Supplementary Material

Study on the adsorption of CuFe₂O₄-loaded corncob biochar for Pb(II)

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Table S1. Texture properties of different samples<sup>a</sup>.

| Samples                      | Specific surface area (m<sup>2</sup>·g<sup>-1</sup>) | Pore volume (cm<sup>3</sup>·g<sup>-1</sup>) | Pore size (nm) |
|------------------------------|--------------------------------------------------|---------------------------------|----------------|
| CCBC                         | 17.1                                             | 0.039                           | 7.93           |
| CuFeO<sub>4</sub>@CCBC(3%)   | 30.7                                             | 0.067                           | 2.57           |
| CuFeO<sub>4</sub>@CCBC(5%)   | 75.0                                             | 0.082                           | 2.44           |
| CuFeO<sub>4</sub>@CCBC(8%)   | 60.7                                             | 0.057                           | 1.89           |

<sup>a</sup> Pore volume was measured at 0.99 of p/p<sub>0</sub>, pore size was calculated from the absorptive branch by BJH method.

Table S2. Kinetics parameters calculated from intra-particle diffusion model for Pb(II) adsorption onto samples (k<sub>i1</sub>: mg·g<sup>-1</sup>·min<sup>-1/2</sup>, k<sub>i2</sub>: mg·g<sup>-1</sup>·min<sup>-1/2</sup>).

| Samples                      | k<sub>i1</sub> (mg·g<sup>-1</sup>·min<sup>-1/2</sup>) | C<sub>1</sub> | R<sup>2</sup> | k<sub>i2</sub> (mg·g<sup>-1</sup>·min<sup>-1/2</sup>) | C<sub>2</sub> | R<sup>2</sup> |
|------------------------------|--------------------------------------------------|-------------|---------|--------------------------------------------------|-------------|---------|
| CCBC                         | 1.39                                             | 1.09        | 0.9959  | 0.83                                             | 4.22        | 0.9166  |
| CuFeO<sub>4</sub>@CCBC(5%)   | 7.61                                             | 83.5        | 0.9930  | 1.84                                             | 113.4       | 0.7159  |

Table S3. Partition coefficient (PC) for Pb(II) adsorption onto CCBC and CuFeO<sub>4</sub>@CCBC(5%).

| Samples                      | Sorbent density (g·L<sup>-1</sup>) | Initial Pb(II) Concentration (µM) | Final Pb(II) Concentration (µM) | Removable rate (%) | Equilibrium Pb(II) sorption capacity (mg·g<sup>-1</sup>) | Partition coefficient (mg·g<sup>-1</sup>·µM<sup>-1</sup>) |
|------------------------------|-----------------------------------|----------------------------------|---------------------------------|-------------------|--------------------------------------------------------|----------------------------------------------------------|
| CCBC                         | 0.67                              | 193.1                            | 176.8                           | 8.4               | 5.06                                                   | 0.029                                                   |
|                             |                                   | 289.6                            | 267.4                           | 7.6               | 6.89                                                   | 0.026                                                   |
|                             |                                   | 386.1                            | 358.8                           | 7.1               | 8.48                                                   | 0.024                                                   |
|                             |                                   | 482.6                            | 450.6                           | 6.6               | 9.95                                                   | 0.022                                                   |
|                             |                                   | 579.2                            | 543.2                           | 6.2               | 11.16                                                  | 0.020                                                   |
|                             |                                   | 723.9                            | 687.7                           | 5.0               | 11.25                                                  | 0.016                                                   |
|                             |                                   | 965.2                            | 926.9                           | 4.0               | 11.50                                                  | 0.012                                                   |
| CuFeO<sub>4</sub>@CCBC(5%)  | 0.67                              | 482.6                            | 198.7                           | 58.8              | 88.25                                                  | 0.444                                                   |
|                             |                                   | 579.2                            | 239.4                           | 58.7              | 106.05                                                 | 0.443                                                   |
|                             |                                   | 723.9                            | 359.9                           | 50.3              | 113.15                                                 | 0.314                                                   |
|                             |                                   | 965.2                            | 575.0                           | 40.4              | 121.29                                                 | 0.211                                                   |
|                             |                                   | 1447.9                           | 1043.2                          | 28.0              | 125.78                                                 | 0.120                                                   |
|                             |                                   | 1930.5                           | 1522.2                          | 21.2              | 126.90                                                 | 0.083                                                   |
|                             |                                   | 2413.1                           | 2005.6                          | 16.9              | 126.98                                                 | 0.063                                                   |
Table S4. Comparison of the adsorption performance of typical adsorbents for Pb(II).

| Adsorbent sample                                      | Adsorption capacities (mg·g\(^{-1}\)) | Reference |
|-------------------------------------------------------|---------------------------------------|-----------|
| MnFeOx@CCBC                                           | 99.60                                 | [1]       |
| Magnetic Douglas fir biochar (MBC)                    | 26.00                                 | [2]       |
| Cannabis biochar (CA400)                              | 106.39                                | [3]       |
| A H3PO4-modified biochar (CFCP)                       | 55.42                                 | [4]       |
| anaerobic digestion sludge biochar (ADSBC600)         | 51.77                                 | [5]       |
| CuFe2O4@CCBC(5%)                                     | 132.10                                | This study|

Table S5. Thermodynamic parameters for the Pb(II) adsorption by CuFeO4@CCBC and CCBC.

| CuFeO4@CCBC(5%) | CCBC |
|-----------------|------|
| \(\Delta G_{m}^{\circ}\) (kJ·mol\(^{-1}\)) | \(\Delta H_{m}^{\circ}\) (kJ·mol\(^{-1}\)) | \(\Delta S_{m}^{\circ}\) (J·mol\(^{-1}\)·K\(^{-1}\)) | \(\Delta G_{m}^{\circ}\) (kJ·mol\(^{-1}\)) | \(\Delta H_{m}^{\circ}\) (kJ·mol\(^{-1}\)) | \(\Delta S_{m}^{\circ}\) (J·mol\(^{-1}\)·K\(^{-1}\)) |
|-----------------|------|
| 303 K           | 7.13 | 41.02 | 10.89 | 80.80 |
| 313 K           | 6.65 | 19.55 | 41.23 | 35.42 | 79.99 |
| 323 K           | 6.30 | 41.03 | 9.29  | 80.84 |

Figure S1. SEM photos of CCBC (a), CuFeO4@CCBC (5%) (b) and mappings of Cu (c), Fe (d).
Figure S2. XRD patterns of CuFe$_2$O$_4$@CCBC (5%) and CCBC.

Figure S3. Nitrogen adsorption/desorption isotherms (a) and pore-size distribution diagram (b) of the samples.

Figure S4. pH drift curves of the samples.
Figure S5. (a) Adsorption kinetics fitted with the pseudo-first-order model of Pb(II). (b) Adsorption kinetics fitted with the pseudo-second-order model of Pb(II). Initial Pb(II) concentration of 500 g·L⁻¹ and 30±1 °C.

Figure S6. Intraparticle diffusion plot of the Pb(II) adsorption. Initial Pb(II) concentration of 500 g·L⁻¹ and 30±1 °C.
**Figure S7.** (a) Langmuir and (c) Freundlich isotherm models fitted onto the Pb(II) adsorption for CuFe₂O₄@CCBC(5%); (b) Langmuir and (d) Freundlich isotherm models fitted onto the Pb(II) adsorption for CCBC. (Contact time = 24 h, pH = 5.0.).

**Figure S8.** Influence of pH and ion strength on Pb(II) sorption.
**Figure S9.** FTIR Spectra of the CuFe$_2$O$_4$@CCBC(5%) and CuFe$_2$O$_4$@CCBC(5%)-Pb.

**Supplementary Materials References**

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