Contribution ID: **77** Type: **Oral presentation**

Treatment of reactive blue dye textile wastewater using copper based metal organic framework

Dyes in wastewater pose significant environmental risks due to their persistence and resistance to conventional biochemical treatment methods. Photocatalytic degradation is an advanced oxidation process that is a sustainable and cost-effective method for dye degradation. In this study, a copper-based metal-organic framework (Cu-MOF), [Cu(4,4'-bipy)Cl]n, was synthesized via a hydrothermal method using 4,4'-bipyridine as a ligand and used to photodegrade reactive blue dye under natural sunlight. The MOF material was characterized through Fourier Transform Infrared Spectroscopy (FTIR) for chemical composition, Scanning Electron Microscopy (SEM) for morphology, X-ray Diffraction (XRD) for crystallinity, and UV–Vis Diffuse Reflectance Spectroscopy (DRS) for light absorption properties. The effects of key parameters, including dye concentration, photocatalyst dosage, and solution pH, were systematically investigated to determine the optimal degradation conditions. The Cu-MOF achieved remarkable 93.7% dye degradation efficiency under optimal conditions (0.4 mg/L dye concentration, 0.45 g catalyst, pH 10). Control experiments revealed that adsorption in the dark contributed to only 30% removal, while photolysis alone had no significant effect. The reusability of the Cu-MOF was assessed over five consecutive cycles, demonstrating stable activity with minimal performance loss. These results highlight the potential of Cu-MOF as an efficient and durable photocatalyst for water and wastewater treatment applications.

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Track Classification: Pollution and waste management: Heavy metals pollution: bioremediation of heavy metals in water bodies and aquatic systems