**Enhanced Fenton-like Oxidation for Pollutant Removal via Zn-BDC/Graphene Oxide Composite Catalyst**

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| **Abstract**  This study developed a Fenton-like oxidation method for the removal of bromophenol blue (BPB) dye from wastewater. Graphene oxide (GO) loaded Zn-BDC (Zn-benzenedicarboxylate) was used as the catalyst. The high surface area of GO and the porous structure of Zn-BDC enhanced the efficiency of the catalyst, enabling the rapid and effective removal of BPB. Reaction conditions, including catalyst dosage, and oxidant concentration, were optimized to achieve maximum removal efficiency.  The effect of H₂O₂ concentration was also investigated, revealing that an optimal concentration of H₂O₂ significantly improved the degradation efficiency of BPB. However, excessive H₂O₂ led to a scavenging effect, reducing the overall removal efficiency. Therefore, maintaining an appropriate H₂O₂ dosage was crucial for achieving maximum catalytic performance (Nie et al., 2020). The effect of catalyst dosage was evaluated, showing that an increase in catalyst dosage resulted in enhanced removal efficiency of BPB up to a certain point. Beyond this optimal dosage, the increase in catalyst amount had a negligible effect on removal efficiency, likely due to the saturation of active sites(Zhu et al., 2019). Therefore, the catalyst dosage was optimized to balance between efficiency and economic feasibility.  Scanning Electron Microscopy (SEM) analysis revealed that the GO-loaded Zn-BDC catalyst had a well-distributed, porous structure, which contributed to its high catalytic activity. According to the SEM analysis the weight percentage of the elements were found as 48.5, 3,8, 21.4 and 26.3 % for C, N, O and Zn respectively.  The SEM images of Zn-BDC@GO shows, the agglomeration of stacked graphene sheets is evident, resulting from strong specific interactions and dispersive forces between the surface groups on the graphene-like layers. The Zn-BDC@GO exhibits a porous and interconnected structure with square and lamellar formations distributed across the graphene sheets.  Fourier Transform Infrared Spectroscopy (FTIR) analysis confirmed the successful loading of graphene oxide onto the Zn-BDC framework. Characteristic peaks were observed at 1720 cm⁻¹ (carbonyl group of GO), 1600 cm⁻¹ (C=C stretching in GO), and 1380 cm⁻¹ (carboxylate groups of Zn-BDC), indicating strong interactions between the two components(Cheng et al., 2022; Yu et al., 2020). In addition, several peaks related to the benzene ring vibration and out-of-plane vibrations of the carboxylate groups were appeared for Zn-BDC at 1630 cm−1 and in 1250–600 cm−1, respectively.  Brunauer-Emmett-Teller (BET) surface area analysis revealed that the GO-loaded Zn-BDC catalyst exhibited a high specific surface area of 897.351 m²/g, providing abundant active sites for the degradation of BPB.  Pore volume and pore radius were found as 0.03 cc/g and 1.908 nm, respectively. The results demonstrated that the GO-loaded Zn-BDC catalyst exhibited high efficiency in BPB removal, with a maximum removal of 95%, making it a promising method for sustainable wastewater treatment. The study also provided analyses on the reusability and stability of the catalyst, highlighting its economic and environmental applicability.  **References:**  [1] Cheng, Y., Luo, Y., Zheng, Y., Pang, J., Sun, K., Hou, J., Wang, G., Guo, W., Guo, X., & Chen, L. ((2022). Self-supporting one-dimensional ZnFe-BDC for electrocatalysis oxygen evolution reaction in alkaline and natural seawater, *International Journal of Hydrogen Energy 47*(84), 35655–35665.  [2] Nie, M., Li, Y., He, J., Xie, C., Wu, Z., Sun, B., Zhang, K., Kong, L., & Liu, J. (2020). Degradation of tetracycline in water using Fe3O4 nanospheres as Fenton-like catalysts: Kinetics, mechanisms and pathways. *New Journal of Chemistry*, *44*(7), 2847–2857.  [3] Yu, W., Sisi, L., Haiyan, Y., & Jie, L. (2020). Progress in the functional modification of graphene/graphene oxide: A review. *RSC Advances*, *10*(26), 15328–15345.  [4] Zhu, J., Zhu, Z., Zhang, H., Lu, H., & Qiu, Y. (2019). Efficient degradation of organic pollutants by peroxymonosulfate activated with MgCuFe-layered double hydroxide. *RSC Advances*, *9*(4), 2284–2291. |

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