RINGKASAN

Penelitian ini berhasil mensintesis dan mengkarakterisasi biochar magnetit dari tandan kosong kelapa sawit dan Fe_3O_4 dari pasir besi Sungai Batang Hari sebagai adsorben *Rhodamin B*. Biochar diperoleh melalui karbonisasi pada 500 °C selama 2 jam dan aktivasi KOH untuk meningkatkan porositas dan gugus fungsional. Dibanding karbon aktif, biochar memiliki struktur *amorf* dan luas permukaan sedang, namun lebih ramah lingkungan dan ekonomis. Fe_3O_4 disintesis secara ramah lingkungan dari pasir besi dengan menggunakan ekstrak kulit nanas sebagai *capping agent*, yang ditambahkan selama proses presipitasi untuk mengontrol pertumbuhan partikel dan mencegah aglomerasi. Selanjutnya, Fe_3O_4 dikompositkan dengan biochar melalui metode hidrotermal. Hasil FTIR menunjukkan adanya interaksi kimia antar komponen, sementara XRD mengonfirmasi kestabilan struktur kristal Fe_3O_4 meski intensitas menurun akibat pelapisan biochar. Karakterisasi VSM menunjukkan sifat *superparamagnetik*, dengan nilai Ms menurun seiring peningkatan rasio biochar. Uji adsorpsi *Rhodamin B* menunjukkan efisiensi tertinggi (85%) pada rasio 2:1 dengan massa adsorben 150–200 mg. Mekanisme adsorpsi melibatkan interaksi elektrostatik, ikatan hidrogen, π–π stacking, dan pertukaran ion. Rasio 3:1 masih efektif, tetapi menunjukkan kecenderungan saturasi dan aglomerasi. Secara keseluruhan, hasil ini menunjukkan potensi besar biochar magnetit sebagai adsorben yang efisien dan berkelanjutan.

SUMMARY

This study successfully synthesized and characterized magnetic biochar derived from oil palm empty fruit bunches and Fe_3O_4 obtained from iron sand of the Batang Hari River as an adsorbent for Rhodamine B. The biochar was produced through carbonization at 500 °C for 2 hours and activated using KOH to enhance porosity and functional groups. Compared to activated carbon, the biochar exhibits an amorphous structure and moderate surface area, while offering greater environmental and economic advantages. Fe_3O_4 was synthesized via a green synthesis approach using iron sand, with pineapple peel extract added during the precipitation process as a *capping agent* to stabilize particle growth and prevent agglomeration. The resulting Fe_3O_4 was then composited with biochar using a hydrothermal method. FTIR analysis revealed chemical interactions between components, while XRD confirmed the crystalline structure of Fe_3O_4 remained stable despite reduced intensity due to biochar coating. VSM analysis showed superparamagnetic properties, with saturation magnetization (Ms) decreasing as the biochar ratio increased. Adsorption tests for Rhodamine B indicated the highest efficiency (85%) at a 2:1 ratio with an adsorbent mass of 150–200 mg. The adsorption mechanism involved electrostatic interactions, hydrogen bonding, π–π stacking, and ion exchange. Although the 3:1 ratio remained effective, it exhibited signs of saturation and particle agglomeration. Overall, the results demonstrate that magnetic biochar has strong potential as an efficient and sustainable adsorbent.