**Appendix A:** **Supplementary Information**

**Graphene Oxide/ZnO Nanocomposites for Efficient Removal of Heavy Metal and Organic Contaminants from Water**

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***Equilibrium adsorption isotherms***

The Temkin isotherm model is a two-parameter model that considers the influences of indirect adsorbate/adsorbent interactions on adsorption procedures. Temkin isotherm considering the impact of the adsorbate interaction on adsorption reactions tends to be applied for heterogeneous adsorption of adsorbate onto an adsorbent [1]. The linearized form of the Temkin isotherm model can be described as follows (eq.S1) [2]:

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

Where, βT is the short form of expression RT/bT, where T(K), R (8.314 J.(mol. K)-1) and bT (J.mol-1) represent the absolute temperature, the gas constant, and Temkin constant relating to the adsorption heat, respectively. Furthermore, KT (L.g-1) indicates the Temkin isotherm constant (equilibrium binding constant). Temkin isotherm assumes that the adsorption heat of all molecules in the layer diminishes linearly on account of an increase in surface coverage [2] [3]. As observed in Fig. S1A and Table 2, the KT levels for four adsorption systems represented relatively small amounts, that is, there was less affinity between the absorbent/adsorbate molecules as there was possibly physical interaction that was confirmed by the BT parameter. If the BT is less than 8 (kJ.mol-1), the adsorption process happens physically [4]. Physical interaction merely contains more of the weak state of adsorbate polarization with adsorbent. The apparent values for the parameter BT (13.241, 16.736, 20.609, and 48.825 (J.mol-1) for MB, MO, Cd2+, and Pb2+ pollutants, respectively), as the indication of the sorption heat, clearly reflected physically weaker adsorption processes.

Flory-Huggins isotherm represents any spontaneity and feasibility of adsorption by describing the degree of surface coverage characteristics of adsorbate on the adsorbent. To put it simply, the Flory-Huggins isotherm model clarifies the behavior of a two-dimensional lattice of non-interacting fragments of diverse sizes. The linearized expression of the Flory-Huggins isotherm is as follows (Eqs 2 and 3) [5]:

|  |  |
| --- | --- |
|  | (2) |
|  | (3) |

Where, θ, KFH (L.mol-1), and nFH, represent the degree of surface coverage, Flory-Huggins equilibrium constant, and the number of adsorbates occupying adsorption sites (Flory-Huggins isotherm exponent). The Flory-Huggins isotherm parameters display a linear plot of log(θ/Ci) vs. log(1-θ), and the results of findings fitting in the form of a gradient obtained were the nFH value, as well as intercept, was the log KFH value [5] [6]. As illustrated in Fig. S1B and Table 2, the adsorbent GO-ZnO had good KFH value revealing the synthetic nanocomposites held better adsorbent-adsorbate interactions. Moreover, the obtained nFH < 1 indicated that more than one active adsorbent site was occupied by the adsorbate.

|  |  |
| --- | --- |
|  |  |
| A) | B) |
| Fig. S1 Linearized fits of the A) Temkin, and B) Flory-Huggins isotherms, for the adsorption of the dye pollutants of the MB and MO (at pH ~ 6) and the heavy metals of the Cd2+ and Pb2+ (at pH ~ 8) onto the synthetic GO-ZnO; Initial conditions: 10 mg of the adsorbent, the initial concentration range: 10 - 175 (mg*.*L-1) at 298 K. | |

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