

1. ABSTRACT

Microplastic contamination in water is a growing concern, prompting the search for effective removal methods. This review illustrates magnetic extraction using magnetized magnetite nanoparticles. These nanoparticles show high adsorption capacity due to their large surface-to-volume ratio. Various oil-based ferrofluids used as surfactants enhance Fe₃O₄ efficiency. Optimal ferrofluid formulation (oil: magnetite ratio 1:2.5) achieved 98.05% microplastic removal from water. In artificial seawater, maximum removal rates reached 98%, and in pure water, up to 94%. Fe₃O₄ nanoparticles offer a cost-effective, sustainable solution for microplastic removal and show promise in purifying water from other contaminants like carcinogens, organic dyes, bacteria, and heavy metals.

2. INTRODUCTION

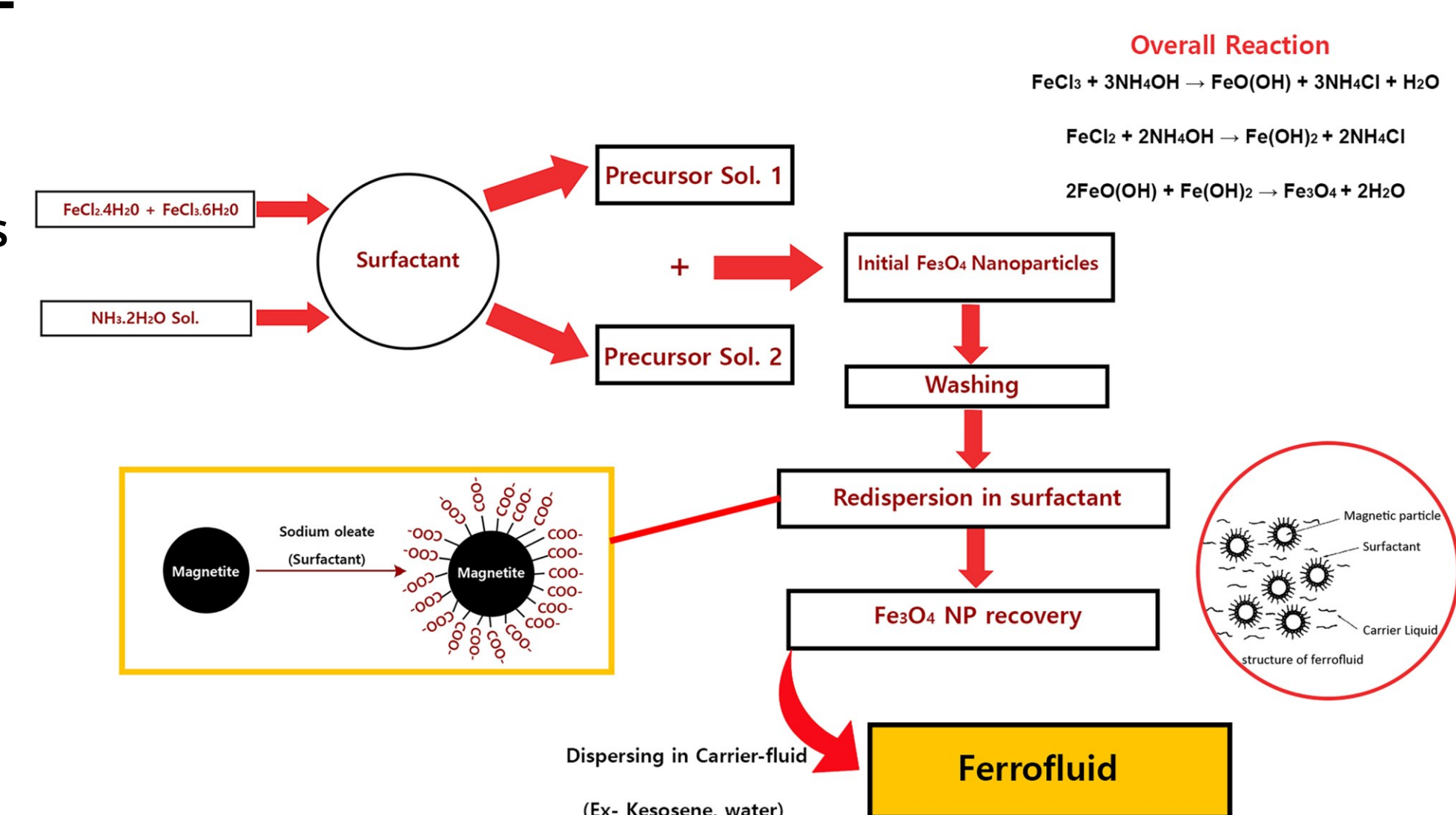
Microplastics (MPs) are a growing global concern, garnering significant attention from both the scientific community and the public. They originate from various sources, including synthetic fibers, industrial processes, household dust, and plastic surface degradation. Fibers account for 52.7% of microplastics in municipal wastewater treatment plants. Additionally, the use of microbeads and resin pellets in products like personal care items and cosmetics further increases microplastic emissions into wastewater treatment plants through municipal effluent discharge systems. These plastic particles, ranging in diameter from 1µm to 5 mm, are collectively termed microplastics. Various methods exist for microplastic removal. Al-based salts use coagulation to remove polyethylene microplastics, though with less than 40% efficiency. Biochar filtration achieves over 95% efficiency in immobilizing 10-µm-diameter microplastic spheres. Sedimentation in wastewater treatment plants effectively removes plastic particles sized 27 to 149 µm. Grbić et al. introduced a magnetic extraction method, involving magnetizing plastics with Fe-coated nanoparticles like iron oxide or magnetite (Fe₃O₄), preferred for their low toxicity and super-paramagnetic properties. These nanoparticles exhibit high effectiveness in hydrocarbon removal from water. Additionally, small super-paramagnetic magnetite nanoparticles offer cost-effectiveness, high sorption rates, and reusability. Nano-ferrofluid, with its high surface area, is promising for industrial applications such as oil spill cleanup. Chen et al. demonstrated its efficacy in anionic dye removal, achieving 95% adsorption capacity in 2 minutes. Microplastics, harmful to both humans and animals, contain additives like dyes and plasticizers, notably phthalates, linked to toxicity, carcinogenicity, and mutagenicity. Phthalates, prevalent in household dust, human urine, and breast milk, show associations with asthma/allergy occurrence, especially in children, and shorter pregnancy durations. Bisphenol-A (BPA) shares similar reproductive toxicity, while polyvinyl chloride (PVC) is considered highly toxic due to its carcinogenic monomer and hazardous additives. Studies reveal microplastics' and their additives' cytotoxic, oxidative stress-inducing, and allergen-producing effects at a cellular level, particularly with polypropylene microplastics.

3. METHODOLOGY

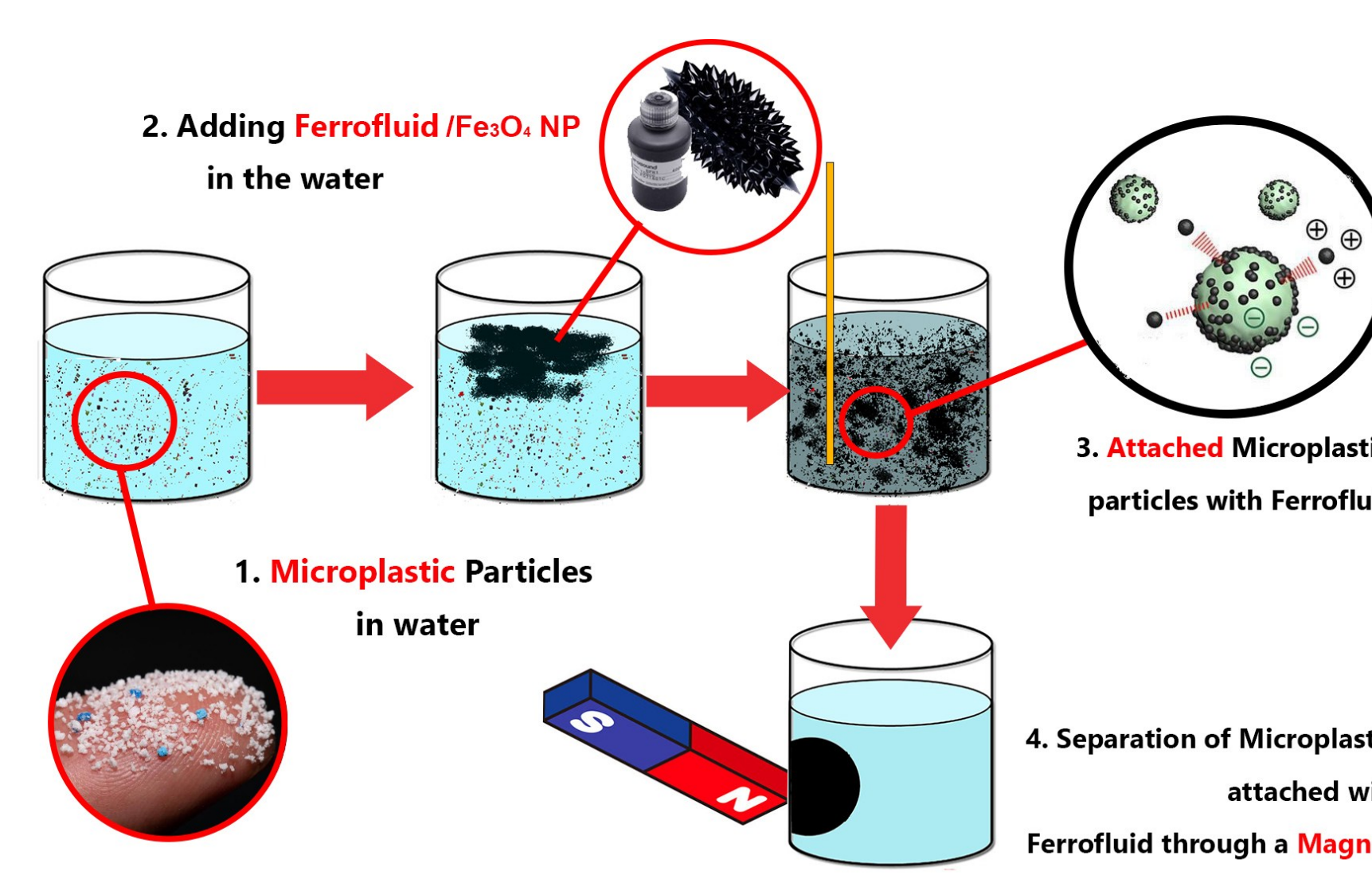
3.1. SYNTHETIC PROCEDURE

- Preparation materials
- Stabilization with surfactants
- Heating and Reaction
- Cooling and Precipitation
- Washing and Purification
- Dispersion in Carrier Fluid

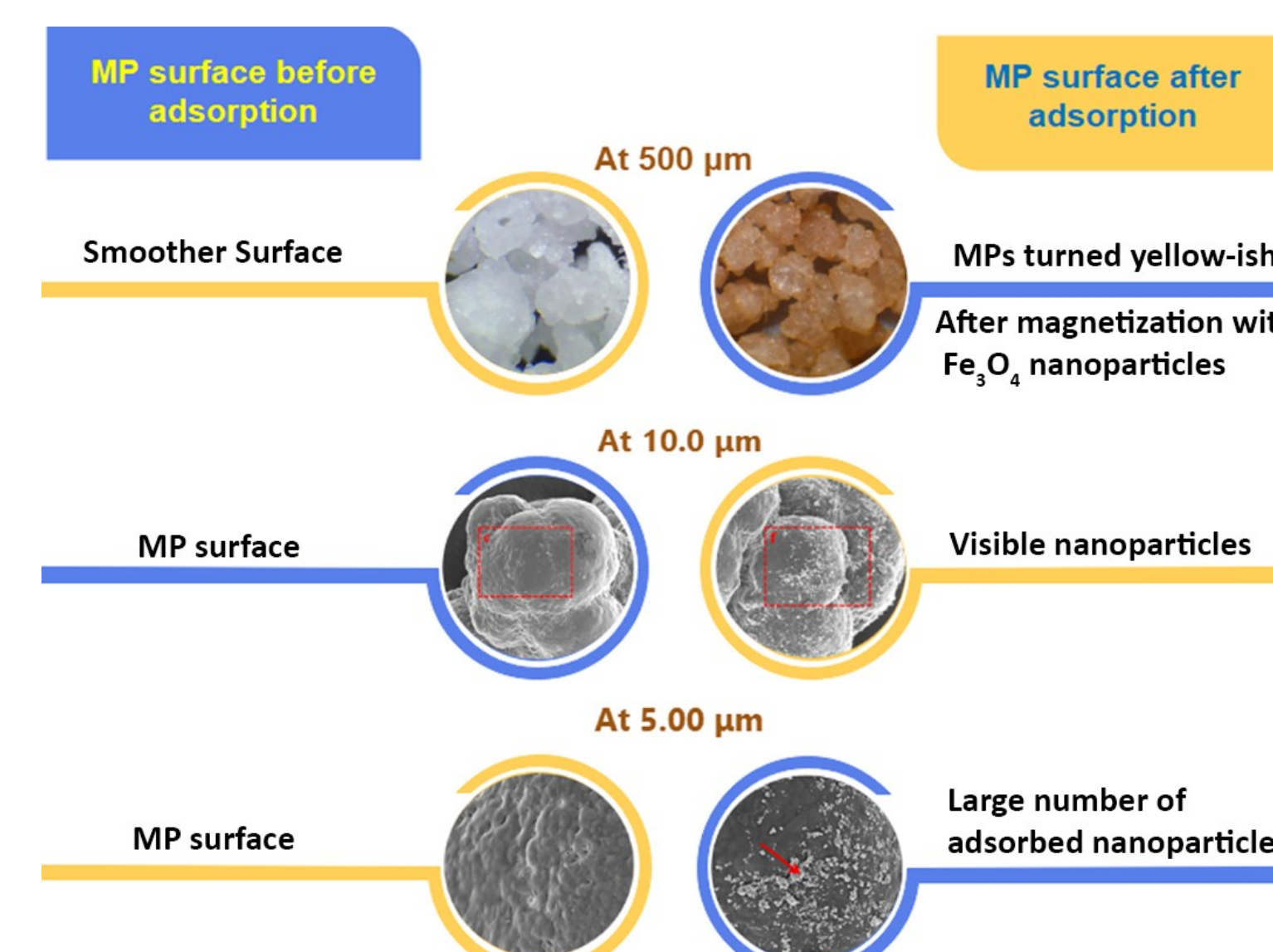
3.2. SYNTHESIS & CHARACTERIZATION



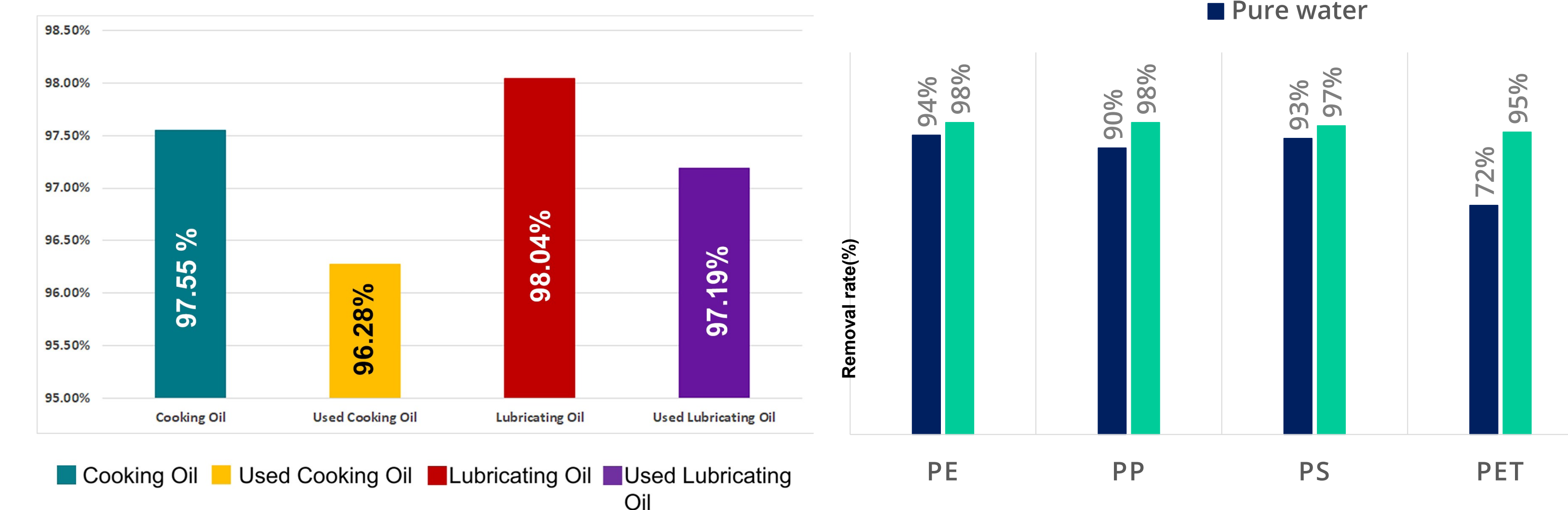
3.3. MECHANISM



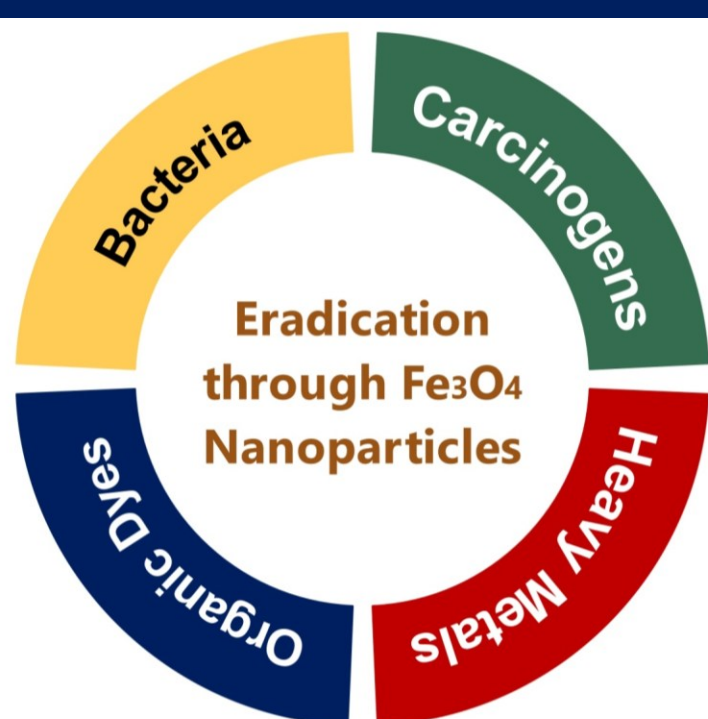
4. MORPHOLOGICAL STUDY



5. RESULT ANALYSIS

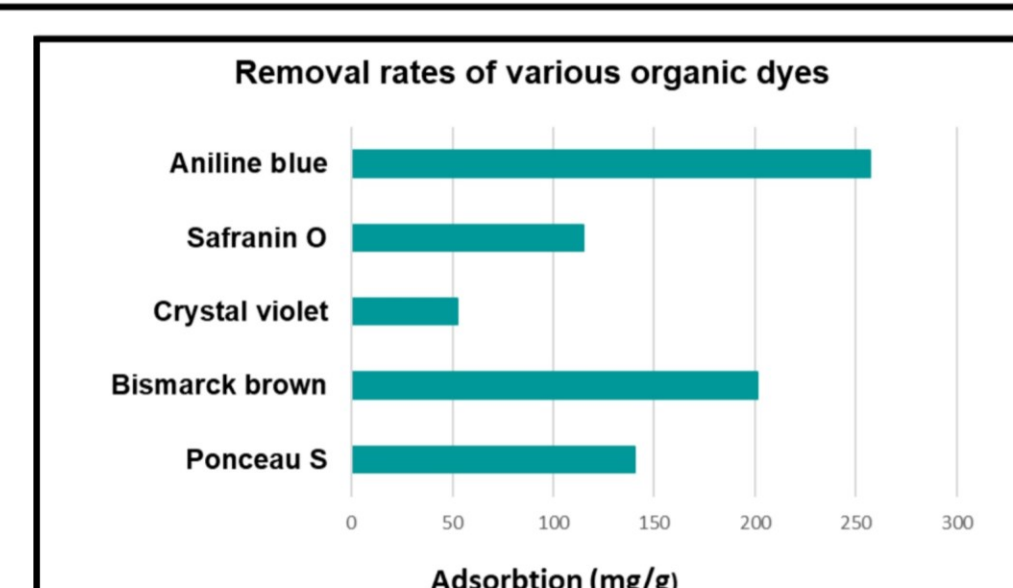
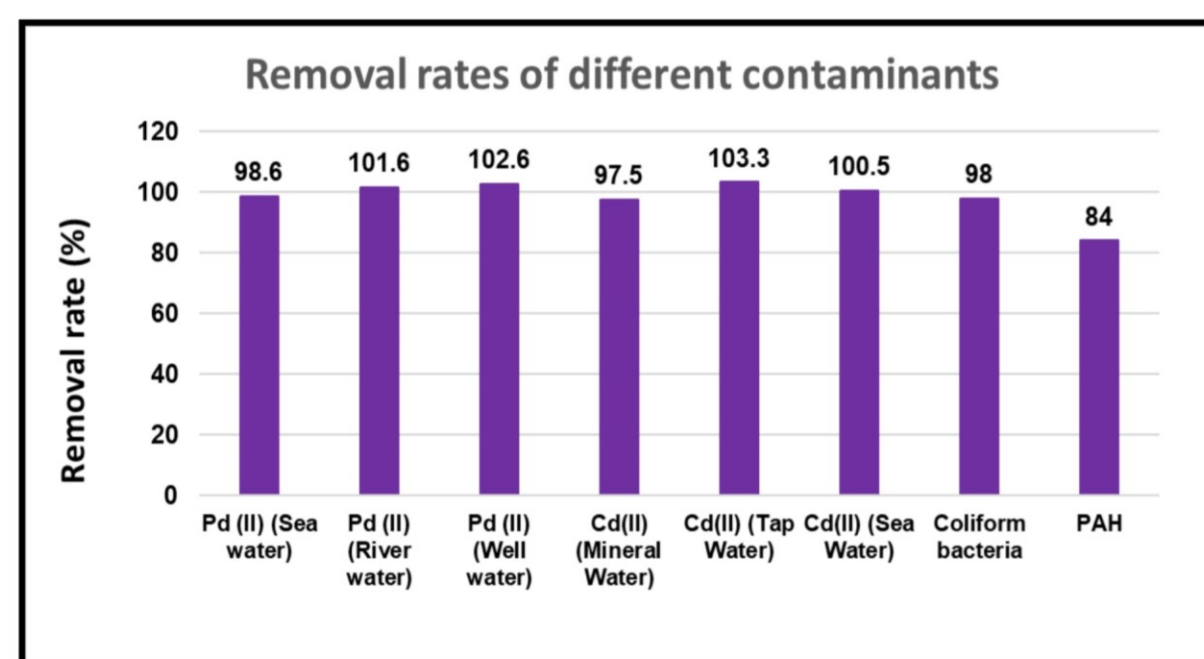


6. FUTURE ASPECTS



Discussion Snippets

- Fe₃O₄ Nanoparticles is cheap, sustainable and can be easily produced.
- Due to different contaminant removal abilities, it can be used as a versatile water purifier.
- More studies needs to be done using diverse contaminants.



7. CONCLUSION

- Fe₃O₄ nanoparticles show high efficiency in removing microplastics.
- Their magnetic separation ability makes the process cost-effective and reusable.
- Potential for scalability in water treatment systems.
- Environmental impact and stability still need more research.
- Represents a sustainable and innovative solution to microplastic pollution.

8. ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to Dr. Sofiah Hamzah and the Environmental Sustainable Material Research Interest Group, Faculty of Ocean Engineering Technology & Informatics, Universiti Malaysia Terengganu, Malaysia, whose research contributions formed the core basis of this presentation. We also acknowledge the Department of Chemistry, University of Chittagong, for academic guidance and support, and extend our appreciation to our peers for their encouragement during the preparation of this work.

9. REFERENCES

- Blackburn, K., & Green, D. (2022). The potential effects of microplastics on human health: What is known and what is unknown. *Ambio*, 51(3), 518-530.
- Martin, L. M., Sheng, J., Zimba, P. V., Zhu, L., Fadare, O. O., Haley, C., ... & Xu, W. (2022). Testing an iron oxide nanoparticle-based method for magnetic separation of nanoplastics and microplastics from water. *Nanomaterials* 12 (14): 2348.
- Frias, J. P., & Nash, R. (2019). Microplastics: Finding a consensus on the definition. *Marine pollution bulletin*, 138, 145-147.
- Hamzah, S., Ying, L. Y., Azmi, A. A. A. R., Razali, N. A., Hairom, N. H. H., Mohamad, N. A., & Harun, M. H. C. (2021). Synthesis, characterisation and evaluation on the performance of ferrofluid for microplastic removal from synthetic and actual wastewater. *Journal of Environmental Chemical Engineering*, 9(5), 105894.
- Nizam, N., Mohanasunthar, S., Azmi, A. A., Anuar, S. T., Ibrahim, Y. S., & Khalik, W. M. A. W. M. (2023). Removal efficiency for micro-polystyrene in water by the oil-based ferrofluid employ response surface methodology. *Sains Malaysiana*, 52(8), 2191-2207.