Development of a Zeolite Composite Material for the Simultaneous Removal of Pharmaceuticals, Personal Care Products (PPCPs), and Perfluorinated Alkyl Substances (PFAS) in Water Treatment

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Perfluorinated alkyl substances (PFAS) are carcinogenic chemicals found in heat, stain, and water-resistant consumer products, including Teflon. Like pharmaceuticals (PPCPs), these “forever chemicals” are found extensively in wastewater and are toxic to humans and the environment. Wastewater treatment facilities (WWTFs) currently lack technology capable of removing PPCPs and PFAS. This investigation assessed the new zeolite composite materials designed in last year’s project to remove these contaminants. Additionally, risk assessments were performed on WWTF effluent data collected last year using the EPA’s Ecological Structure Activity Relationships program. Efficacy of the six zeolite composite variants was assessed through Langmuir isotherm modeling. Isotherm models were constructed for each of the 17 PPCPs and 3 PFAS of concern included in batch experimentation; adsorption capacity and adsorption favorability were determined from each linearized model. Potential trends in adsorption capacity and favorability between zeolite composite variants were analyzed across several dimensions, including both adsorbate and adsorbent properties. Three conclusions were drawn: 1) PPCP and PFAS concentrations in effluent violated accepted safety thresholds and predicted no effect concentrations, demonstrating a need for new WWTF technology targeting micropollutants, 2) the novel zeolite composite materials effectively removed both PPCPs and PFAS simultaneously as shown through isotherm modeling, and 3) no single mechanism was found to predict efficacy between variants in a complex solution. Through isotherm modeling, the zeolite composites were demonstrated to perform better than existing WWTF methods under comparable conditions.

Awards Won:
Third Award of $1,000