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Engineering of Arsenic Removal from Natural Water Using a Coiled Flow Inverter

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ABSTRACT

Wastewater treatment is a global challenge which requires integration of process optimization, intensification, and automation to reduce cost and improve scalability. For this purpose, developing cost effective compact and sustainable water treatment system tailored for diverse water quality conditions is crucial to meet global clean water requirements. Coiled Flow Inverter (CFI) has emerged recently as an ideal candidate for multiphase mixing owing to its enhanced mass transfer rates due to equidistant 90^{o} bends, which addressed the poor mixing, excessive space requirement and prolonged pollutant treatment time in the conventional water pollutants adsorption method.

Arsenic is considered one of the most toxic water pollutants that can result in severe health issues, including skin lesions, developmental disorder, cardiovascular disease, kidney failure and lung cancer. This work leverages the enhanced radial mixing,cost-effectiveness and compact engineering of coiled flow inverter (CFI) reactor to advance the adsorption of arsenic from natural water.

A comprehensive evaluation on the effects of various parameters including flowrates (10mL/min, 135 mL/min), initial pollutant concentration (1-200 ppm), adsorbent dosage (0.2-2 mg/mL) and pH (2-10) were performed. Findings showed that a remarkable 98% adsorption efficiency for As(V) was achieved within a short residence time of 38 seconds at a flow rate of 135 mL/min, initial concentration of As(V) at 10 mg/L and adsorbent dosage of 1.5 mg/mL. To demonstrate its practical application, studies performed on selectivity in the presence of co-ions (Phosphate, Sulphate, Chloride and Carbonate), adsorbent regeneration and effect of water matrix (Torrens River water) confirmed that CFI reactor has good selectivity for As(V), can operate well in repeated cycles after adsorbent regeneration and removes 99%, As(V) from Torrens River water. Benchmarking experiments in Batch and CFI reactor verified that outstanding removal efficiency (98 %) can be attained in 38 seconds at 135 mL/min flow rate in CFI reactor compared to 24 hrs in batch reactor, demonstrating the efficacy of the miniaturized compact device based on CFI for improved water purification technology

showing its potential for practical applications.

KEY WORDS

Coiled flow inverter, Arsenic, waste-water tretament, Process Intensification

BIOGRAPHY

Rabia Sabir is a chemical engineer from Pakistan with 8 years of experience in academia as Lecturer, currently pursuing a PhD in Chemical Engineering at the University of Adelaide, Australia. With a strong foundation in chemical engineering, she is focused on developing innovative solutions to address the global challenges of water contamination. Her current research explores advanced methods for efficient water treatment, particularly in the removal of emerging contaminants. Combining engineering expertise with a passion for sustainable environmental solutions, Rabia aims to contribute significantly to the development of more effective and accessible water treatment technologies.

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