

**UNIVERSITI TEKNOLOGI MARA**

**FABRICATION OF AN  
IMMOBILIZED CROSS-LINKED  
CHITOSAN-GLYOXAL FILM AS AN  
EFFECTIVE ADSORBENT FOR  
ADSORPTION AND DESORPTION  
OF REACTIVE ORANGE 16 AND  
METHYL ORANGE DYES**

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**MSc**

**June 2020**

## AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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and Methyl Orange Dyes

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## ABSTRACT

Chitosan was cross-linked with Glyoxal to produce an immobilized film of cross-linked chitosan-glyoxal film (Chi-Gly film) to act as potential adsorbent for Reactive Red 16 (RO16) and Methyl Orange (MO) dyes from aqueous solutions. The physicochemical properties of Chi-Gly film were determined *via* pH-Potentiometric titration, surface area (BET) analysis, elemental analysis, Scanning Electron Microscopy with Energy Dispersive X-Ray (SEM-EDX), X-Ray Diffraction (XRD), Thermogravimetric analysis (TGA), Fourier Transform Infrared Spectroscopy (FT-IR), pH at the point of zero charge (pHpzc), water swelling, and mechanical strength. The characterizations indicated that the Chi-Gly film was thermally stable, extremely low swelling index with high adhesion strength on glass plate, amine group (-NH<sub>2</sub>) content was 32.52 %, and pHpzc of ~6.0 indicating a negative surface charge occurs above pHpzc. The maximum adsorption capacities for RO16 and MO on Chi-Gly film were 1554.3 mg/g and 1451.9 mg/g, respectively, at Chi-Gly film thickness of 8.5 μm, pH ~ 3, and temperature 303 K. The Langmuir isotherm model showed better fit to the equilibrium data than the Freundlich and Temkin models. The kinetic uptake results were well described by the Pseudo-First-Order (PFO) kinetic. The mechanism of adsorption included mainly hydrogen bonding interaction, electrostatic attractions, *n*- $\pi$  stacking interaction and Yoshida H-bonding. The thermodynamic adsorption functions ( $\Delta G^\circ$ ,  $\Delta H^\circ$  and  $\Delta S^\circ$ ) showed that the adsorption of RO16 and MO on Chi-Gly film was spontaneous and exothermic in nature under examined conditions. This study revealed that immobilized Chi-Gly film as a potential and reusable adsorbent for at least three cycles of adsorptions without losing much its adsorptive activity and no filtration process was required for adsorbent recovery.

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