Application of natural polysaccharide-based hydrogel materials in heavy metal pollution in water environment

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Introduction

- Heavy metal pollution, such as **Cu(II) but not other priority toxic heavy metal**, yet becomes lake water security problem not admitting ignoring.
- Hydrogels are 3D polymer networks that gain increasing attention over applications in water treatment due to their **broadly tunable physicochemical features.**
- **Wide source, easy availability,** etc. raw materials from agricultural and forestry solid waste.
- Traditional polysaccharide -based hydrogels still have **defects in terms of intrinsic properties**

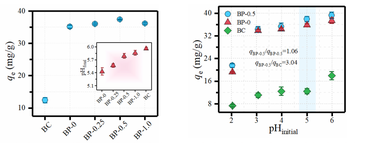
Methodology

- **The main raw materials of hydrogels**: high or Low esterified pectin extraction from grapefruit peel, grapefruit peel biochar or pectin extract residue biochar before and after ball-milling and commercial sodium alginate. The above mixture was dropped into $CaCl_2$ solution for gelation, **the primary ion-crosslinkage combined with hydrogen bonding, and hydrophobic bonding,** etc. contributed to the formation of a 3D network structure.
- Factors like component contents of biochar and pectin, pH, contact time, adsorbate concentration and coexisting substances were systematically investigated in batch and dynamic modes.

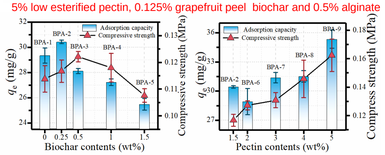
Waste control by waste

Results

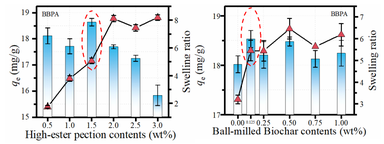
5% low esterified pectin, 0.25% grapefruit peel biochar

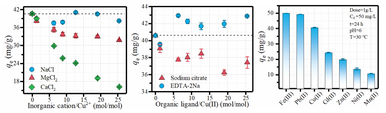


5% low esterified pectin, 0.125% grapefruit peel biochar and 0.5% alginate



1.5% high esterified pectin, 0.125% ball-milled pectin extraction residue biochar and 1.0% alginate



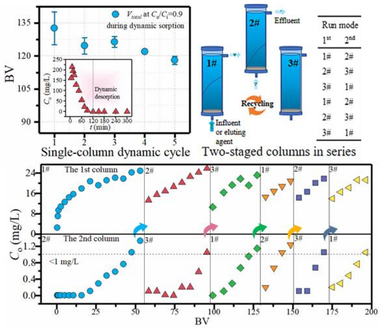


- The optimized conditions of BPA, BP and BBPA were obtained.
- The hydrogel sorbents showed better environmental adaptability. in the presence of inorganic salts or organic ligands as well as good adsorption potential for other heavy metal [e.g. Pb(II)]. Taking BPA as example.
- Crucially, the hydrogels showed good regeneration ability in batch or dynamic sorption experiments. Taking BP as example, in the column experiments, Cu(II) ions in the simulated Cu(II)-containing lake water could be effectively removed (<1 mg/L) using tandem two columns (two uses and one stand-by), with continuous treating196 BV (6658 mL) actually polluted lake water.

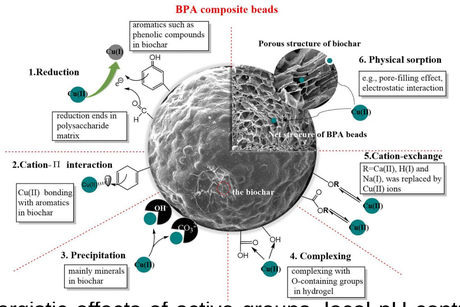
Table 1. Chemical properties of the raw lake water.

Na^+	Mg^{2+}	Ca^{2+}	Cu^{2+}	COD	TN	TP
23.20	9.28	23.84	N.A.[a]	14.83	0.73	0.04

[a] Not available in raw water while simulating it to 50 mg/L



Conclusions



- The synergistic effects of active groups, local pH control and porous effect are helpful for Cu(II) sorption.
- Biochar as a reinforcing filler, improved the mechanical and sorption performance of these hydrogel sorbents
- It proved that cation-exchange, complexation, reduction of Cu(II) to Cu(I), Cu-π bonding, micro-precipitation and porous-effect enhanced Cu(II) removal.

Acknowledgments

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References

[1] W. Zhang, et al., 2020. Novel pectin based composite hydrogel derived from grapefruit peel for enhanced Cu(II) removal. *J. Hazard. Mater.*, 384, 121445. ESI Highly Cited Paper

[2] W. Zhang, et al., 2021. Efficient heavy metal removal from water by alginate-based porous nanocomposite hydrogels: The enhanced removal mechanism and influencing factor insight, *J. Hazard. Mater.*, 418, 126358.