ADSORPTON OF PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS) ON FLUORO-SORB® ADSORBENT

KINETICS AND ADSORPTION ISOTHERMS

Background:

Dr. Jinxia Liu, McGill University, studied the performance of FLUORO-SORB® 200 Adsorbent for removing per- and polyfluoroalkyl substances (PFAS) from an aqueous film-forming foam (AFFF) contaminated groundwater. Batch experiments demonstrated that Fluoro-sorb adsorbent is highly effective as an adsorbent for a variety of PFAS compounds in a contaminated groundwater. Removal amounts, adsorption isotherm, and kinetic data are presented.

The AFFF-contaminated groundwater, which was collected near a firefighting training area at a former airfield, contained total PFAS of 64.9 ±1.0 µg/L, with PFOA (5.99 ±0.11 µg/L) and PFOS (14.2 ±0.3 µg/L) present. Chemical oxygen demand (COD) was 7.9 mg/L and total organic carbon (TOC) was 2.4 mg/L. Other non-PFAS contaminants detected were diesel (C10 -C28, 0.43 mg/L) and acetone (8.3 mg/L). Mineral concentrations of calcium (50 mg/L), magnesium (6.6 mg/L), sodium (2.6 mg/L) and potassium (0.77 mg/L) were measured. The initial pH value of the groundwater was pH 8.

Batch adsorption experiments were carried out with Fluoro-sorb adsorbent using various adsorbent-to-liquid ratios. The AFFF-impacted groundwater (400 ml) and 5 to 40 mg of the media were mixed in 500 mL high-density polyethylene (HDPE) bottles. Samples for PFAS analysis were collected at time intervals up to 168 hours. For the isotherm results, equilibrium was considered to be at 168 hours. Experiments were run in triplicates, and the results presented are mean values.

PFAS Removal Amounts:

The PFAS removal amounts for the 40 mg of media tests at the 168 hour time point are shown in Table 1. These results demonstrate that Fluoro-sorb adsorbent is a highly effective option for adsorption of a variety of PFAS compounds.

Table 1: The amount of PFAS removal in batch tests with 40 mg of FLUORO-SORB® 200 Adsorbent after 168 hours.

PFAS Type	PFAS Name	Starting Concentration (µg/L)	Removal Percent
Perfluoroalkyl sulfonic acids	PFOS	15.37	95.5%
	PFHpS	0.446	>93.3%
	PFHxS	15.59	97.2%
	PFPeS	0.287	>97.6%
	PFBS	0.206	85.7%
Perfluoroalkyl carboxylic acids	PFOA	6.058	90.9%
	PFHpA	0.673	79.0%
	PFHxA	4.304	50.5%
	PFPeA	1.534	31.3%
Perfluoroalkyl sulfonamides	FOSA	0.797	97.9%
	FHxSA	12.69	82.9%
	FBSA	1.058	38.9%
Fluorotelomer sulfonic acid	6:2 FTS	7.755	76.6%
	8:2 FTS	0.443	90.2%
Cyclic	PFECHS	0.149	>96.7%

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Kinetic Studies:

The kinetics of PFAS adsorption for PFOS, PFOA, PFHxS, PFHpA, PFHxA, and PFBS (results for other compounds available upon request) for batch studies with three dosages of Fluoro-sorb adsorbent and the AFFF-contaminated groundwater are shown in Figure 1. The initial adsorption of PFAS was rapid up to ~24 hours and then slowed the until equilibrium was reached.

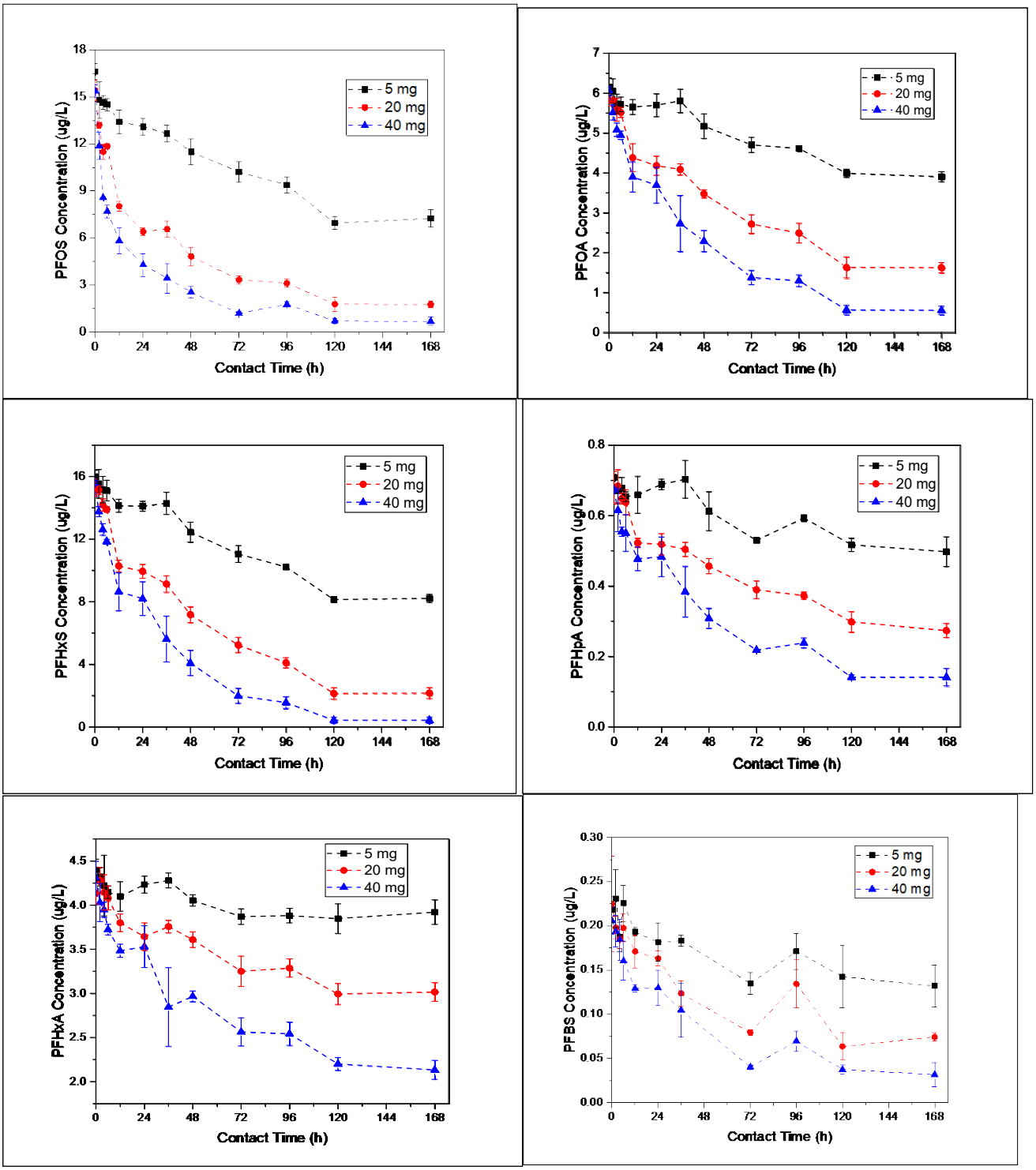

Figure 1: Adsorption kinetics of PFOS, PFOA, PFHxS, PFHpA, PFHxA, and PFBS on FLUORO-SORB® 200 Adsorbent in batch studies with contaminated groundwater.

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Adsorption Isotherms:

Shown below in Figure 2, isotherms were created from the batch adsorption tests to show the uptake of PFAS by Fluoro-sorb adsorbent. Isotherms for PFHpA, PFHxA, and PFBS were linear in the concentration range tested. In contrast, anionic (PFOA, PFPeS, PFHxS, PFHpS, PFOS, and 6:2 FtSA) and neutral (FHxSA and FOSA) PFAS showed a piecewise isotherm that included an initial linear isotherm followed by a Langmuir-type isotherm. The adsorption capacity was significantly influenced by small changes in PFAS concentration at the ug/L level.

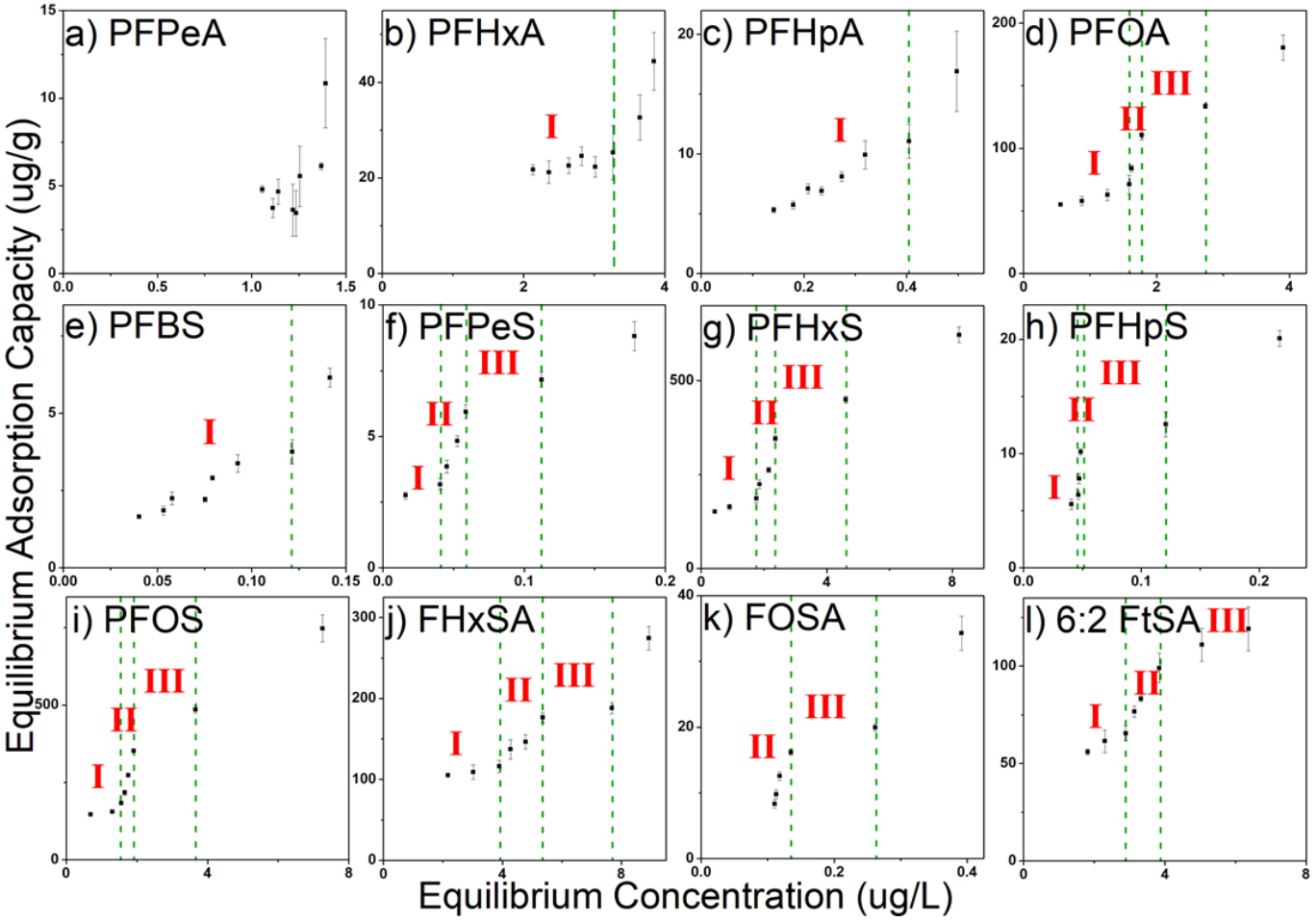

Figure 2: Adsorption isotherms of PFAS on FLUORO-SORB® 200 Adsorbent. Piecewise isotherms were measured: Ⅰ, linear-type isotherm; Ⅱ and Ⅲ, Langmuir-type isotherm (Yan et al. 2020).

Reference: Yan, B., Munoz, G., Sauvé, S., and Liu, J. (2020) "Molecular mechanisms of per- and polyfluoroalkyl substances on a modified clay: a combined experimental and molecular simulation", Water Research, 184, 116166.