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# $PbO_2$ Potential in Anodic Oxidation for Microplastics Removal from Bay Water in the Philippines

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## INTRODUCTION & AIM

A piece of plastic with a longest dimension smaller than 5 mm to 1 µm is referred to as microplastics. These plastics have become more abundant over time in our aquatic environment, being detected on the surface of every ocean, as well as in almost all beaches in the world [1].

Microplastics are ubiquitous environmental pollutants that may be harmful to ecosystem as well as human health [2].

Numerous methods for removing microplastics have been developed in response to their adverse effects.

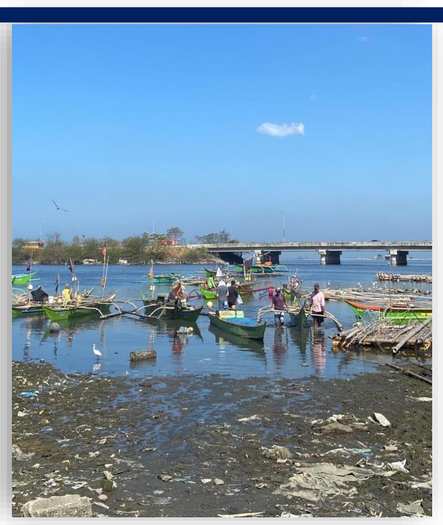


Fig 1. Bacoor Bay, Philippines

Anodic oxidation is one chemical treatment that has been shown to be successful in eliminating microplastics. Anodic oxidation produces hydroxyl (•OH) radicals that break the polymeric bonds of microplastics, leading to their degradation into nontoxic molecules, such as $CO_2$ and $H_2O$, without the need for adding chemicals that may also lead to another form of pollution [3].

This study assessed the anodic oxidation process's potential to lower the amount of microplastics in Bacoor Bay water samples by employing $PbO_2$ as the anode. The efficiency of $PbO_2$ anode in anodic oxidation will be based on the removal of microplastics and suspended particles.

## METHOD

Collection of water samples
↓
Physical Characterization of Microplastics
↓
Pre-treatment Quantification of Microplastics
↓
Anodic Oxidation using $PbO_2$
↓
Post-treatment Quantification of Microplastics
↓
Testing of Additional Water Parameters (Pb, pH & COD)
↓
Evaluation of Anodic Oxidation Results

Fig 2. Methodological Framework

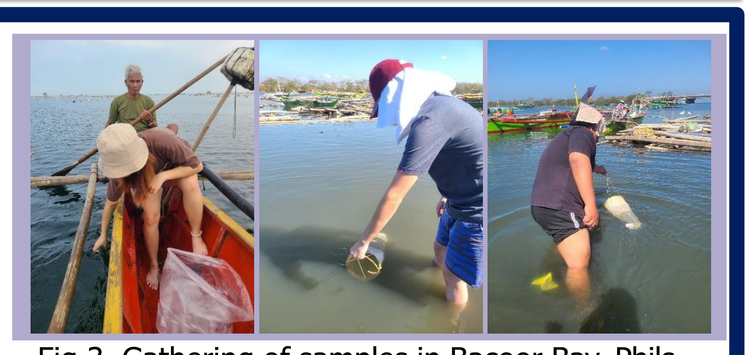


Fig 3. Gathering of samples in Bacoor Bay, Phils.

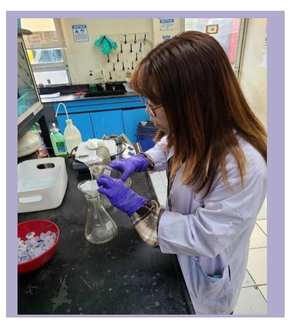


Fig 4. Filtration of actual water samples.

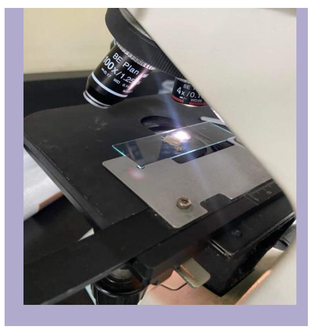


Fig 5. Visual inspection for identifying microplastics using a microscope.

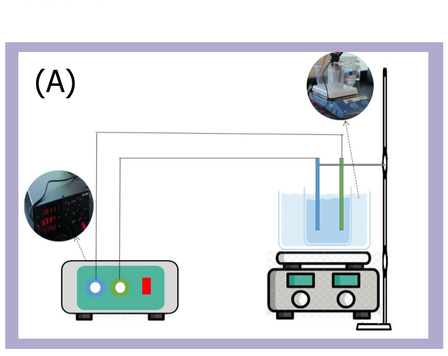



Fig 6. (a) Schematic diagram and (b) actual anodic oxidation setup

The microplastics and turbidity removal efficiencies were calculated following the Equations (1) and (2).

$$\text{microplastic removal efficiency (\%)} = \frac{\text{initial weight} - \text{final weight}}{\text{initial weight}} \times 100 \quad (1)$$

$$\text{turbidity removal efficiency (\%)} = \frac{\text{initial turbidity} - \text{final turbidity}}{\text{initial turbidity}} \times 100 \quad (2)$$

## RESULTS & DISCUSSION

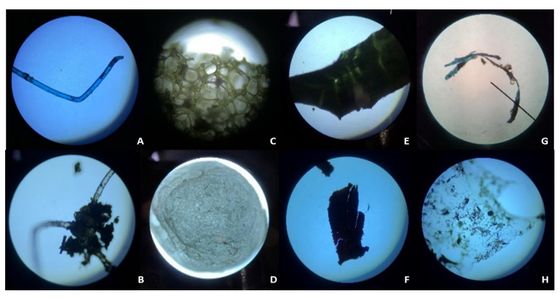
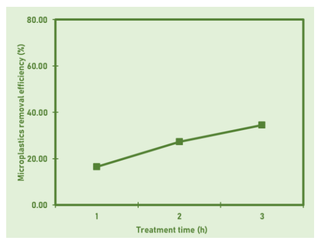


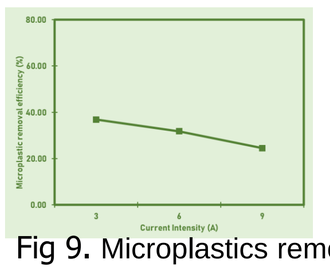

Fig 7. Micrographs of microplastics

**Characterization of microplastics**
A: shape-fiber; size-5mm; color-blue
B: shape-fiber; size-3mm; color-transparent
C: shape-foam; size-4 mm; color-yellow
D: shape-pellet; size-1 mm; color-white
E: shape-fragment; size-5 mm; color-green
F: shape-film; size-2 mm; color-red
G: shape-fiber; size-5 mm; color-blue
H: shape-film; size-4 mm; color-transparent



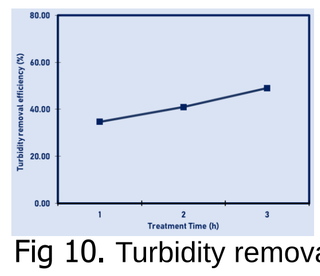

- ✓ Longer reaction time ensures complete oxidation reaction to proceeds.
- ✓ More or enough •OH radicals were produced after 3 h to attack and biodegrade microplastics.

Fig 8. Microplastics removal efficiency at different reaction time.



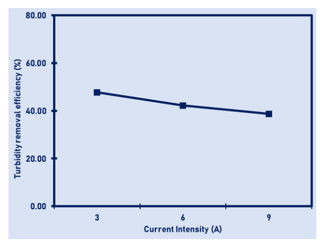

- ✓ Higher current intensities cause more reactive oxygen species, leading to a higher removal efficiency.
- ✓ However, the $PbO_2$ anode in the solution may have degraded thermally as a result of the heat generated during the process causing a lower efficiency.

Fig 9. Microplastics removal efficiency at different current intensities.




- ✓ The increased in reaction time has increased the turbidity removal efficiency using $PbO_2$ anode

Fig 10. Turbidity removal efficiency at different reaction time.




- ✓ As the current intensity increased from 1 A to 3 A, the efficiency of removing turbidity decreased by 9.01 %.
- ✓ An increase in the heat of reaction may have resulted in the resistance of the suspended particles to coagulate.

Fig 11. Turbidity removal efficiency at different current intensities.

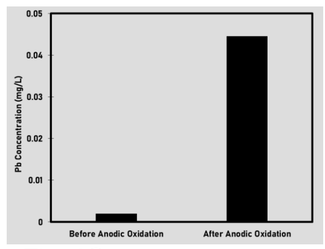



Fig 12. Pb concentration (3 Amperes and 3 hours).

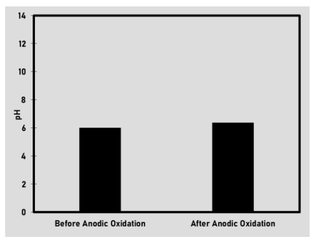



Fig 13. pH readings (3 Amperes and 3 hours)

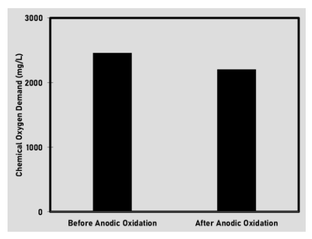



Fig 14. Chemical Oxygen Demand (COD) concentrations (3 Amperes and 3 hours)

## CONCLUSION

The potential of anodic oxidation with a $PbO_2$ anode to lower the concentration of suspended solids and microplastics in a bay water sample has been demonstrated in this study. Anodic oxidation with $PbO_2$ anode was able to reduce the microplastics concentration from Bacoor Bay, Cavite water sample with a 42.53% removal efficiency. This has been supported by the reduced COD readings after the treatment.

## FUTURE WORK / REFERENCES

[1] Crawford, C. B., & Quinn, B. (2016). *Micro plastic pollutants*. Elsevier Science.
[2] L. An, Q. Liu, Y. Deng, W. Wu, Y. Gao, and W. Ling, "Sources of microplastic in the environment," in *Microplastics in terrestrial environments*, W. Ling, Ed. Cham: Springer, 2020, pp. 143–159.
[3] S. Martic, M. Tabobondung, S. Gao and T. Lewis, "Emerging electrochemical tools for microplastics remediation and sensing," *Frontiers in Sensors*, vol. 3, August 2022.