**A green route to a highly porous activated carbon from agricultural waste for mercury removal**

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**Supporting information**

# Text S1: models for isotherm fitting

The Langmuir model is given by (Ayoob & Gupta, 2008):

|  |  |
| --- | --- |
|  | (1) |

Where qe is the amount adsorbed at equilibrium per unit weight of adsorbent (mg/g), Ce is the equilibrium concentration of adsorbate in the liquid phase (mg/L), Qmax and KL are the Langmuir constants and are referred to as the maximum adsorption capacity (mg/g) and affinity parameter of the adsorption system.

Equations are often linearized for ease of plotting and are given by:

|  |  |
| --- | --- |
|  | (2) |

The Freundlich isotherm is expressed using equation 3 where Kf is the Freundlich parameter that expresses the amount adsorbed (mg/g)(L/mg)1/n and n represents the adsorption strength (Ayoob & Gupta, 2008). The value of 1/n ranges between 0 and 1. Values below 1 imply chemisorption and values above 1 indicate cooperative adsorption. Unlike the Langmuir isotherm, the Freundlich model assumes multilayer adsorption with uneven distribution of heat and affinities over heterogeneous surface energies (Hadi et al., 2015). This isotherm model is criticized for its inability to abide by Henry’s law at low concentrations of the target contaminant (Ho et al., 2002).

|  |  |
| --- | --- |
|  | (3) |

The corresponding linear form is given by:

|  |  |
| --- | --- |
|  | (4) |

Other isotherm models employed in this study include Tempkin and Toth isotherm models and are presented in equations 5 and 6 respectively.

|  |  |
| --- | --- |
|  | (5) |

|  |  |
| --- | --- |
|  | (6) |

# Text S2: models for kinetic fitting

Various models have been developed to predict the uptake rate of the adsorption system where the Pseudo-first order and Pseudo-second order are the most commonly used models in liquid phase adsorption studies. Pseudo-first order is proposed by Lagergren for the adsorption of oxalic and malonic acid onto the charcoal and is expressed as in equation 7 (Lagergren, 1898).

|  |  |
| --- | --- |
|  | (7) |

Linearizing equation 7 yields equation 8:

|  |  |
| --- | --- |
|  | (8) |

qe (mg/g) and qt (mg/g) parameters represent adsorption capacities at equilibrium and time t respectively, and K1 represents the rate parameter (1/min). Pseudo-first order is known to be valid after the system has been running for long periods of time - when the adsorption system is nearing equilibrium and at the initial stage of the adsorption (Mckay et al., 1999). This model is applied to interpret data at small time intervals.

Pseudo-second order is used for large intervals, and it predicts that the adsorption rate is a second order function with respect to available active sites (Ho & McKay, 1999). It is represented mathematically in the form of equation 9:

|  |  |
| --- | --- |
|  | (9) |

Equation 10 represented the linearized of the Pseudo-second order model:

|  |  |
| --- | --- |
|  | (10) |

Where K2 is the rate parameter in g/mg/min. These model parameters are empirical constants with no distinct significance as no research works have been implemented to identify their underlying physicochemical phenomena when the model fitting is finalized (Tan & Hameed, 2017). The purpose behind fitting these models into kinetic studies is merely to complement the adsorbent evaluation.

Other kinetic models used in the study include Elovich and the intra-particle diffusion model and are presented in equations 11 and 12 respectively.

|  |  |
| --- | --- |
|  | (11) |

|  |  |
| --- | --- |
|  | (12) |

Figure S1. Van't Hoff curve for the adsorption of mercury onto WSAC from aqueous solutions.

Figure S2. Linearized intraparticle diffusion plot for the adsorption of mercury onto WSAC at room temperature, unaltered pH and mass dosage of 0.01 g.

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