

Window model of activated carbon filters for reducing carbon dioxide concentration and improving the indoor air quality inside houses exposed air pollution.

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Abstract

This study investigates the viability of improving indoor air quality (IAQ) by means of a window filter model that uses activated carbon generated from locally obtained biomass to absorb carbon dioxide (CO₂) from the air. Using typical window size, three different residential building scenarios were examined in terms of window-to-floor ratio. To evaluate how well-proposed filter configurations capture natural daylighting and ventilation, simulation tests were run in four main directions. Using continuous reactor setups and four biomass waste materials (coffee grains, sunflower seed shells, oak sawdust, and almond shells that were pyrolyzed and potassium hydroxide impregnated), precursor kinds, bed height, and filter ratio were carefully experimentally investigated.

Different biochar yields were found using adsorption tests using fixed bed filters filled with the synthesized activated carbon; almond shells had the highest production (31.9%), followed by oak sawdust (29.78%), sunflower seed shells (23.6%), and coffee grains (22.1%). In light of this, almond shells outperformed oak sawdust, sunflower seed shells, and coffee grains in terms of adsorption capacity and filter efficiency. Continuous breakthrough testing revealed that raising the bed height and filter ratio significantly improved CO₂ filter efficiency and adsorption capacity.

According to research, choosing the right biomass precursors and maximizing filter ratios can help fine-tune the adsorption effectiveness of synthetic activated carbon and, in turn, the CO₂ filter efficiency. Additionally, adding more filters to box windows or dividing filter sections in regular windows proved to increase airflow, which is consistent with cross-ventilation theories and produces acceptable results.