INDONESIAN SCIENCE PROJECT OLYMPIAD

ISPO RESEARCH REPORT

A Sustainable Desiccant-Evaporative Cooling System Based on Polyurethane-Graphene Oxide (PU-GO) Nanocomposite with Solvent Exchange Method: Synthesis, Composite Characterization, and Performance Analysis

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ABSTRACT

The increase in global temperatures and reliance on refrigerant-based air conditioners contribute to rising greenhouse gas emissions. This research aims to develop a desiccant-evaporative cooling system using polyurethane-graphene oxide (PU-GO) nanocomposite foam as a sustainable air-cooling alternative with a higher Energy Efficiency Rating (EER) without using refrigerants (CFCs and HFCs). Graphene oxide (GO) was synthesized using the modified Hummers method, confirmed by FTIR and XRD. FTIR analysis showed successful graphite oxidation with C=C stretching (1580.24 cm^{-1}) and O–H stretching (3130.53 cm^{-1}). XRD analysis displayed a diffraction peak at 11.35° (2θ) with a d-spacing of 0.778 nm, confirming GO formation. PU-GO foam was synthesized via the solvent exchange method using isopropyl alcohol (IPA) as a solvent. GO addition enhanced PU hydrophilicity, evidenced by a contact angle reduction from 101.632° to 68.309° and increased O–H groups on FTIR. Pre-treatment enlarged average pore size by 46.35% and porosity by 12.779%, boosting water absorption. Saturation tests showed PU-GO foam absorbed up to 333% of its weight, outperforming conventional evaporative pads: sliced wood (90%), Celdek (85%), and straw (76%). Desiccant-evaporative cooling system tests using PU-GO foam reduced air temperature by 5–7°C, achieving a cooling capacity of 1,315.71 BTU/h. With a power consumption of 224.24 W, the system reached an EER of 5.87 BTU/Wh, significantly higher than conventional AC units (0.69–1.85 BTU/Wh). These results demonstrate PU-GO foam's potential as an energy-efficient and eco-friendly air-cooling solution.

Keywords: Desiccant-evaporative cooler, solvent exchange, nanocomposite, polyurethane-graphene oxide, efficiency