Paper 210

Development of Efficient Defluoridation Materials and Their Application in Rural Drinking Water Purification

Fluoride ions are common harmful contaminants in rural drinking water, and excessive fluoride intake can lead to fluorosis, posing serious health risks to local populations. Fluoride contamination is especially prevalent in certain regions of China and worldwide. With growing awareness of rural water safety and advances in environmental technologies, the development of efficient, cost-effective, and suitable defluoridation materials tailored for rural applications has become a critical research priority.

Currently, common defluoridation technologies include adsorption, ion exchange, and reverse osmosis. However, some of these methods suffer from high costs, operational complexity, or potential secondary pollution. Among them, adsorption stands out for its simplicity, affordability, and material versatility. Nevertheless, traditional adsorbents often face limitations such as low adsorption capacity, poor selectivity, and unsatisfactory regeneration performance, hindering their widespread application in rural water purification.

This study focuses on the synthesis and performance optimization of novel high-efficiency defluoridation materials. Strategies such as porous structure engineering, surface functionalization, and composite material fabrication are explored to enhance adsorption capacity and selectivity. The materials are evaluated in real rural water samples to assess their defluoridation effectiveness and regeneration capability. Adsorption kinetics, isotherms, and thermodynamics analyses are conducted to elucidate the interaction mechanisms between fluoride ions and adsorbents, providing guidance for material design and application.

Additionally, practical defluoridation devices tailored to rural needs are designed to facilitate the industrial application of the developed materials. The research outcomes are expected to offer an economical, environmentally friendly, and effective solution for fluoride contamination in rural drinking water, thereby protecting public health and promoting ecological sustainability.