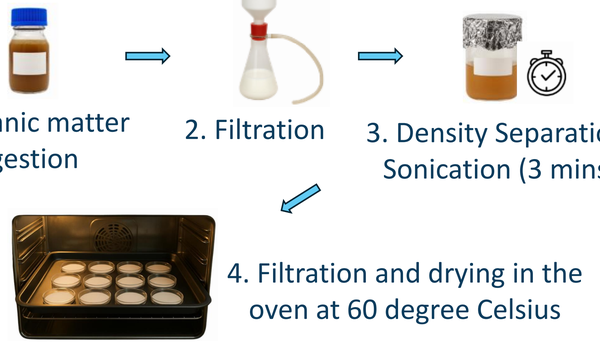
SAMPLE COLLECTION



Wastewater and sludge sample collection

SAMPLE PRETREATMENT

Wastewater



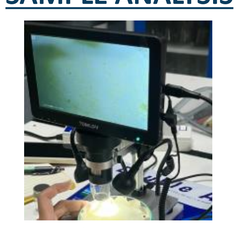
1. Organic matter digestion
2. Filtration
3. Density Separation, Sonication (3 mins)
4. Filtration and drying in the oven at 60 degree Celsius

Sludge

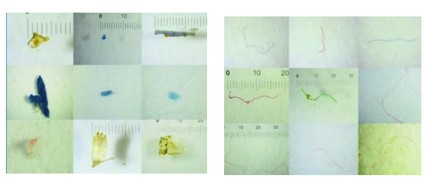
1. Drying
2. Density Separation
3. Organic Matter Digestion
4. Filtration and Drying

Organic Matter Digestion: **Fenton's Reagent** 1:1 ratio (20.0 mL of 0.05 M $FeSO_4 \cdot 7HO_2O$, 20.0 mL of 30 % H_2O_2)
Filtration: **Whatman No.93 filter paper** 110mm diameter
Density Separation: 5.73 M **NaCl** 100.0 mL

SAMPLE ANALYSIS



Digital Microscope



fragment

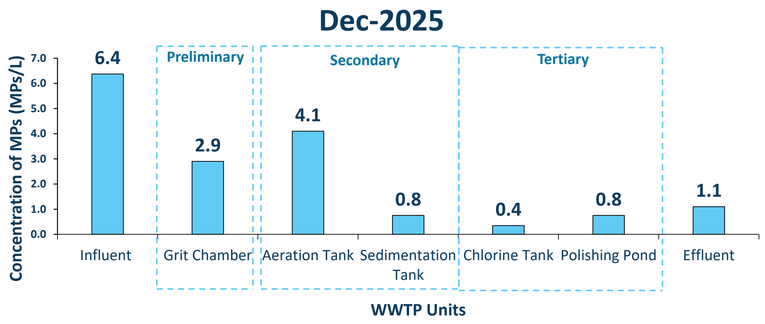
fibers

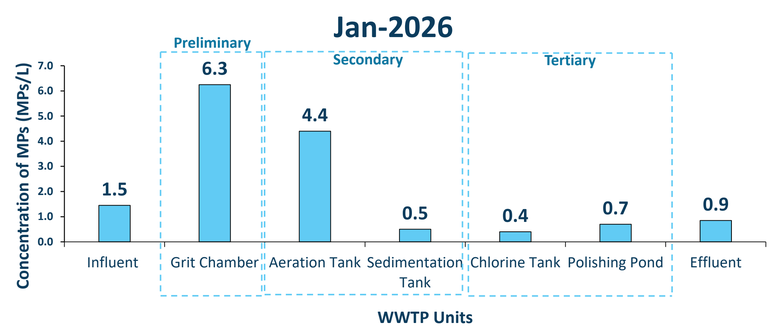


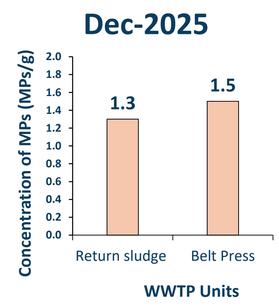
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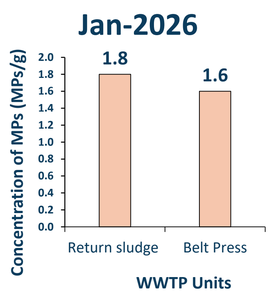
RESULTS AND DISCUSSION

Concentration of MPs across wastewater treatment stages





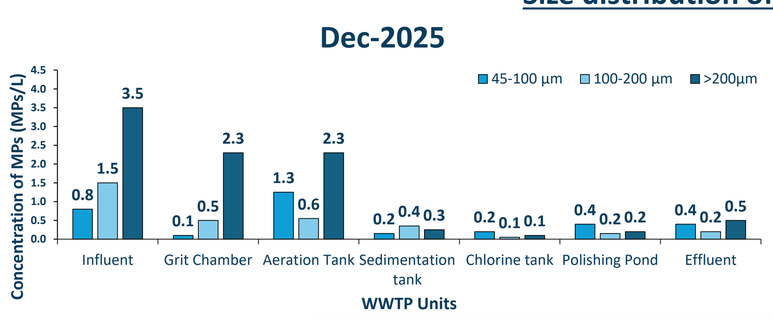


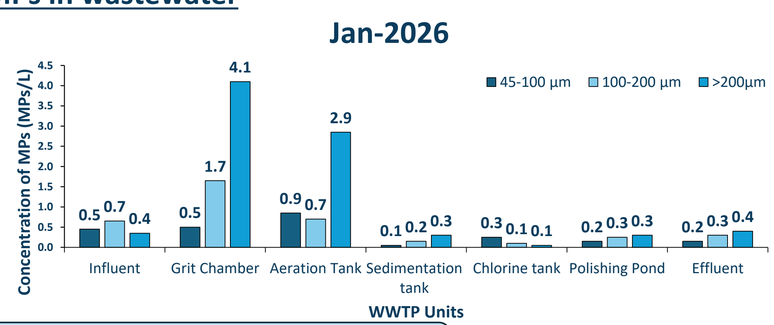


- Preliminary stage shows negative removal in Jan-2026.
- Secondary sedimentation achieves highest removal.

- MPs were detected in both return and dewatered sludge.
- Sedimentation transfers MPs from wastewater to sludge.
- Sludge acts as a major sink for MPs in WWTP.

Size distribution of MPs in wastewater

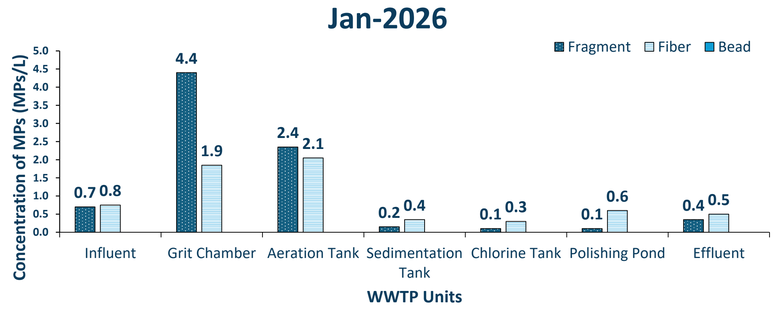


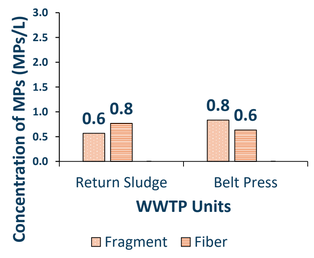


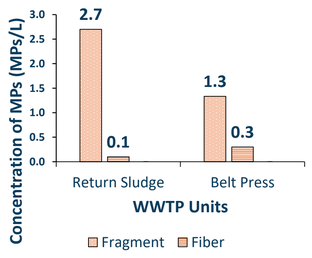
- Larger MPs (>200 µm) dominate the preliminary stage and show highest removal in secondary treatment
- Secondary sedimentation is the most effective stage, especially for larger particles

Morphological distribution of MPs in wastewater









- Fragments dominated in both months and are removed more than fibers, as they have different settling behaviors.
- Preliminary and tertiary stages cannot remove efficiently, and this can be likely due to redistribution or fragmentation of MPs.
- Presence of MPs after belt press confirms that sludge can act as a secondary pathway if they are reused as fertilizers in soil.

Removal Efficiencies of MPs

Dec-2025

Treatment Stage	Removal Efficiency (%)
Overall	82.7
Preliminary	54.5
Secondary	74.1
Tertiary	-46.7

Jan-2026

Treatment Stage	Removal Efficiency (%)
Overall	41.4
Preliminary	-331.0
Secondary	92.0
Tertiary	-70.0

- **Overall removal varied** between months (82.7% in Dec-2025; 41.4% in Jan-2026), indicating temporal fluctuations in MP loading and treatment performance.
- **Secondary treatment showed the highest removal efficiency** (74.1–92.0%), confirming it as the main stage responsible for MP reduction.
- **Negative removal values in preliminary and tertiary stages** suggest possible resuspension, fragmentation, or redistribution of MPs within the system.

CONCLUSIONS

- CMU WWTP acts as a partial barrier with an overall removal efficiency of ~62% but residual MPs are continuously discharged into receiving waters (Long-term discharge may contribute to environmental accumulation and ecosystem exposure).
- Secondary sedimentation is the most critical control point for MP removal (74.1~92.0 %)
- MPs were found to accumulate in sludge. Therefore, effective sludge management strategies are important to prevent MPs secondary pathways.

ACKNOWLEDGEMENT

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[2] Lian, Y., Wang, X., Sun, P., Wang, H., & Fang, C. (2025). Occurrence, characteristics and removal of microplastics in wastewater treatment plants with different treatment processes. Chinese Journal of Chemical Engineering. Advance online publication.