

ABSTRACT

*Carbon dioxide (CO₂) emissions are the main contributor to global warming, thus requiring effective and environmentally friendly adsorbent materials. Activated carbon/l-lysine composite is a hybrid material that combines activated carbon as a porous adsorbent with lysine as a functional modifier to enhance interactions and improve adsorption capacity. Chemically, CO₂ acts as a Lewis acid because its carbon atom can serve as an electron-pair acceptor. Therefore, optimal capture requires materials with Lewis base surfaces that act as electron-pair donors. This study aims to evaluate the adsorption performance of activated carbon/l-lysine composites as an effective CO₂ adsorbent. The research was conducted in four stages: preparation of carbon from coconut shell through thermal activation, chemical activation using red betel leaf (*Piper ornatum*) extract as a source of alkaloid metabolites to introduce basic groups, oxidation with KMnO₄ to increase hydroxyl (–OH) groups, and composite formation with l-lysine, which acts as a Lewis base due to its reactive amine (–NH₂) groups as electronpair donors. This modification was designed to create a more basic carbon surface, rich in active functional groups, and possessing pore structures larger than CO₂ molecules (0.33 nm), thereby promoting Lewis acid–base interactions to improve selectivity and adsorption capacity. Characterization was carried out using Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), Particle Size Analyzer (PSA), Brunauer Emmett Teller (BET) nitrogen adsorptiondesorption, and Thermogravimetric Analysis (TGA). CO₂ adsorption testing was performed using the volumetric method based on the real gas principle, which accounts for molecular volume and intermolecular forces to better represent actual gas behavior. The results showed that activation with red betel leaf extract was successful, as indicated by the FTIR data where the C–H group shifted to the C–N range at 1318 cm⁻¹. Oxidation with KMnO₄ was confirmed by the appearance of O–H and C–O–Mn groups at 3280 and 497 cm⁻¹, respectively. The activated carbon/l-lysine composite exhibited improved performance, as demonstrated by the increased BET data and good thermal stability in TGA, with gradual mass loss corresponding to lysine decomposition and activated carbon structure. SEM analysis revealed surface changes coated with a fine white layer, while the ninhydrin test confirmed the presence of primary amine groups with a strong purple coloration. The results showed that the activated carbon/l-lysine composite achieved the highest CO₂ adsorption percentage of 49%.*

Keywords: *Activated carbon, composite, l-lysine, CO₂ adsorption.*