UNIVERSITI TEKNOLOGI MARA

MOLYBDENUM DISULPHIDE / REDUCED GRAPHENE OXIDE (MOS_2/RGO) FOR HYBRID PHOTODEGRADATION OF PERFLUOROOCTANOIC ACID (PFOA) IN AQUEOUS SOLUTION

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ABSTRACT

Perfluorooctanoic acid (PFOA) has been regarded as one of emerging pollutants due to its environmental persistence, bioaccumulation, and potential toxicity. The high persistent due to C-F bond leading to difficulty on removing the PFOA. There are many methods to remove PFOA and photocatalytic degradation as one suitable method due to its capabilities to reduce the environmental impact, safe, and does not consume a large amount of energy. The current investigation focused on the facile synthesis of molybdenum disulphide (MoS_2/rGO) nanocomposite with different weight percentages of MoS_2 (1%, 5% and 15% w.r.t. to rGO) prepared via hydrothermal methods. Meanwhile, rGO were synthesized via Modified Hummer's Method. The incorporation of MoS_2/rGO undergoes three optimization process of pH, amount catalyst loading and contact time. The effective incorporation of MoS_2 on the GO structures was substantially confirmed via various characterization tools. Fourier Transform Infrared Spectroscopy (FT-IR), X-ray Diffractometer (XRD) and Raman Spectroscopy showed significance peak of MoS_2, GO and MoS_2/rGO composites. UV- Visible Spectroscopy (UV-vis) and X-ray Photoelectron Spectroscopy (XPS) showed that MoS_2/rGO was successfully incorporated. The morphology of MoS_2, GO and MoS_2/rGO was showed by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). The Selected Area Electron Diffraction (SAED) exhibited clear diffraction rings that can be distinguished as MoS_2 and GO. Thermogravimetric analysis (TGA) was carried out which proved the stability of the photocatalysts. The surface area analysis was obtained by Brunauer Emmet Teller (BET) technique which showed MoS_2/rGO-15 consist higher surface area which is good in photocatalytic activity. The composites were applied as photocatalysts to degrade PFOA using a photoreactor equipped with an 18-watt fluorescent lamp analyzed using High Performance Liquid Chromatography (HPLC). MoS_2/rGO-15 showed superior photocatalytic properties for degrading PFOA under optimum parameters with kinetic rate constant $k = 0.0758\ min^{-1}$ and $t_{½} = 1.524$ hours based on the Langmuir-Hinshelwood (L-H) model. Under the optimizations condition, the analytical performances were determined for studied analyte. The steadiness and reusability studies indicate that the MoS_2/rGO-15 composites can be reused for up to six cycles without affecting the functional group of photocatalyst. Real water sample analysis revealed that MoS_2/rGO-15 is efficient in the degradation of perfluorooctanoic acid (PFOA) in river water sample with 77% degradation percentage. Overall, the findings of this study aid in uncover the potential of MoS_2/rGO as one of promising material for development of photocatalyst for organic wastewater degradation under low cost indoor fluorescent light irradiation.

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

Water is one of the vital nutrients needed by the living things for their sustainable life. Contamination of water from various chemicals is a major concern because countless inorganic and organic compounds pollute our groundwater and surface water (Ahuja, 2019). Water contamination primarily occurs through the direct discharge of hazardous substances from industrial, commercial, and residential sources into bodies of water, the transport of pollutants in storm water runoff and the leaching of contaminated soil into the water bodies of water (Gesamp, 1988). In addition, growing amounts of non-conventional chemicals discharge in wastewater, surface water as well as drinking water has elevated great distress.

Perfluorinated compounds (PFCs) are industrial chemicals that caught an environmental and public health concern due to their persistence and potential for bioaccumulation. PFCs exhibit immunotoxicity, (Dewitt et al., 2012) neurotoxicity (Onishchenko et al., 2011), endocrine disrupting effects, (White et al., 2011) and development deficits. Perfluorooctanoic acid (PFOA) derivatives from PFCs' family are commonly used in surfactants, fire retardants, high-temperature lubricants, and Teflon production (Mitchell et al., 2013). In addition, there are some advantages of PFOA such as to make products more resistant to stains, grease and water. As a result, these compounds have been widely found in consumer and industrial products, as well as in food items (US Environmental Protection Agency (USEPA), 2016). PFOA differs from the other persistent pollutants because it is water-soluble and readily migrates to groundwater (Davis et al., 2007) and bioaccumulates in blood serum and liver rather than fatty tissue (Lau et al., 2007).