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From vertical to horizontal column ion exchange for nuclear effluent remediation: Process intensification technology

Column ion exchange technology has been used globally for many decades in the nuclear industries. Yet, several critical limitations to ion exchange column operation result in low throughputs, such as the limitation of adsorbent size to reduce frictional pressure drop issues [1] and the slow adsorption kinetics [2]. To tackle this issue, and create a more sustainable and efficient treatment solution, research was undertaken using tubular horizontal column ion exchange using agitated tubular reactors (ATRs). ATRs are intensified plug-flow reactors [3, 4], where high-rate horizontal shear is generated with inner agitator bar, decoupling mixing dynamics from the bulk flow. Prajitno et al. [5] conducted the experiments by comparing the performance of static vertical column ion exchange with the horizontal column ion exchange using ATR (Figure 1) on strontium removal using natural clinoptilolite zeolite with particle size ˜ 300 m average as the adsorbents. The results showed that the ATR had ˜30% increase in performance (in terms of both adsorption capacity and breakthrough values) and a 2-3 times faster relative flow rate than static vertical column. Improvements were due to enhanced mixing and adsorption kinetics from the lateral shear imparted in the ATR [5]. This can be an alternative solution for new remediation treatment plants, which can lead to more space efficient and sustainable process future. Current work is also investigating how such technologies may be embedded with other downstream unit operations for an integrated waste management approach.

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