**Supplementary data**

**Occurrence of Contaminants in Drinking Water Sources and the Potential of Biochar for Water Quality Improvement: A Review**

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Table S1. Adsorption capacity of different biochar for microbial, inorganic, and organic contaminants in aqueous solutions.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Order** | **BC feed stock****Pyro.temp. (oC)/ duration**  | **BC treatment** | **Used BC quantity** | **Used method (technique)** | **Contaminant** | **Initial conc. of adsorbate** | **Adsorption capacity** | **References** |
|  |   |   |   |   | **Inorganic** |   |   |   |
| 01 | Spent mushroom compost500/2h | Aluminum hydroxide-coated BC | 0.4–8.0 g/L | Batch adsorption experiments | Fluoride | 5–100 mg/L (pH 6.0–8.0) | 36.5 mg/g | (Chen et al., 2016) |
| 02 | Woody yard wastes500/15h | Original BC | 25g/L | Batch adsorption experiments with permeable reactive barriers | Copper | 2 - 500 mg/L | 7.51 mg/g | (Beiyuan et al., 2017) |
| Zinc | 2.44 mg/g |
| Lead | 10.2 mg/g |
| 03 | Bagasse300/2h | BC+polysulfone mixed matrix hollow fiber membrane | 0.5g/L | Batch adsorption experiment with mixed matrix membrane technique | Copper | 12.8 mg/L (pH 5) | 24.47 mg/g | (He et al., 2017) |
| Lead | 0.21 mg/L (pH 5) | 79.76 mg/g |
| 04 | Sewage sludge 400/2h | Magnetic BC, Fe2+/Fe3+ plus SO42-solution without ZnCl2 | 2 g/L | Batch adsorption experiments | Lead | 20-1000 mg/L | 99.85 mg/g | (Ifthikar et al., 2017) |
| Magnetic BC, Fe2+/Fe3+ plus SO42-solution with ZnCl2 | 249 mg/g |
| 05 | Douglas fir 900-1000/1-10 s | Original BC | 2 g/L | Batch adsorption experiments | Lead | 10 – 250 mg/L (pH 5) | 37.7 mg/g (25oC) | (Karunanayake et al., 2018) |
| 38.2 mg/g (35oC) |
| 39.8 mg/g (45oC) |
| Cadmium | 14.6 mg/g (25oC) |
| 15.7 mg/g (35oC) |
| 16.0 mg/g (45oC) |
| Fe3O4-magnetized BC | Lead | 26.0 mg/ (25oC) |
| 26.0 mg/g (35oC) |
| 26.8 mg/g (45oC) |
| Cadmium | 11.0 mg/g (25oC) |
| 11.1 mg/g (35oC) |
| 11.3 mg/g (45oC) |
| 06 | Water hyacinth 250/1h | Fe2/Fe3 Co-precipitated magnetic BC | 1:200 (solid: solution v/v) | Batch adsorption experiments | As(V) |  2 -105 mg/L (pH 5.3) | 7.41 mg/g | (Zhang et al., 2016) |
|
| 07 | Hickory chips 600/2h | Fe-impregnated BC | 2g/L | Batch adsorption experiments | As(V) |  0.1- 55 mg/L (pH ~5.8) | 2.16 mg/g | (Hu et al., 2015) |
| 08 | Chestnut shell450/2h | Magnetic gelatin-modified BC | 0.4g/L | Batch adsorption experiments | As(V) | 0.2–50 mg/L (pH 4) | 43.15 mg/g (25oC) | (Zhou et al., 2017) |
| 46.89 mg/g (35oC) |
| 49.15 mg/g (45oC) |
| 09 | Oak wood ~500/NA | Original BC | 1 g/L | Batch adsorption experiments | As (III)  | 0.05-7.0 mg/L(pH 7.0) | ~3.16 mg/g | (Niazi et al., 2017b) |
| As(V) | 0.05-7.0 mg/L (pH 6.0) | ~3.89 mg/g |
| 10 | Perilla leaves 300/NA | Original BC | 1 g/L | Batch adsorption experiments | As (III) | 0.05-7.0 mg/L (pH ~7.0) | ~ 4.71 mg/g | (Niazi et al., 2017a) |
| Perilla leaves 700/NA | As (III)  | ~11.01 mg/g |
| Perilla leaves 300/NA | As (V) | ~3.85 mg/g |
| Perilla leaves 700/NA | As(V) |  ~7.21 mg/g |
| 11 | NA | Fe2O3 supported CNT | 0.5 g/L | Batch adsorption experiments | Sb (III) | 1.5 mg/L (pH 7) | 6.23 mg/g | (Yu et al., 2013) |
| 12 | Pine sawdust 300/2h | Original BC | 3 g/L | Batch adsorption experiments | Ammonium | 10 - 100 mg/L (pH 7) | 5.38 mg/g | (Yang et al., 2017) |
|  | Pine sawdust 550/2h | 3.37 mg/g |
|  | Wheat straw 550/2h | 2.08 mg/g |
| 13 | Hickory chips 600/1h | Sodium dodecyl benzene sulfonate modified CNT-BC nanocomposites  | 2mg/L | Batch adsorption experiments | Lead | 40 mg/L | 15.2 mg/g |  (Inyang et al., 2015) |
|  | Sugarcane bagasse600/1h | 13.7 mg/g |
| 14 | Orange peel 250/6h | Magnetic BC |  NA | Batch adsorption experiments | Phosphate | 0-12 mg/L | 0.512 mg/g | (Chen et al., 2011) |
|  | Orange peel 400/6h | 0.219 mg/g |
|  | Orange peel 700/6h | 1.24 mg/g |
| 15 | Corn straw 400/2h | Iron modified BC | 1g/L | Batch adsorption experiments | Phosphate | 2.2- 12 mg/L | 0.56 mg/g | (Liu et al., 2015) |
| 16 | Pine sawdust 300-500/2h | Steam activated BC | 2 g/L | Batch adsorption experiments | Phosphate | 0-40 mg/L (pH 7) | 1.0 -1.4 mg/g | (Lou et al., 2016) |
| 17 | Conocarpus green waste 600/4h | Original BC | 10 g/L | Batch adsorption experiments  | Nitrate | 1–200 mg/ L (pH 6) | 16.47 mmol/kg | (Usman et al., 2016) |
| MgO-BC | 45.36 mmol/kg |
| FeO-BC | 20.27 mmol/kg |
|  |   |   |   |   | **Organic** |   |   |   |
| 18 | Water hyacinth/350 | Original BC | 2-10 mg/L | Batch adsorption experiments | Caffeine | 5 mg/L | 2.488 mg/g | (Ngeno et al., 2016) |
| 19 | Douglas fir/ 900–1000 | MagneticBC | 2 g/L | Batch adsorption experiments | Salicylic acid | 25-500 mg/L | 89.91 mg/g (15oC)92.42 mg/g (25oC)96.17 mg/g (35oC)108.78 mg/g (45oC) | (Karunanayake et al., 2017) |
| 20 | Pine wood/425 | Original BC | 4 g/L | Batch adsorption experiments | Salicylic acid | 25 - 100 mg/L | 7.56 mg/g (25oC)16.84 mg/g (35oC)22.70 mg/g (45oC) | (Essandoh et al., 2015) |
| 21 | Switchgrass425/1h | Original BC | 2 g/L | Batch adsorption experiments | Metribuzin  | 40–400 mg/L | 151 mg/g (25oC) | (Essandoh et al., 2017a)  |
| 223 mg/g (35oC) |
| 206 mg/g (45oC) |
| Magnetic switchgrass BC | 155 mg/g (25oC) |
| 205 mg/g (35oC) |
| 155 mg/g (45oC) |
| 22 | Tea waste/700Tea waste/700Burcucumber/700Oak wood/400Bamboo/400 | Original BCSteam activationOriginal BCOriginal BCOriginal BC | 2.5g/L | Batch adsorption experiments | 2,4-Dichlorophynoxy acetic acid | 10-500 mg/L(pH 7) | 10.05 mg/g58.85 mg/g42.67 mg/g26.66 mg/g28.92 mg/g | (Mandal et al., 2017) |
| 23 | Switchgrass425/60s | Original BC | 1 g/L | Batch adsorption experiments | 2,4-Dichlorophenoxy acetic acid | 25-400 mg/L | 133 mg/g (25oC) | (Essandoh et al., 2017b) |
| 134 mg/g (35oC) |
| 129 mg/g (45oC) |
| 2-methyl-4-chlorophenoxyacetic acid | 50-150 mg/L  | 38.31 mg/g (25oC) |
| 50.01 mg/g (35oC) |
| 50.01 mg/g (45oC) |
| 24 | Bamboo380/2h |  H3PO4-modified BC | 0.1g/L | Batch adsorption experiments | Sulfathiazole | 0.5–50 mg/L | 237.71 mg/g | (Ahmed et al., 2017) |
| Sulfamethazine | 65.74 mg/g |
| Sulfamethoxazole  | 88.1 mg/g |
| 25 | Orange peel 250/6h | Original BC |  NA | Batch adsorption experiments | Naphthalene | 0.02-0.95$ | 2.99 mg/g | (Chen et al., 2011) |
|  | Orange peel 400/6 h | Original BC | 9.39 mg/g |
|  | Orange peel 250/6 h | Magnetic BC | 0.835 mg/g |
|  | Orange peel 400/6 h | Magnetic BC | 23 mg/g |
|  | Orange peel 250/6 h | Original BC |  p-nitrotoluene | 0.01 to 0.91$ | 7.44 mg/g |
|  | Orange peel 400/6 h | Original BC | 29.7 mg/g |
|  | Orange peel 250/6 h | Magnetic BC | 2.22 mg/g |
|  | Orange peel 400/6 h | Magnetic BC | 43.4 mg/g |
| 26 | Bamboo 550/NA | Original BC | 75 g/L | Batch adsorption experiments | Furfural | 5000 mg/L -20000 mg/L | 109.17 mg/g | (Li et al., 2014) |
| Oxidation by KMnO4 | 93.55 mg/g |
| Oxidation by HNO3  | 96.34 mg/g |
| Treated with NaOH | 102.04 mg/g |
| Heat treatment  | 253.16 mg/g |
| 27 | Rice husk 300/3h | Original BC | 1 g/L | Batch adsorption experiments | Carbofuran  | 5-100 mg/L (pH 5) | 30.73 mg/g | (Mayakaduwa et al., 2016) |
|  | Rice husk 500/3h |   | 48.75 mg/g |
|  | Rice husk 700/3h |   | 132.87 mg/g |
|  | Rice husk 700/3h | Steam activated BC |   | 160.77 mg/g |
| 28 | Hickory chips 600/1h | Sodium dodecyl benzene sulfonate modified CNT-BC nanocomposites  | 2g/L | Batch adsorption experiments | Sulfapyridine  | 20 mg/L  | 27.9 mg/g | (Inyang et al., 2015) |
|  | Sugarcane bagasse600/1h | 19.36 mg/g |
| 29 | Castor oil cake400/1h | HNO3 activated BC | 10% BC (w/w) | Carbon paste modifiedelectrode with BC activated by HNO3 (drinking water) | Methyl parathion | 1.0 × 10−4 mol/L (pH 5) | 0.76 μA L/μmol# | (de Oliveira et al., 2017) |
| Original BC | 0.46 μA L/μmol# |
| 30 | Grass straw 400/1h | Original BC | 0.005-0.2g/L | Batch adsorption experiments | Phenanthrene | 0.002–1.10 mg/L | 3.89 - 5.33 mL/g Ɨ | (Jin et al., 2017) |
| Oxidizion by HNO3 | 4.25 - 5.67 mL/g Ɨ |
| Animal waste 400/1h | Original BC | 3.51 - 5.56 mL/g Ɨ |
|  | Oxidizion by HNO3 | 2.70 - 5.39 mL/g Ɨ |
| 31 | loblolly pine chips with bark300/15min | NaOH activated oxygen-based BC | 0.005-0.05g/L | Activated BC-ultrafiltration hybrid system | Humic acid | 5 mg/L | 1.230 mg/g | (Chu et al., 2017) |
| NaOH activated nitrogen-based BC | 1.306 mg/g |
|  |  |   |   |   | **Microbial** |   |   |   |
| 32 | Willow wood300/NA | HCl treated BC | 25g/L | Batch adsorption experiments | Deoxyribonucleic acid (DNA)  | 20 - 40 mg/L | 1.89 mg/g | (Wang et al., 2014) |
|  | Willow wood400/NA | 2.52 mg/g |
|  | Willow wood 500/NA | 5.73 mg/g |
|  | Willow wood600/NA | 5.15 mg/g |

BC: Biochar

NA: Not Available

# Electrode sensitivity

ƗlogKd (Kd = solid phase concentrations of sorbate/ solution phase concentrations of sorbate)

$Relative initial concentrations = initial concentration/aqueous solubility

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