**Supplementary material**

**Efficient removal of** **Cr6+ by magnetically modified biochar from aqueous solution**



**Fig. S1** The images of the magnetic separation of the MB-600 after use.



**Fig.S2** The zeta potential value of the MB-600℃.



**Fig.S3** The Cr6+ adsorption data fitting intraparticle diffusion model.



**Fig.S4** The reusability results of MB-600℃ after three cycle.



**Fig.S5** The calculated result of -COOH, -OH, and Fe-O groups interactions with Cr6+.



**Fig.S6** Breakthrough curve for Cr6+ adsorption.

**Table S3** The maximum adsorption capacity of similar adsorbents forCr6+ **r**emoval from wastewater.

|  |  |  |
| --- | --- | --- |
| Adsorbents | Maximum adsorptioncapacity (mg/g) | References |
|  | Cr6+ |  |
| Cassava root biochar/ZnO | 28.37  | [[1](#_ENREF_1)] |
| nZVI/sewage sludge co-pyrolyzed magnetic biochar | 13.27 | [[2](#_ENREF_2)] |
| Carbon nano-onions  | 27.86 | [[3](#_ENREF_3)] |
| ZnO/ZnS/corn stover biochar  | 24.5 | [[4](#_ENREF_4)] |
| CTAB-Peanut shell biochar | 22.93 | [[5](#_ENREF_5)] |
| Ball milled Fe0-biochar | 14.59  | [[6](#_ENREF_6)] |
| Magnetic biochar | 42.7 | [[7](#_ENREF_7)] |
| Zn/iron-based sludge/biochar | 27.04 | [[8](#_ENREF_8)] |
| MC/nano-Fe3O4@PPy | 35.68 | [[9](#_ENREF_9)] |
| biochar-based iron oxide composites | 24.37  | [[10](#_ENREF_10)] |
| N-doped Fe3O4/carbon | 30.14 | [[11](#_ENREF_11)] |
| FeOOH-coated ϒ-Fe2O3 | 16.0 | [[12](#_ENREF_12)] |
| Fe3O4/C | 15.24 | [[13](#_ENREF_13)] |
| MB-600℃ | 30.41 | This work |

**Table S4** Fixed bed models and corresponding parameters.

|  |  |  |
| --- | --- | --- |
| Model | Equations | Parameters |
| Thomas |  | *KTh* (mL min-1 mg-1) is the Thomas constant, *qth* (mg g-1)is the maximum adsorption capacity, *M* (mg) is the weight of PFMC, *V* (mL min-1) is the inlet flow. |
| Yoon-Nelson |  | KYN (min-1) is the Yoon-Nelson constant and t0.5 (min) is the time required for 50% breakthrough. |

**Table S5** Parameters and coefficients of determination obtained for Thomas and Yoon-Nelson models.

|  |  |  |
| --- | --- | --- |
| Models | Parameters | Pb(II)  |
|  | qth (mg g-1) | 56.64 |
| Thomas | KTh (mL min-1 mg-1) | 0.00064 |
|  | R2 | 0.9505 |
| Yoon-Nelson | T0.5% (min) | 97.23 |
|  | KYN (min-1) | 0.0013 |
|  | R2 | 0.9560 |

**Table S6** The total production cost of the MB-600℃

|  |  |
| --- | --- |
| Item | Cost |
| Feedstock | $50,000/year |
| Processing Labor | $8,000/year |
| Electricity purchased | $10,000/year |
| Maintenance | $15,000/year |
| Consumables | $9,500/year |
| Pyrolysis machinery depreciation | $30,000/year |
| FeCl3 cost  | $621, 546/year |
| Production cost of MB-600℃ | $2.48/1kg |

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