MINERALIZATION AND DETOXIFICATION OF DYEING WASTEWATER USING INTEGRATED OZONATION AND BIOREACTOR SYSTEM

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by

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high initial dye concentrations. Under the optimized conditions at an initial dye concentration of ~4.4g/L, the cost of electricity consumption was found to be reduced significantly (by ~25-30 %). Therefore, this study recommended having a dye-enriching step for the regular textile effluent to achieve the desired dye loading before performing the ozonation.

Finally, when the ozonation was integrated with anaerobic/ aerobic biological treatment to improve the overall dye removal efficiency, processing time, and toxicity, it was noted that the anaerobic biodegradation and ozonation processes, both, resulted in high (>95%) color removal. The ozonation process offered faster color removal than the anaerobic process; however, the latter offered a higher COD and toxicity reduction. Therefore, the proposed strategy for textile wastewater treatment comprises ozonation as the first step primarily for rapid color removal, with a subsequent biodegradation step for meeting the mineralization and detoxification targets. A combined phyto- and geno-toxicity assays as suggested in this work should be used to evaluate the toxicity of the treated dyeing water.

Future work may focus on the scale-up study of the proposed ozonated-bioremediation approach to degrade azo dyes of the textile wastewater at high volume. To enrich the dye concentration before ozonation, a pretreatment step (maybe a physical method) should be explored. A consortium of potent microbes identified from the actual textile effluent discharge site may be used to accelerate the biodegradation further. Other avenues, apart from irrigation, gardening, or washing, where the treated dyeing water may be used as a raw material may be explored.

9 Bibliography

Abdellah, M. H., S. A. Nosier, A. H. El-Shazly, and A. A. Mubarak. 2018. "Photocatalytic decolorization of methylene blue using TiO2/UV system enhanced by air sparging." *Alexandria Engineering Journal* 57 (4):3727-35. doi: https://doi.org/10.1016/j.aej.2018.07.018.

Abu Talha, Md, Mandavi Goswami, B. S. Giri, Anjaney Sharma, B. N. Rai, and R. S. Singh. 2018. "Bioremediation of Congo red dye in immobilized batch and continuous packed bed bioreactor by Brevibacillus parabrevis using coconut shell bio-char." *Bioresour Technol* 252:37-43. doi: https://doi.org/10.1016/j.biortech.2017.12.081.

Agarry, S. E., T. O. K. Audu, and B. O. Solomon. 2009. "Substrate inhibition kinetics of phenol degradation by Pseudomonas fluorescence from steady state and wash-out data." *International Journal of Environmental Science & Technology* 6 (3):443-50. doi: 10.1007/BF03326083.

Ahmad, Akil, Siti Hamidah Mohd-Setapar, Chuo Sing Chuong, Asma Khatoon, Waseem A. Wani, Rajeev Kumar, and Mohd Rafatullah. 2015. "Recent advances in new generation dye removal technologies: novel search for approaches to reprocess wastewater." *RSC Advances* 5 (39):30801-18. doi: 10.1039/C4RA16959J.

Aiba S Fau - Shoda, M., M. Shoda M Fau - Nagatani, and M. Nagatani. "Kinetics of product inhibition in alcohol fermentation. Reprinted from Biotechnology and Bioengineering, Vol. X, Issue 6, Pages 845-864 (1968)." (0006-3592 (Print)).

Ajmal, Anila, Imran Majeed, Riffat Naseem Malik, Hicham Idriss, and Muhammad Amtiaz Nadeem. 2014. "Principles and mechanisms of photocatalytic dye degradation on TiO2 based photocatalysts: a comparative overview." *RSC Advances* 4 (70):37003-26. doi: 10.1039/C4RA06658H.

Amaral, F. M., M. T. Kato, L. Florêncio, and S. Gavazza. 2014. "Color, organic matter and sulfate removal from textile effluents by anaerobic and aerobic processes." *Bioresour Technol* 163:364-9. doi: 10.1016/j.biortech.2014.04.026.

Ameta, Rakshit, Anil K. Chohadia, Abhilasha Jain, and Pinki B. Punjabi. 2018. "Chapter 3 - Fenton and Photo-Fenton Processes." In *Advanced Oxidation Processes for Waste Water Treatment*, edited by Suresh C. Ameta and Rakshit Ameta, 49-87. Academic Press.

Ananthashankar, A. E. 2013. "Production, Characterization and Treatment of Textile Effluents: A Critical Review." *Journal of Chemical Engineering & Process Technology* 05. doi: 10.4172/2157-7048.1000182.