UNIVERSITI TEKNOLOGI MARA

SYNTHESIS OF POLYMER NETWORKS FOR REMOVAL OF AZO DYES FROM AQUEOUS SOLUTIONS

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ABSRACT

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Rapid industrialization growth has led to the high volume of effluent discharges containing undesirable pollutants, such as dyes and heavy metal ions, into the environment, leading to environmental pollutions and raising health concerns. A variety of adsorbents have been reported recently for elimination of harmful dyes in wastewater without causing secondary contamination with different high capacities. Hydrogels are three-dimensional crosslinked polymer networks, which are soft and contain a huge amount of water. The presence of functional groups, such as hydroxyl, carboxylate and amine moieties, in the polymer-based adsorbents play a significant role in facilitating the removal of target dyes and other pollutants in aqueous solutions. In this work, polymer network consisting of sodium humate grafted poly(acrylic acid) (PAA-HA), poly(acrylamide-*co*-1-vinylimidazole) (P(AAm-*co*-VIm)) and commercial poly(vinyl alcohol) (PVA) were prepared via free radical polymerization, followed by cyclic freeze-thaw, where the polymers were first dissolved in aqueous solutions. The functional polymers and polymer networks were characterized using ATR-FTIR, NMR and SEM. Swelling behaviour of the polymer networks in deionized (DI) water and phosphate buffer saline (PBS) media at neutral pH was also investigated. The swelling ratio of the three-component polymer network (PVA/PAA-HA/P(AAm-*co*-VIm) was 3490% in DI water after 24 h of swelling, which was much higher compared to 492% in PBS media. Effects of polymer-based adsorbent dosage ranging from 1 to 2 g/L on the adsorption of selected azo dyes were investigated. Methylene blue (MB) and methyl orange (MO), which are azo dyes, were the model cationic and anionic dyes used to investigate the adsorption capacity of the polymer network in aqueous solutions. Removal efficiencies (>90%) were observed for MB for all adsorbent dosage using two-component, PVA/PAA-HA and three-component, PVA/PAA-HA/P(AAm-*co*-VIm) polymer networks compared to removal efficiencies for MO (<5%) for all polymer network systems. Therefore, the adsorbent dosage of 1 g/L was selected as the most suitable dosage for the adsorbent considering its high removal efficiency and amount of adsorbent materials, thus their cost-effectiveness for real-time applications in adsorbing pollutants from the wastewaters.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

Water pollution has become a major worldwide issue, posing a threat to the entire biosphere and harming the lives of people all over the world. Dyes are colouring agents used in various industries and are common water pollutants that have to be treated because certain dyes are toxic and harmful to aquatic organisms and environment. Small amount of dyes at concentration below 1 ppm, can change the colour and quality of water and considerably affect the aquatic environment (Mehdizadeh *et al*., 2020). Thus, dyes and other chemicals have high tendency to pollute the environment and water resources such as rivers, lakes and reservoir (Velusamy *et al*., 2021).

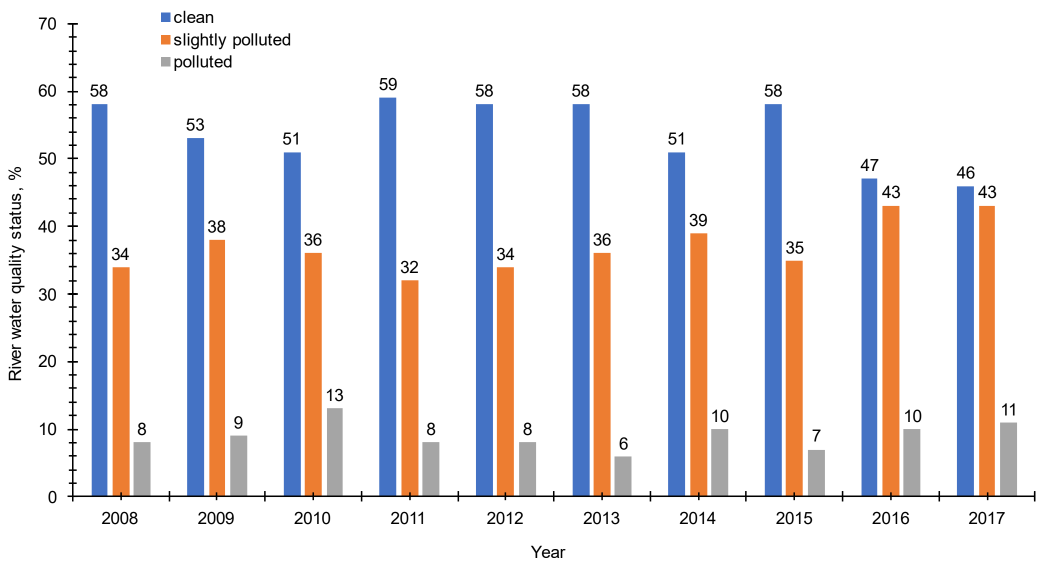

Figure 1.1 River water quality in Malaysia from 2008 to 2017 (Goi, 2020).

CHAPTER 2

LITERATURE REVIEW

2.1 Adsorption

Adsorption is a process of mass transfer in which solutes or removable species are transported from a runny phase onto the surface of a solid phase (Manchisi *et al.*, 2020). During the process of adsorption, a gas or liquid (adsorbent), forms a molecular film (adsorbate) (Singh *et al.*, 2018). In a report by the United States Environmental Protection Agency (USEPA), the adsorption process is one of the most excellent and best wastewater treatment techniques among others (Anil *et al.*, 2020).

Physisorption is also known as Van der Waals adsorption, which is a natural attraction between the surface of the atoms and the atoms, particles or ions that are absorbed on the surface (Agboola and Benson, 2021). Physisorption is regarded as a weak, reversible process (Heinrich *et al.*, 2020), which is not specific, because the atoms are not chemically bound to the surface atoms, but they occupy a certain area of the surface. Physisorption does not require an activation energy, which is an inverse process where the atoms, molecules or ions, which are adsorbed on the surface, have the ability to move within a specific surface that are nonlocalized (Mhemeed, 2018).