

Upcycling Powdered Activated Carbon into High-Performance Pelletized Adsorbents for VOC Removal

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Activated carbon (AC) is widely utilized across various industrial fields, including air purification, energy storage, water treatment, food and beverage processing, and pharmaceutical and medical applications, owing to its excellent adsorption performance and tunable morphology and pore characteristics. However, the AC market has recently experienced a significant decline in supply-chain stability due to the heavy reliance on limited precursor resources and production concentrated in a small number of countries, making it highly sensitive to global geopolitical conditions and environmental policy changes. In particular, the implementation of carbon neutrality policies in China has led to a reduction in coal-derived AC production, resulting in a sharp increase in global demand for coconut-derived AC. This shift has caused substantial fluctuations in raw material prices and supply imbalances, further intensifying uncertainties throughout the AC industry. Such changes in the supply environment not only hinder the stable procurement of AC but may also lead to a long-term decline in the competitiveness of industrial adsorbents and filtration materials. Under these circumstances, the development of technologies for the regeneration and recycling of AC has emerged as a critical challenge for ensuring domestic supply stability and achieving technological self-reliance.

In this study, the activated carbon pellets (AC-Pellet) was prepared using recycled powder type AC for VOCs adsorption. The recycled powder type AC was pelletized into 2 mm pellets using a acrylic binder. The texture properties of AC-Pellet were studied by BET with N₂/77K isotherm adsorption curves. The strength and abrasion characteristics of AC-Pellet were analyzed based on ASTM D3802 and D5159, respectively. In addition, the VOCs adsorption behavior of AC-Pellet was analyzed by breakthrough experiments. The specific surface area of AC-Pellet was observed to be approximately 900-1,000 m²/g. Furthermore, the strength and abrasion characteristics of AC-Pellet were observed to be 99.6-99.8% and 10-50 mg/min, respectively. Especially, the VOCs adsorption characteristics of AC-Pellet were influenced by pelletizing conditions. As a result, this study presents an efficient method to recycle AC from regeneration, supporting circular use of resources and supply stability.